3.12 SEPARATION CRITERIA FOR SAFETY RELATED MECHANICAL AND ELECTRICAL POWER EQUIPMENT

3.12.1 INTRODUCTION

This section describes the various separation criteria utilized in the design of mechanical and electrical safety related systems and auxiliary support systems; outside of the NSSS scope delineated in Section 7.1

3.12.2 MECHANICAL SYSTEMS

The mechanical safety related auxiliary support and safety related systems to which the separation criteria apply are identified in Table 3.12-1 and Table 3.12-2. Mechanical descriptions of the systems covered by this section are given in Chapters 6 and 9.

3.12.2.1 Criteria

3.12.2.1.1 General Criteria

Redundant systems are separated from each other so that single failure of a component or channel will not interfere with the proper operation of its redundant/diverse counterpart.

The affected mechanical systems and equipment are separated so that systems important to safety are protected from the following hazards:

a) The pipe break dynamic effects outlined in Section 3.6.

b) Environmental effects as a result of pipe breaks and as outlined in Section 3.11

c) Flooding effects as a result of pipe breaks and as outlined in Section 3.4.

d) Missiles as defined in Section 3.5.

e) Fires capable of damaging redundant mechanical safety equipment.

The need for adequacy of separation to protect the safety equipment from the above hazards are determined in conjunction with the criteria specified in Sections: 3.4 (flood protection), 3.5 (missile protection), 3.6 (pipe rupture), 3.11 (environmental design), and the Fire Protection Review Report.

3.12.2.1.2 Svstem Separation Criteria

Piping from a redundant safety system is run independently of its counterparts, unless it can be shown that no single credible event, e.g., LOCA, is capable of causing piping failure that could prevent reactor shutdown. Supports and restraints of redundant mechanical components and piping are not shared, unless such sharing does not significantly impair their ability to perform their safety function.

Penetrations to the primary containment are separated or other adequate provisions are made so that the initial break of one piping branch of a system does not render its redundant counterpart(s) inoperable.

3.12.2.1.3 Phvsical Separation Criteria

Mechanical equipment and piping are separated from each other so that single failure of a device or component will not interfere with the proper operation of its redundant counterpart.

3.12.2.2 Separation Techniques

The methods used to protect redundant Auxiliary Support Systems from the above hazards (Subsection 3.12.2.1.1) fall into four categories of separation techniques: plant arrangement, barriers, spatial separation, and alternatives.

a) Plant Arrangement

A basic design consideration of plant layout is that redundant divisions of a safety system should not share common equipment areas. However, equipment common to a particular safety system division can share a common area if that equipment does not constitute a hazard within itself to another safety system of the same division.

Failure of any non-safety related structure, system, or component shall not result in failure of any safety related structures, system, or component.

To accomplish Auxiliary Support Systems separations through plant arrangement, redundant division of a safety system may be placed in different compartments or even on different elevations. Non-safety equipment, components, or piping should not be run above safety equipment unless they are adequately restrained or it can be demonstrated that failure will not impair function of the safety equipment.

b) Barriers

Barriers are most often used in restricted areas where a particular hazard (e.g., small turbine missiles) is more easily identified or where other techniques are inappropriate (e.g., separation between control boards). Separation by barriers is an extension of separation by the use of compartments in plant arrangement. Separation was also accomplished through the use of suitably designed equipment that in itself acts as a barrier. In many cases, the barrier may enclose the hazard (e.g., a compartment around a high speed turbine driven pump) in lieu of effecting a direct separation between redundant systems.

c) Spatial Separation

Spatial separation is another method of separating redundant safety systems and protecting them from the hazards described in Subsection 3.12.2.1.1.

For example, in areas where a barrier would be impractical, piping has been rerouted so that jet impingement resulting from a break would be dissipated by the distance traveled. In this example, partial barriers or restraints could also be used, as well as by hardening design (e.g., heavier housing construction) of system components within the hazard area. When it can be shown that a hazard would have only a certain sphere of effectiveness (e.g., for pipe whip, a rotation about a plastic hinge at the next restraint), spatial separation was considered adequate.

d) Alternatives

When one of the above techniques is impractical, a suitable alternative was used, some of which were additional restraints, hardening design, or temporary system isolation under accident conditions. When the redundant safety component cannot be held safe from common hazards by the alternatives outlined above, more resistant components were selected. An example would be the use of high pressure piping in a low pressure safety system to ensure its ability to withstand the effect of a break in adjacent high pressure lines.

3.12.3 ELECTRICAL SYSTEMS AND EQUIPMENT SEPARATION CRITERIA

Electrical and actuation systems are described in detail in Chapters 8 and 7, respectively.

3.12.3.1 Affected Svstems

The electrical portions of the systems identified in Tables 3.12-1 and 3.12-2 are designed to the criteria of Subsection 3.12.3.2. Equipment covered by the requirements in this Subsection include: instrument channels, trip systems, and trip actuators.

3.12.3.2 General Criteria

The resulting installations satisfy the criteria of IEEE 279-1971, 10CFR50 Appendix A, General Design Criteria 3, 17, and 21, as further clarified and limited below. The affected electrical systems and equipment are separated such that systems important to safety are protected from the following hazards:

a) Fires in cable raceways due to an electrical fault that could cause failure of insulation on other cables.

b) Mechanical damage of electrical equipment in a single location.

c) Single Design Base Event (DBE) should not disable essential automatic or manual protective function, i.e., reactor scram, primary containment isolation, core cooling, etc.

Identification

Identification and division/channels conform to the following:

a) Panels and racks, not part of the PGCC, are labeled with distinctive marker plates. The marker plates include identification of the proper division/channel, as listed in Table 3.12-1.

b) Junction and/or pull boxes, not part of the PGCC, have identification similar to and compatible with the panels and racks considered above.

c) Cables external to cabinets and/or panels, not part of the PGCC, are marked to distinguish them in color from other cables and to identify their separation division/channel as applicable.

d) Raceways, not part of the PGCC, identified as described in Subsection 3.12.3.4.2.1.b.

e) For PGCC panels and racks refer to Section 7.1.2a.3.

f) For cables external to panels and racks but within the PGCC, refer to Section 7.1.2a.3.

3.12.3.3 Svstem Separation Criteria

See Section 7.1.2a.3.

3.12.3.4 Electrical Phvsical Separation Criteria

3.12.3.4.1 General Separation Criteria

Methods of Separation

The separation of circuits and equipment is achieved by separate safety class structures, distance, or barriers, or any combination thereof.

Compatibilitv with Mechanical Svstems

Class 1E circuits are routed and/or protected such that failure of related mechanical equipment of one redundant system cannot disable Class 1E circuits or equipment essential to the operation of the other redundant system(s).

Racewav Sharing of Class 1E and non-Class 1E Circuits

See Subsection 8.1.6.1.

3.12.3.4.2 Specific Separation Criteria

3.12.3.4.2.1 Cables and Racewavs

a) General

The minimum separation distances specified in paragraphs d) and e) are based on open ventilated trays. Where these distances are used to provide adequate physical separation:

1) Cable splices in raceways are prohibited
2) Cables and raceways involved are flame retardant
3) The design basis is that the cable trays will not be filled above the side rails
4) Hazards will be limited to failures or faults internal to the electric equipment or cables.

In areas where the raceway separation criteria cannot be met due to physical limitation, each circuit in the raceway is to be analyzed to assure that the Class 1E function is not degraded to an unacceptable level. The specific analysis of each case is documented by a controlled document.

b) Identification of Non-PGCC Cables and Racewavs

Exposed Class 1E raceways are identified in a distinct and permanent manner at intervals not to exceed 15 ft. In addition, these raceways are also identified where

they pass through walls and/or floors, and enclosed areas. Class 1E raceways are identified prior to the installation of their cables.

Cables installed in these raceways are identified with the separation group color at intervals not exceeding 5 ft. to facilitate initial verification that the installation conforms to the separation criteria. These cable identifications are applied prior to or during their installation.

Class 1E cables are identified by a permanent marker at each end in accordance with the design drawings or cable schedule.

Color coding is used to meet the above requirements and to distinguish between redundant Class 1E cables and non-Class 1E cables.

c) Identification of PGCC Cables and Racewavs

Refer to Subsection 7.1.2a.3.2.

d) Cable Spreading Areas/Control Structure Complex

The control structure complex consists of two elevations of relay rooms, two cable spreading areas, and the main control room. Below the main control room is the lower cable spreading room, which facilitates cable convergence from the computer room and the lower relay rooms (which are below the lower cable spreading room) to the general plant areas, and to the cable entrance areas at the bottom of the control room panels. The lower relay rooms consist mainly of control and instrument panels of non-Class 1E systems and one division (i.e., Division II) of redundant systems as listed in Subsection 3.12.3.1. The main control room panels are mounted on a raised floor assembly with cable trays and wireways that enter the bottom of the main control room panels. Above the main control room are the upper relay rooms and the upper cable spreading area. The upper cable spreading area facilitates cable convergence from the upper relay room to the general plant areas, to the top of the main control room panels and to the control room raised floor. The upper relay room consists mainly of control and instrument panels of non-Class 1E systems and the other division (i.e., Division I) of the redundant systems listed in Subsection 3.12.3.1. The relay room panels and cabinets are integrated with a module type floor assembly with lateral and longitudinal ducts that act as raceways and barriers. The cabling interface between the PGCC and the spreading area is made at termination cabinets on the periphery of the relay room floor assemblies.

The relay rooms and spreading room areas do not contain high energy equipment (such as switchgear, transformers) or potential sources of missiles or pipe whip and are not used for storing flammable materials.

Circuits in the relay room and main control room are limited to control functions, instrument functions, and those power supply circuits and facilities serving the main control room and instrument systems.

Where for operational reasons redundant channel/division Class 1E cables are not separated by different safety class structures (e.g., two relay rooms and spreading areas), the minimum separation distance between the redundant Class 1E cable trays is 1 ft. horizontally and 3 ft. vertically. Where 1 ft. horizontal separation is not possible, one of the two following requirements is met: a fire barrier is placed between the redundant cable trays 1 ft. above the trays or to the ceiling; or cables of each channel/division are installed in rigid steel conduit or totally enclosed raceway up to a point where the 1 ft. spacing requirement is met. Where cables of redundant channel/divisions must be stacked one above the other with less than 3 ft. vertical spacing, one of the following requirement is met: a) a fire barrier is placed between the trays and extended to 6 in. of each side of the tray system or to the wall, or b) a solid steel tray cover is installed on the lower cable tray and the upper tray has a solid bottom up to a point where 3 ft. vertical separation is met; or c) the cables of each redundant channel/division are installed in rigid steel conduit or totally enclosed raceway to a point where the 3 ft. vertical separation exists. The minimum separation distance between these rigid steel conduit and totally enclosed raceway is 1 inch, except as noted in Section 8.1.6.1 (Regulatory Guide 1.75 (1/75), Part 7).

Separation requirements between Class 1E trays and non-Class 1E trays are the same as separation of redundant channel/division, except that the minimum separation distance between Class 1E tray and non-Class 1E conduit or totally enclosed raceway is 1 inch.

Free air temporary cables can be installed with no separation distance from totally enclosed Class 1E raceways. Temporary cables are non-Class 1E and have a specified removal date or removal event. Tests have demonstrated the acceptability of a single solid metal cable cover as a barrier when the worst case electrical fault occurs to a cable resting on the metal cable tray cover. The cables inside the cable tray maintained their functional capability during the testing.

Permanent free air telephone (PABX) cables can be installed with a separation distance of one-foot horizontal and three-foot vertical from Class 1E ventilated cable tray. Physical separation between the permanent free air telephone (PABX) cables and Class 1E enclosed raceway shall be 6 inches. Tests have demonstrated the acceptability of a single solid metal conduit as a barrier when the worst case electrical fault occurs to a cable resting on the barrier. The cables inside the conduit maintained their functional capability during the test[jcb1]

In confined spaces, where fire barriers cannot be installed, lesser separation distance between open trays than those specified above shall be allowed in the following areas that are protected by ionization type detectors with total flooding or

manual spurt CO_2 suppression systems. (Refer to Fire Protection Review Report, Table 6.1-1, "SSES Fire Areas" for room numbers and fire zones.) Examples of confined spaces are:

1) Cable chases/soffits

2) Raised floor section

e) General Plant Areas

In plant areas from which potential hazards such as missiles, external fires, and pipe whip are excluded, the minimum separation distance between redundant Class 1E cable trays is 3 ft. between trays separated horizontally if no physical barrier exists between trays. If a horizontal separation of less than 3 ft. exists, alternate methods as stated in paragraph d) above are required. Vertical stacking of trays is avoided wherever possible; however, where cable trays of redundant channel/divisions are stacked, a minimum vertical separation distance of 5 ft. is required, or alternate methods as stated in paragraph d) above are required. Where a cross-over of one tray over another carrying redundant channel/division is made, and minimum vertical separation distance cannot be maintained, one of the following requirements is met; a) a solid cover is installed on the lower tray to extend 1 ft. 0 in. minimum either side of the upper tray, b) fire barriers are installed minimum 1 in. from the upper tray and extend 1 ft. 0 in. minimum beyond the crossing tray.

Separation requirements between Class 1E and non-Class 1E trays are the same as separation of redundant channel/division, except that the minimum separation distance between Class 1E tray and non-Class 1E conduit or totally enclosed raceway is 1 inch.

Free air temporary cables can be installed with no separation distance from totally enclosed Class 1E raceways. Temporary cables are non-Class 1E and have a specified removal date or removal event. Tests have demonstrated the acceptability of a single solid metal cable cover as a barrier when the worst case electrical fault occurs to a cable resting on the metal cable tray cover. The cables inside the cable tray maintained their functional capability during the testing.

Permanent free air telephone (PABX) cables can be installed with a separation distance of one-foot horizontal and three-foot vertical from Class 1E ventilated cable tray. Physical separation between the permanent free air telephone (PABX) cables and Class 1E enclosed raceway shall be 6 inches. Tests have demonstrated the acceptability of one-foot horizontal and three-foot vertical distances to prevent migration of electrical faults from the low energy free air telephone cables to the Class 1E cables. Tests also have demonstrated the acceptability of a single solid metal conduit as a barrier when the worst case

electrical fault occurs to a cable resting on the barrier. The cables inside the conduit maintained their functional capability during the test[jcb2].

f) Power Generation Control Complex - (PGCC)

Refer to Subsection 7.1.2a.3.3.6.

g) The Lighting Fixture Cords

The non-Class 1E lighting fixture cord connects a lighting fixture to a single phase, 277V power supply. The cord is a #14 AWG SO insulated cable (with grounding conductor) installed in free air carrying a maximum load current of 1.0 ampere. The minimum separation between the free air lighting fixture cord and a Class 1E open tray is 6 inches. If the above minimum separation cannot be satisfied, tray covers or conduits will be provided for the Class 1E raceway in the vicinity of the free air lighting fixture cord. The lighting fixture cord does not have sufficient combustible material or energy which could cause failure of the nearby Class 1E cables.

Non-Class 1E lighting conduits, containing a single circuit rated less than 300 VAC and 10 amp or 20 amp for receptacles, are treated as control conduits for separation purposes. The separation criteria is as stated in Section 8.1.6.1 (Regulatory Guide 1.75(1/75), Part 7). The lighting fixture cords, which are exposed in free air containing #12 AWG wires and about 3 to 5 feet in length, shall be maintained at 6" minimum separation from a Class 1E raceway.

h) An exception to the above subsections d) and e) is the 450 MHz radio antenna cable network.

The 450 MHz radio antenna is the plant security communication radio system (non-Class 1E). This system utilizes an antenna cable network installed exposed (not enclosed in raceway) on the cable raceway supports throughout the plant. The jacketing material of the antenna cable is flame retardant. The cable has been tested and passed IEEE 383 and ASTM Proc. D2633 part 30.

Separation between this antenna cable and other class 1E raceways is not required because:

1) The antenna cable is a low energy circuit. A short circuit of the antenna cable would not produce enough energy to cause degradation of any other circuits.

2) The antenna cable is not routed with any other cables.

3) The antenna cable jacket is made of flame retardant material.

4) The antenna cable does not terminate in close proximity or routed through any equipment with voltage level higher than 120V AC.

5) The maximum radio frequency (rf) power output level of the antenna cable is 37.5 watts.

6) Where redundant safe shutdown raceways are separated by less than 20 feet, fire barriers have been provided to protect one division per Fire Protection Review Report Section 4.11.

3.12.3.4.2.2 Standbv Power Supply

a) Emergencv Diesel Generators

Redundant Class 1E diesel generator units are located in separate safety class structures and have independent air and fuel supplies.

b) Auxiliaries and Local Controls

The auxiliaries and local controls for diesel generators are in the same safety class structure as the unit they serve, except for the Diesel Generator A, B, C and D fuel oil transfer pumps that are located in separate safety class structures at the fuel oil storage tanks (see Subsection 9.5.4).

3.12.3.4.2.3 DC Svstem

a) Batteries

Redundant Class 1E batteries are placed in separate safety class structures. The structures are served by redundant ventilation equipment.

b) Battery Chargers

Battery chargers and their respective switchgears are placed in separate safety class structures from their respective redundant Class 1E batteries.

3.12.3.4.2.4 Distribution Svstem

a) Switchgear

Redundant Class 1E distribution switchgear groups are placed in separate safety class structures.

b) Motor Control Centers

Redundant Class 1E motor control centers are physically separated in accordance with the requirements of Subsection 3.12.3.4.1.

c) Distribution Panels

Redundant Class 1E distribution panels are physically separated in accordance with the requirements of Subsection 3.12.3.4.1.

3.12.3.4.2.5 Primary Containment Electrical Penetrations

Redundant Class 1E primary containment electrical penetrations are physically separated in accordance with the requirements of Subsection 3.12.3.4.1. The minimum physical separation for redundant penetrations meets the requirements for cables and raceways given in Subsections 3.12.3.4.2.1through 3.12.3.4.2.6.

3.12.3.4.2.6 Main Control Room and Relay Room Panels

a) For NSSS panels see Subsection 7.1.2a.3.1.1.

b) All non-NSSS panels containing safety-related equipment and circuits are provided as follows:

1) Generally, panels are divisionalized (i.e., are devoted to one (1) division only) and are physically separated from the redundant division's panels.

2) In cases where redundant channel/division Class 1E circuits, or RPS and other Class 1E and non-Class 1E circuits are located in the same enclosure, physical separation is achieved by minimum of 6" spatial separation, steel barriers, metallic enclosure, or metallic flexible conduit.

Where the above separation methods are not feasible, one of the separation group circuits are to be covered with a qualified non-metallic barrier material. A description of the material and analysis to regulatory requirements is provided in Subsection 8.1.6.t.14 (Conformance to Reg. Guide 1.75).

3) All requirements for connection of control circuits between separated divisions are accomplished with MDR relays to provide positive isolation of the circuits.

4) All the annunciator and computer digital inputs are classified as non-Class 1E circuits. These circuits are not separated from the Class 1E circuits within the Class 1E panels in which the non-Class 1E input is

derived. The interface devices used in the Class 1E circuits to develop the annunciator and computer digital inputs are listed in Table 3.12-3. An analysis for each circuit in which these devices are used has shown that a failure mode which prevents the Class 1E circuits from meeting their minimum performance requirements does not exist. This is based upon the application/function of the interface devices in each individual circuit.

TABLE 3.12-1

ESP DIVISION SEPARATION

Division I	Division II
Core Spray Loop A	Core Spray Loop B
Automatic Depressurization System A	Automatic Depressurization System B
Residual Heat Removal Loop A	Residual Heat Removal Loop B
High Pressure Coolant Injection System (Inboard Valve)	High Pressure Coolant Injection System except the inboard steam line isolation valve
Reactor Core Isolation Cooling System except the inboard steam line isolation valve	Reactor Core Isolation Cooling System (Inboard Valves)
Nuclear Steam Supply Shutoff System (Inboard Valves)	Nuclear System Supply Shutoff System (Outboard Valves)
Recirculation Pump Trip Loop A	Recirculation Pump Trip Loop B
Emergency Service Water Loop A	Emergency Service Water Loop B
RHR Service Water Loop A	RHR Service Water Loop B
Containment Instrument Gas Loop A	Containment Instrument Gas Loop B
Containment Atmospheric Control System A	Containment Atmospheric Control System B
Standby Gas Treatment System Train A	Standby Gas Treatment System Train B
Reactor Building HVAC Isolation and Recirculation System A	Reactor Building HVAC Isolation and Recirculation System B

TABLE 3.12-1

ESP DIVISION SEPARATION

Division I	Division II
Drywell HVAC System A	Drywell HVAC System B
Control Structure HVAC System Train A	Control Structure HVAC System Train B
Control Structure Chilled Water System Loop A	Control Structure Chilled Water System Loop B
Battery Room Ventilation System A	Battery Room Ventilation System B
HVAC Coolers for Div I	HVAC Coolers for Div II
Standby liquid Control System Pumps A[(1)] and B[(1)] and Explosive Valves A[(1)] and B[(1)]	
Class 1E 250V DC Supply System I	Class 1E 250V DC Supply System II
480V Swing Bus and Associated Motor-Generator Set Div I	480V Swing Bus and Associated Motor-Generator Set Div II
Class 1E 480V AC MCCs	Class 1E 480V AC MCCs
Class 1E 120V AC Distribution Panels	Class 1E 120V AC Distribution Panels
Class 1E 125V DC Distribution Panels	Class 1E 125V DC Distribution Panels

[(1)]The redundant standby liquid control pumps and explosive valves are powered from different electrical buses.

TABlE 3.12-2

CHANNEl SEPARATION

Channel A	Channel B	Channel C	Channel D
Standby Diesel Generator & Auxiliaries A (Common to Units 1 and 2)	Standby Diesel Generator & Auxiliaries B (Common to Units 1 and 2)	Standby Diesel Generator & Auxiliaries C (Common to Units 1 and 2)	Standby Diesel Generator & Auxiliaries D (Common to Units 1 and 2)
Standby Diesel A Ventilation System (Common to Units 1 and 2)	Standby Diesel B Ventilation System (Common to Units 1 and 2)	Standby Diesel C Ventilation System (Common to Units 1 and 2)	Standby Diesel D Ventilation System (Common to Units 1 and 2)
Class 1E 4160 V Switchgear	Class 1E 4160 V Switchgear	Class 1E 4160 V Switchgear	Class 1E 4160 V Switchgear
Class 1E '80 V Load Center	Class 1E 480 V Load Center	Class 1E 480 V Load Center	Class 1E 480 V Load Center
Class 1E 480 V MCC (Common to Units 1 and 2)	Class 1E 480 V MCC (Common to Units 1 and 2)	Class 1E 480 V MCC (Common to Units 1 and 2)	Class 1E 480 V MCC (Common to Units 1 and 2)
Class 1E 125 V Distribution Panel	Class 1E 125 V Distribution Panel	Class 1E 125 V Distribution Panel	Class 1E 125 V Distribution Panel

Note:

Additionally, a fifth diesel generator is provided which can be manually realigned as a replacement for any one of the other four diesel generators. This fifth diesel generator has its own ventilation and electrical support systems.

When this fifth diesel generator is substituted for any one of the other four diesel generators, the fifth diesel generator and it's auxiliaries assimilate the separation channel of the diesel generator which was substituted.

TABLE 3.12-3

Main Control Room and Relay Panel Annunciator and Computer Interface Device

ANNUNCIATOR INTERFACE DEVICES	
Agastat Type EGP	GE Type HFA
Riley 86 T/C Monitor	P&B Type KH-4690
Westronics Recorder	Agastat Type E7000
GE Type CR2940 SW	GE Type 2820
Bailey 745 Alarm	P&B Type MDR
GE Type CR105	Agastat Type TR
C-H Type 10250T PB	GE Type HMA

COMPUTER INTERFACE DEVICES	
GE Type CR 105	Agastat Type E7024
GE Type HFA	P&B Type KH-4690
GE Type HMA	GE IRM Switch 216X494G19
Agastat Type EGP	