2.4 SAFE SHUTDOWN ANALYSIS

2.4.1 Introduction

Within this section, the term "safe shutdown" is used in the narrowly defined sense to refer only to achieving a safe shutdown condition following a fire. It is therefore used interchangeably with "post-fire safe shutdown".

2.4.1.1 Purpose

The purpose of this analysis is to demonstrate that for a fire in any single plant fire zone in the Braidwood plant, sufficient equipment will remain operational in other parts of the plant to achieve and maintain a safe shutdown condition in both units independent of that fire zone. For the purpose of this analysis, hot standby and cold shutdown are defined as follows:

a. Hot standby - A plant condition in which the reactor is subcritical with a shutdown margin per the Technical Requirements Manual, and the primary coolant system average temperature is greater than or equal to 350°F.

b. Cold shutdown - A plant condition in which the reactor is subcritical with a shutdown margin per the Technical Requirements Manual, and the primary coolant system average temperature is less than or equal to 200°F.

A safe shutdown condition is achieved by satisfying the following requirements:

a. maintain a condition of negative reactivity,

b. monitor and control the primary system coolant inventory and pressure,

c. remove decay heat,

d. provide process monitoring capability, and

e. provide essential support functions.

2.4.1.2 Analysis Criteria

The criteria used as a guideline for this safe shutdown analysis are that for a fire in any fire zone in the plant, sufficient redundant and/or diverse equipment will remain available to ensure that the capability to achieve safe shutdown still exists independent of equipment or systems located within or affected by the fire in the affected fire area/zone. The requirements listed above in Subsection 2.4.1.1 shall be satisfied.

A secondary goal of the analysis was to identify adjacent fire zones in the plant where the wall or barrier separating the two fire zones does not meet the separation requirements of Section C.5.b of BTP CMEB 9.5-1. For those cases, one of the following was provided: 1) a BTP CMEB 9.5-1 deviation was prepared for which justification for the existing separation is provided, 2) an evaluation was performed per the guidance of Generic Letter 86-10, which determined that the barrier is adequate to prevent the spread of fire such that redundant safe shutdown components are not adversely affected, or 3) the separation was upgraded to a justifiable level.

2.4.1.3 Evaluation Methodology

The evaluation methodology, which was utilized to conduct this safe shutdown evaluation, can be summarized as follows:

a. Systems, components, and instrumentation that could be used to satisfy the safe shutdown requirements listed in Subsection 2.4.1.1 were identified. Criteria and assumptions used to identify safe shutdown components are provided in following Subsection 2.4.1.4. The systems so identified are listed in Table 2.4-1, and the equipment and instrumentation so identified are listed in Table 2.4-2.

b. Once safe shutdown equipment and instrumentation had been identified, power, control and instrumentation cables necessary for the operation of this equipment and instrumentation were then identified. For equipment, the cables identified include power cables back to the primary source of power (the 4160V and 480V safety-related buses, MCCs, and the 125Vdc distribution buses), and all control cables necessary for proper functioning of the control circuit. For instrumentation, cables identified include power feeds from the instrument power buses, and signal cables to primary display locations (usually the main control room, the remote shutdown control panels, and/or the fire hazard panel). Cables associated with tertiary functions are not included. The detailed criteria used for the cable selection process are provided in following Subsection 2.4.1.5.

c. Once the list of safe shutdown cables was generated, the routing of each cable through the plant fire zones was identified. This was accomplished in the following manner. For the Byron/Braidwood plants, the cable tray system has routing points identified at frequent intervals. Each of these routing points was assigned the number of the fire zone in which it was located. A computerized database containing important cable data is maintained for all cables in the plant. For cables routed in the tray system, the routing points through which the cable passes are listed in the database. Using the routing point/fire zone correlation which was developed, the fire zones through which each safe shutdown cable passes were listed.

For cables routed wholly or partially in conduit, or in free air, the cable routings were manually checked, and all fire zones through which they passed were added to the previously generated list of fire zones for each cable. The cable data base is kept current and is updated periodically, thus, the routing information is current and representative of the as-built condition of the plant.

d. A logic model of the plant was developed to aid the analysts in performing the area analysis. The logic model is in the form of a fault tree. It incorporates each individual component from the safe shutdown equipment list, and associated cables, if any.

e. An area analysis was performed for each fire zone in the plant that contains safe shutdown components or cables. The logical model of the plant was used to identify each instance where components or cables located within a given fire zone are redundant to each other. Each such occurrence is evaluated to determine other acceptable means to satisfy safe shutdown requirements. The means of satisfying the safe shutdown requirements for each such occurrence is documented by identification of an “exception”. The “exceptions” provide the detailed rationale why the presence of redundant components or cables is acceptable from a safe shutdown viewpoint. Typical “exceptions” consist of the following items:
1) identification of a manual action to compensate for the postulated fire damage (e.g., manually operate a valve with its handwheel);
2) justification for existing physical separation as documented in a BTP CMEB 9.5-1 deviation or technical evaluation per the guidance of NRC Generic Letter 86-10; or 3) fire proofing of potentially affected cables.

2.4.1.4 Identification of Safe Shutdown Equipment

The philosophy used in generating the Byron/Braidwood safe shutdown equipment lists was to identify as much safety-related equipment as possible which could be available during and/or after a fire and utilized to perform the safe shutdown functions identified in Subsection 2.4.1.1. The result is that the list includes redundant and in some cases diverse equipment for performing each function. It also follows that not all of this equipment needs to be available to achieve safe shutdown following a fire in any plant fire zone.

The safe shutdown equipment list that has been generated for the Braidwood plant is presented below.

a. Systems which may be used by the operators to perform the safe shutdown functions of reactivity control, primary coolant system inventory and pressure control, decay heat removal, and provide essential support are listed in Table 2.4-1.

b. Equipment and instruments which may be used to accomplish the safe shutdown functions for both hot standby and cold shutdown are listed in Table 2.4-2. The equipment on this list includes redundant, and in some cases, diverse means of accomplishing the safe shutdown functions.

The safe shutdown component selection process and criteria are described below. Once the safe shutdown systems were identified, the P&IDs for those systems were reviewed to identify essential safe shutdown flowpaths and system boundaries.

Component selection was performed by reviewing the flowpaths to identify components which require operation/repositioning to accomplish the desired safe shutdown function. In addition, components whose fire-induced spurious operation could impair safe shutdown are identified. This includes normally open valves/dampers in the required flowpath whose spurious closure could prevent the required flow, and normally closed valves/dampers forming a system boundary whose spurious opening could divert flow from the desired flowpath.

The following guidelines were used to determine which components to include on the safe shutdown equipment list:

a. Components such as pumps and fans which require operation to accomplish the desired safe shutdown function are listed on the safe shutdown equipment list.

b. Valves or dampers in the identified safe shutdown flowpath whose spurious operation could adversely affect system operation are included on the safe shutdown equipment list. Manual valves or dampers requiring repositioning during the post-fire shutdown are also included. Manual valves/dampers/check valves which do not require manual actions during the post-fire shutdown are not required to be included.

c. Electrically operated/controlled valves or dampers constituting system boundaries are evaluated for spurious operation. If the spurious operation of a single valve or damper could have a significant adverse impact on the capability to achieve a safe shutdown function by diverting flow from the desired safe shutdown flowpath, then the valve or damper is included on the safe shutdown equipment list. When performing this evaluation, it is necessary to consider only a single spurious actuation. Normally closed manual valves and properly oriented check valves credited as system boundaries are not required to be included.

d. Manual drain, vent, and instrument root valves are not included on the safe shutdown equipment list.

e. Safety/Relief valves provided for equipment and piping protection are not included. However, safety/relief valves which provide an active safe shutdown function, such as main steam safety valves, or pressurizer power-operated relief valves, are included on the safe shutdown equipment list.

f. Loops or bypasses within a system where spurious operation would not result in a loss of flow or inadequate flow to safe shutdown flowpaths are not included in the safe shutdown equipment list.

g. For tanks, all outlet lines are evaluated for their functional requirements. For lines not required to be functional, a means of isolation is included when necessary to prevent unnecessary drawdown of the tank. Tank fill lines are also evaluated as necessary.

h. Steam traps in the safe shutdown flowpath, designed to remove condensate and trap steam, are not included in the safe shutdown equipment list. Based on this design function, steam exiting via these flowpaths is considered to have a negligible impact on RCS cooldown.

i. Solenoid pilot valves are not listed on the safe shutdown equipment list. The process valves with which the pilot valves are associated are identified on the safe shutdown equipment list. Cabling for the solenoid pilot valves is associated with the process valve component number.

j. Passive mechanical components such as tanks, heat exchangers and pressure vessels are specifically included on the list for completeness.

k. Fire dampers in the flowpath whose operation could adversely affect system operation, whether actuated by fusible links or electro-thermal links, are included on the list. Fire dampers actuated by electro-thermal links are evaluated for spurious operation.

l. Equipment that is not normally required for safe shutdown, but whose spurious operation could either prevent or have a significant adverse impact on the capability to achieve a safe shutdown function, is included on the safe shutdown equipment list.

Components for functions not involving mechanical/fluid flowpaths (e.g., process monitoring, essential power, support systems) were then identified. The following guidelines were used:

a. For the process monitoring function, the guidance provided in IE Information Notice No. 84-09 was considered in the identification of the minimum set of instruments that are required to monitor plant process variables.

b. Power supplies for safe shutdown components that require power to achieve their safe shutdown function are identified as safe shutdown components. Identification of power supplies includes both motive and control power sources.

c. Safe shutdown components typically are major components within a safe shutdown system, such as pumps, fans, valves, tanks, electrical busses, etc. The subcomponents such as panels, cabinets, control boards, solenoids, relays, switches, transmitters, etc. are not included on the safe shutdown equipment list. The circuits associated with these items are included via the cable selection criteria, and the cables are listed with the major safe shutdown components. Therefore, these subcomponents are implicitly accounted for in the analysis via identification of the electrical schematic diagrams and their identified safe shutdown cables.

d. Other diesel-backed support systems such as service water, component cooling water, HVAC, heat tracing, lubrication, and air systems are included in the safe shutdown equipment list if required for system support.

e. For the 4160Vac ESF switchgear busses, special selection criteria apply. Power feeds to these busses, and loads fed from these busses are controlled by air circuit breakers (ACBs). The fire-induced spurious closure of an ACB in conjunction with a fault on the feed cable or bus bar associated with that ACB could disable the bus. Therefore, all 4160Vac ACBs which are not associated with a safe shutdown component are specifically listed on the safe shutdown equipment list.

2.4.1.5 Cable Selection Criteria and Damage Assumptions

The criteria used to select safe shutdown cables for components identified on the safe shutdown equipment list, and the assumed failure modes and related assumptions are described in the following subsections.

2.4.1.5.1 Cable Selection Criteria

The method used to identify safe shutdown cables is described in the following paragraphs.

a. Review the safe shutdown equipment list to determine all safe shutdown components which are required to be evaluated. All electrically powered or electrically controlled components are identified. Passive mechanical components such as pressure vessels, tanks, heat exchangers and manual valves are excluded from the list of components to be evaluated.

b. For each component, review the applicable schematic diagram, single-line diagram, instrument loop schematic, wiring diagram, or vendor drawings, as required.

c. For electrically powered components, the power cable from the primary power supply for the component (e.g. 4160Vac or 480Vac safety-related buses or MCCs, or 125Vdc distribution panel) is identified as a safe shutdown cable if the component is an active component.

d. For electrically controlled components whose control circuits receive power from separate and specific power sources, the control power cables are identified as safe shutdown cables.

e. For electrically controlled components, each conductor in the control circuit is reviewed to evaluate the effect on the circuit of the four postulated failure modes (open circuit, short circuit, short to ground, hot short) described in the following subsection. If the effect of one or more of the failure modes is to render the component unavailable, or cause a spurious operation of the component, then the cable which carries that conductor is identified as a safe shutdown cable.

f. The following assumptions were made when evaluating safe shutdown component control circuit conductors for failures:

1) Components are assumed to be in their normal operating position.

2) All relay, position switch, and control switch contacts in the control circuit are assumed to be in the position that corresponds to the normal plant operating condition of that device unless specifically stated otherwise.

3) Test switches in the control circuits are assumed to be in their normal plant operating position.

4) Automatic logic interlocks from other circuits are assumed to be in a permissive position unless the circuits for the interlock are included in the safe shutdown cable selection for the component of concern, or the interlock is otherwise shown to be unaffected by fire.

5) Isolation switches in control circuits are analyzed in their expected positions. For control room operation, isolation switches are not operated and are assumed to be in the "REMOTE" position. For local operations, both "REMOTE" and "LOCAL" positions are considered, since the switches are initially in the "REMOTE" position, and will subsequently be placed in the "LOCAL" position. (The diesel generators are an example of a component that must be evaluated with the switches in both positions).

6) Annunciator alarm, metering, and instrument circuits and cables whose failure does not impact safe shutdown functions are not included in the safe shutdown equipment-cable list.

7) Associated circuits cables, as defined in Generic Letter 81-12 and clarified in a NRC Memorandum dated March 22, 1982, are identified unless manual actions are identified that mitigate the consequences of the postulated cable failure.

g. For instrumentation required for safe shutdown, power cables from the Instrument Buses to the required instruments were identified as safe shutdown cables. Also, instrument cables from the required instrument sensors to the required instrument indicators were also identified as safe shutdown cables.

h. The final product of the safe shutdown cable selection process is an equipment - cable list which lists required safe shutdown cables for each electrically powered and/or controlled safe shutdown component. The list includes appropriate annotations or notes to identify cables capable of causing spurious operation of the component, and for components with isolation switches, the list identifies cables which cause loss of local and/or control room control.

2.4.1.5.2 Cable Damage Assumptions

This subsection describes the basic assumptions made with regard to fire damage to electrical cables.

a. The insulation and external jacket material of electrical cables is susceptible to fire damage. Damage may assume several forms including deformation, loss of structure, cracking, and ignition. The relationship between exposure of electrical cable insulation to fire conditions, the failure mode, and time to failure may vary with the configuration and cable type. To accommodate these uncertainties in a consistent and conservative manner, this analysis assumes that the functional integrity of electrical cables is lost when cables are exposed to a postulated fire in a fire area, except where protected by a fire rated barrier within the fire area (or radiant energy shield within containment). Electrical cable failures are limited by the following considerations:

   1) Fire damage occurs throughout the fire area or fire zone under consideration.

   2) Fire damage results in an unusable cable that cannot be considered functional with regard to ensuring proper circuit operation.

b. Fire-induced damage to cables may cause the following types of failures:

   1) Open Circuit - An individual conductor that loses electrical continuity.

2) Short Circuit - An individual conductor that comes into electrical contact with another electrical conductor and bypasses the normal electrical load (i.e., relay coil, solenoid valve, motor, etc.), thereby resulting in a very high current flow.

3) Short to Ground - An individual conductor that comes into electrical contact with a grounded conducting device, such as a cable tray, conduit, or metal housing.

4) Hot Short - An energized conductor that comes into electrical contact with another conductor and bypassing control contacts in a circuit, thereby spuriously energizing the affected electrical load.

c. For components which do not form part of a high-low pressure interface between the RCS and a lower pressure system, credible circuit failures include multiple open circuits, short circuits, shorts to ground, and a single hot short on any one conductor within the control circuit. For these components, 3-phase ac power circuit cable-to-cable proper phase sequence faults and 2-wire ungrounded dc circuit cable-to-cable proper polarity faults are considered of sufficiently low likelihood that they are not assumed to be credible. This assumption is consistent with guidance provided in Generic Letter 86-10.

d. For components which do form part of a high-low pressure interface between the RCS and a lower pressure system, credible circuit failures include multiple open circuits, short circuits, shorts to ground, and multiple hot shorts within the control circuit. In addition, 3-phase ac power circuit cable-to-cable proper phase sequence faults and 2-wire ungrounded dc circuit cable-to-cable proper polarity faults are considered to be credible, and must be evaluated. The application of this assumption to high-low pressure interfaces is discussed in Section 2.4.3.

2.4.1.6 Associated Circuits and Other Electrical Issues

Associated circuits and other electrical issues that are relevant to BTP CMEB 9.5-1 are discussed in the following sections.

2.4.1.6.1 Common Power Source Associated Circuits

For the majority of ESF power supplies, this issue is addressed by providing coordinated circuit protection between the feed breakers for a supply and the load breakers fed by the supply. Calculations are available to demonstrate proper breaker coordination for these power supplies. The coordinated circuit protection ensures that the power supply will provide sufficient current to a faulted load to clear the load breaker prior to affecting the power supply feed breaker. Such coordination is demonstrated for the following ESF power supplies: 1) 4160Vac switchgear buses; 2) 480Vac unit substations; 3) 480Vac motor control centers; 4) 125Vdc distribution systems; and 5) 120Vac distribution panels located on some of the 480Vac ESF MCCs.

The interrupting device design is factory tested to verify overcurrent protection as designed in accordance with the applicable standards. The low and medium voltage switchgear (480V and above) circuit breaker protective relay will be periodically tested to demonstrate that the overall coordination scheme remains within the limits specified. The molded case circuit breakers will be periodically manually exercised and inspected to ensure ease of operation. In addition, a sample of these breakers will be periodically tested to determine that breaker drift is within the allowed according to the design criteria, and all the tests will be performed in accordance with an accepted industry testing program. In the instances where fuses are being used as interrupting devices, administrative controls will ensure that correct replacement fuses will be used. Therefore, a common source with the redundant shutdown equipment is always protected.

For the Braidwood station, one bifurcated feed is present between 480Vac switchgear bus 132X and motor control centers 132X3 and 132X5 (component id numbers 1AP12E, 1AP24E and 1AP32E, respectively). This is accounted for in the safe shutdown analysis by including the feed cables for both MCCs with the safe shutdown cable list for each MCC.

Coordinated circuit protection cannot be demonstrated for each unit's four 120 Vac instrument power buses between the main feed breakers and the load breakers. The 120Vac instrument bus distribution panels are normally powered from the 120Vac vital instrument inverters, which current limit at 150% of rated output current. This is accounted for in the safe shutdown analysis by including all of the cables fed from each 120Vac instrument bus distribution panel as safe shutdown cables. Therefore, an instrument bus is only considered to be available for safe shutdown use if none of the bus's cables are routed in the fire zone being analyzed.

2.4.1.6.2 Common Enclosure Associated Circuits

This issue is not a concern at Braidwood for the following reasons. The raceway system is divided by unit, by division (train), by safety class, and by cable type (power, control, or instrument). Each raceway is assigned a segregation code, and only cables with the same segregation code are routed together. Therefore, cables from unit 1 are not routed together with cables from unit 2. Cables from one division (e.g. Division 11) are not routed together with cables from the redundant division (e.g. Division 12). Non-safety related cables are not routed together with safety related cables. Finally, power, control and instrument cables are not intermixed within any given raceway; each is routed in separate raceways with cables of the same type. In addition, cables used for Braidwood meet the flame test of IEEE 383-1974, which demonstrates that the cable does not propagate fire outside of the area of flame impingement. Thus, in the absence of external influences, a cable fire in one fire zone will not propagate through the raceway system to a different fire zone.

When non-safety related cables share a common enclosure (e.g., control panel, motor control center, terminal box) with safety related cables, an analysis has been performed and documented to demonstrate that a failure of the non-safety related cable will not degrade any safety related circuits in the enclosure.

2.4.1.6.3 Multiple High Impedance Faults (MHIF)

High impedance faults are defined in Generic Letter 86-10 as postulated faults which result in fault currents just below the breaker/fuse fault current setting or rating. Therefore, high impedance faults by definition do not result in clearing of the fault by the load breaker (or fuse). The referenced Generic Letter requested nuclear plant licensees to consider multiple (simultaneous) high impedance faults on safe shutdown power supplies. The concern is that the summation of fault current from such faults on both safe shutdown and non-safe shutdown loads could trip the main feed breaker for the affected safe shutdown power supply prior to clearing the individual load faults.

For Braidwood Station, MHIF are not considered to be credible for medium voltage buses (4.16 kV and 6.9kV) because at this voltage level, postulated arcing faults will clear by one of two mechanisms. The fault current will rapidly propagate into a bolted fault, which will be cleared by the individual feed breaker, or the energy of the postulated fault will be sufficient to vaporize the target and break the fault circuit path. Also, at this voltage level, phase-to-phase and three-phase arcing faults approach the magnitude of a three-phase bolted fault. Even if this fault were to remain an arcing fault, it would be cleared by the protective devices. Minimum arcing ground faults are not a concern at the medium voltage level because the individual load breakers are provided with ground fault protection. Coordination of the ground fault protection between the bus main supply breaker and the individual load breakers ensures that a ground fault on an individual load will trip the load breaker first.

MHIF are considered to be credible at the 480 Vac level. An analysis has been performed to demonstrate that the 480 Vac switchgear buses and MCCs required for safe shutdown are adequately protected against MHIF. For phase-to-phase and three-phase MHIF, the analysis assumed that the normally energized cables that are not routed in the fire zone under consideration will draw their rated full load current. A High Impedance Fault (HIF), where the load current is assumed to be just below the trip setpoint of an individual load breaker, is assumed to be present on all normally energized cables that are routed in the zone under consideration. To address the design basis of one spurious operation, the worst case (i.e., largest breaker trip rating) normally de-energized load on the bus is assumed to be always faulted due to the fire. The analysis verified that the individual load breakers would trip before the main supply breaker for phase-to-phase and three-phase MHIF.

High impedance arcing ground faults were also evaluated for the safe shutdown 480 Vac switchgear buses. Each 480 Vac switchgear breaker provides phase overcurrent protection.

Additionally, ground fault protection is provided for each 480 Vac switchgear bus by a ground overcurrent relay that monitors current on the 4160 – 480/277 volt transformer secondary grounded neutral. If a ground fault is sensed, the ground overcurrent relay will trip the 4160 volt supply breaker to the transformer that feeds the 480 Vac switchgear bus. However, an arbitrary fault current, just below the feed breaker trip setting, is not credible. Research has shown that the minimum arcing ground fault current is 38 percent of the bolted three-phase ground fault value. If the ground fault current is less than 38 percent, the ground fault will self extinguish. If the ground fault current is greater than 38 percent, the energy of the fault will cause the fault current to go to a condition close to a three-phase bolted fault current value. The analysis has verified that for each high impedance arcing ground fault, the individual load breaker will clear 38 percent of the three-phase bolted fault current value prior to the ground overcurrent relay tripping the switchgear bus supply breaker. Therefore, the safe shutdown 480 Vac switchgear buses and MCCs are adequately protected against both ungrounded MHIF and grounded arcing MHIF.

For the 120 Vac distribution buses, high impedance arcing faults are not considered to be credible. Based upon research, the peak line-to-neutral voltage is not high enough to cause arcing current to flow. However, a coordination analysis has been performed to verify that the circuit breakers for the 120 Vac distribution buses provide adequate protection against multiple faults with minimum fault current values. For worst case loads with the longest cable runs and therefore the lowest fault currents, the analysis calculated the minimum fault current that could be present at a load taking into account the impedance of the cable between the bus and the load. The analysis verified that the load protective device (i.e., a fuse or circuit breaker) would trip before the upstream protective device. The analysis also verified that the upstream protective devices have adequate margin to accommodate multiple faults. Therefore, the 120 Vac voltage level distribution buses are adequately protected against multiple faults with minimum current values.

A MHIF analysis has not been performed for the 120 Vac instrument power buses. As stated previously in Section 2.4.1.6.1, an instrument bus is only considered to be available for safe shutdown use if none of the bus's cables are routed in the fire zone being analyzed.

For the 125 Vdc distribution buses, high impedance arcing faults are not considered to be a concern, because the fault will either develop into a full bolted fault or will self extinguish. Given the very small maximum separation requirements between conductors for an arc to occur at the 125 Vdc level, there is enough energy in a 125 Vdc fault to melt the two conductors together which will result in a bolted fault that will trip the protective device or to burn the wire open. However, a coordination analysis has been performed to verify that the circuit breakers for the 125 Vdc distribution buses provide adequate protection against multiple faults with minimum fault current values. For worst case loads with the longest cable runs and therefore the lowest fault currents, the analysis calculated the minimum fault current that could be present at a load taking into account the impedance of the cable between the bus and the load.

The analysis verified that the load protective device would trip before the upstream protective device. The analysis also verified that the upstream protective devices have adequate margin to accommodate multiple faults. Therefore, the 125 Vdc voltage level distribution buses are adequately protected against multiple faults with minimum current values.

2.4.1.6.4 Spurious Operations

The licensing basis of the Braidwood plant is to assume one spurious actuation per fire, as documented in the Byron and Braidwood SERs. Each electrically controlled component on the safe shutdown equipment list was considered to be susceptible to postulated spurious operations.

As discussed in criteria (b) and (l) from the component selection criteria presented in Subsection 2.4.1.4, the spurious operation of valves and dampers in safe shutdown flowpaths was considered during the component selection process. The effects of postulated spurious operation of these components, and the required actions to mitigate them, if any, are addressed in the safe shutdown analyses for individual fire zones in Section 2.4.2. Post-fire operating procedures have also been prepared which include manual actions to address postulated spurious operations for selected electrically driven safe shutdown components (fans and pumps powered from the 4160Vac ESF switchgear buses). For other electrically powered components (480Vac and lower rated supplies), the spurious start of an inactive component has no adverse consequences (e.g., spurious start of a small pump or fan). For these components, any damage to the components' control circuit is assumed to render the component unavailable for safe shutdown. No specific discussion of spurious operation is provided.

2.4.1.6.5 Cable Fireproofing Material

1. The fire wraps continue to meet their full qualification per the historical standard and that an evaluation was performed to compare these raceway fire wraps against more recent guidance and acceptance criteria established by the NRC. The comparison determined the raceway wraps would provide at least 49 minutes fire resistance using the more recent guidance. This shorter duration is acceptable, as stated in the evaluation, primarily based on the fire load in these areas not being capable of producing a 49-minute fire and not adversely challenging the fire wrap systems. The evaluation was performed in response to IEN 95-52, and documented under AT #00003019-01-01.

2. The 3M Interam Type E-54 fire wrap is an acceptable one-hour and three-hour fire barrier based on existing qualification reports and test data (ASTM E-119 Fire Test, Hose Stream tests, etc.). Furthermore, the 3M Type E-54 fire wrap possesses endothermic properties and shall not be treated as a combustible. Per the Technical Evaluation of 3M Interam one and three-hour Fire Protective Wraps Applied to Electrical Circuits (June 1999), the E-50 series of 3M Interam base material has passed the ASTM E-136 testing requirements for noncombustible materials. It has also passed the ASTM E-84 testing requirements for surface flame spread (with a flame spread rating of 0.7). The ASTM E-136 testing was conducted at Omega Point Laboratories in January of 1995, project 14540-99235 (CTP-2004), and the ASTM-E84 testing was conducted at Underwriter's Laboratories, report file R10125, Project 82NK21937.

   It is recognized that deviations from the tested fire wrap configuration will occur. Generic Letter 86-10 also recognizes this fact and allows for technically justified deviations. Any deviations that occur during the installation will be evaluated based on the criteria discussed in Generic Letter 86-10 (e.g., continuity of the fire barrier, adequacy of the barrier thickness, etc.) prior to acceptance of the installation.

2.4.1.7 Assumptions

The following assumptions were made in performing the safe shutdown analysis:

1. Initial Plant Operating Conditions
   a. Both units of the station are operating at 100% power.
   b. Normal system and component alignments are assumed.

2. All safe shutdown components and systems are assumed to be available prior to the onset of the fire. In other words, no allowance is made for systems or components being out of service for maintenance or testing.

3. Independent failures (i.e., failures that are not a direct consequence of fire damage) of systems, equipment, instrumentation, controls, or power supplies do not occur before, during, or following the fire.

4. The postulated fire shall not be considered to occur simultaneously with other accidents, events, or phenomena such as a design-basis accident except a Loss of Offsite Power (LOOP). Furthermore, for any given fire zone, a LOOP need only be postulated if the offsite power circuits are affected by a fire in that fire zone. When it can be demonstrated that a fire in a specific zone will not affect the offsite power circuits, and alternate shutdown capability is not credited, then a LOOP need not be postulated to occur. In the event of a LOOP and the failure of the emergency diesel generator to auto start due to fire damage, station emergency procedures initiate actions to restore at least one ESF 4 KV bus using the unit to unit 4 KV cross-tie or local start of the emergency diesel generator. The SSA credits either local start of the emergency diesel generator or use of the 4 KV cross-tie in the fire zones where LOOP can occur. Depending upon what equipment is affected by the fire, station procedures may require the stopping of the Reactor Coolant Pumps (RCPs), isolation of RCP seal cooling, and proceeding to cold shutdown using natural circulation in the reactor coolant system.

5. Assumptions regarding fire damage to mechanical components are described in Subsection 2.1.1(h) of the Fire Hazards Analysis.

6. Assumptions regarding fire damage to electrical cables are described in previous Subsection 2.4.1.5.2 “Cable Damage Assumptions.”

7. For a control room fire, evacuation of the control room is assumed. However, credit is taken for reactor trip and verification of control rod insertion prior to evacuation. Control rod insertion is sufficient to ensure subcriticality to maintain hot standby. For this event, the operators would utilize plant procedures 1(2) BwOA PRI-5 Control Room Inaccessibility - Unit 1(2) and fire response guideline procedures to control the plant.

8. For fires outside the control room, the operators are assumed to remain in the control room and to utilize the instruments and controls provided there to the greatest extent, in accordance with existing station procedures. Operators would utilize fire response guideline procedures in conjunction with Emergency, Abnormal, Normal and General Operating procedures to place the plant in a safe condition during fires affecting safe shutdown equipment. The fire response guideline procedure provides operators with guidance describing the potential affects of a fire on a specific fire zone basis and actions to mitigate the potential affects. When proper operation of equipment cannot be performed or confirmed from the control room, alternate procedures are utilized. For example, 1(2) BwOA PRI-5 Control Room Inaccessibility - Unit 1(2), or 1(2)BwOA ELEC-5 Local Emergency Control of Safe Shutdown Equipment - Unit 1(2) could be used (this list is not meant to be complete - other procedures are available and could be used). These procedures are symptom-oriented rather than event-oriented. That is, there are no special procedures for fire in fire zone X, rather the procedures cover the loss of equipment X for whatever reason. Where the safe shutdown analysis shows that control cables from both redundant trains of equipment are located in the same fire zone, credit is taken for shutdown via local operation of equipment as specified in various plant procedures (including but not limited to the procedures referenced above). However, reference to a particular procedure for a particular fire zone, is not a commitment to automatically use that procedure in the event of a fire in that zone. For a fire less severe than the design basis fire, normal control room controls will continue to be used as long as they remain undamaged.

9. If a fire causes electrical shorting or overload, it is assumed that automatic circuit protection will function properly. If manual action is required to reclose a breaker that is not in the fire zone, credit is taken for such action where the breaker is accessible.

2.4.1.8 Repairs

For many of the fire zones, credit is taken for making repairs to equipment in order to perform one or more of the safe shutdown functions. In all cases, such credit is taken only to accomplish a function required for cold shutdown. The ability to achieve and maintain hot standby independent of each fire zone, without taking credit for repairs, is demonstrated in Subsection 2.4.2.

Specific repairs credited for individual fire zones are discussed in Subsection 2.4.2 and summarized in Table 2.4-3. Most repairs identified consist of installing temporary cable to replace cables that are assumed to be damaged by a fire. For each repair credited in Subsection 2.4.2, a procedure has been written and is available to cover the repair. The procedure is general for each type of repair. For example, a repair procedure covers the temporary repair of cables and is applicable for all zones where such repairs are referenced. For each repair credited in Subsection 2.4.2, the quantity and specific type of materials required by the analysis and the procedure are reserved onsite.

The nature and scope of these repairs are such that they can be implemented and cold shutdown can be achieved in the affected unit(s) within 72 hours. This meets the requirements of BTP CMEB 9.5-1. The repairs would be performed by the plant's normal maintenance staff, who possess adequate training to complete these tasks. Neither additional nor specially trained personnel would be required. Furthermore, the repairs are simple enough that no special efforts to demonstrate the capability to implement them within a 72 hour time period (and subsequently achieve cold shutdown) are deemed to be necessary.

For Measurement Uncertainty Recapture (MUR) Power Uprate (EC 378382(B-1) EC 378383(B-2) EC378380(BR-1) EC378381(BR-2)), an analysis was performed based on bounding repair activities performed concurrently with bounding plant operating conditions and concluded that the unit can reach cold shutdown in 72 hours. (Reference EXBY001-RPT-001 Rev 0, dated March 14, 2011 BYRON & BRAIDWOOD FIRE PROTECTION COLD SHUTDOWN EVALUATION IN SUPPORT OF MUR PU REPORT)

2.4.1.9 Staffing Requirements for Safe Shutdown

Staffing requirements for safe shutdown are met by the minimum plant operating staff as set forth in the current plant procedure that governs staffing. A control room fire is generally assumed to be the most restrictive fire with regards to staffing, since evacuation of the main control room (MCR) is required for both units. Fire damage assumptions for a postulated control room fire are addressed in the introductory paragraphs to subsection 2.4.2.3. Based upon the assumptions, three licensed-operators and four operators (7 personnel) will be available to shut down the fire affected unit and the opposite unit. Also, four operators and a fire brigade chief will be available for fire brigade activities. Current minimum staffing levels described in procedure BwAP 320-1 are adequate to support shutdown of both units as specified above, and also staff the fire brigade.

2.4.2 Fire Area/Zone Safe Shutdown Analysis

The following safe shutdown analysis is performed on a fire zone basis. For Byron and Braidwood, the fire zones on which this analysis are based are considered to be equivalent to fire areas.

The fire zone boundaries and designations originated during the preparation of the original fire hazards analysis, prior to the issuance of 10CFR50 Appendix R and BTP CMEB 9.5-1. However, these same zone boundaries and designations were utilized during preparation of the original Byron unit 1 safe shutdown analysis (circa 1982), and the subsequent safe shutdown analyses for the other three units. They are retained during the current re-analysis.

All fire zone boundaries in the safety related auxiliary building, where most safe shutdown equipment is located, consist of walls, floors and ceilings of substantial construction. Many fire zone boundaries carry a three hour fire rating, and therefore qualify as fire area boundaries. Many other fire zone boundaries are designated as radiation barriers, flood barriers or ventilation barriers. The Fire Area Analysis has demonstrated that a fire in any fire zone of the plant will not propagate to adjacent fire zones. Therefore, for the purpose of the safe shutdown analysis, the existing fire zones are considered to be equivalent to fire areas.

The present analysis applies to both unit 1 and unit 2. A safe shutdown component/cable listing and evaluation are provided for the majority of the fire zones included in the Fire Area Analysis (Section 2.3). Essentially all safety related and many non-safety related areas are included. Those fire zones which are not addressed primarily consist of outbuildings and administrative offices, which obviously have no safe shutdown impact.

For the individual fire zone evaluations, the discussion follows a structured format. First, common systems are addressed. Common safe shutdown systems include the control room ventilation (VC) system and the auxiliary building ventilation (VA) system supply and exhaust fans. Other systems, such as component cooling and essential service water, have the capability to be shared, but are normally operated in a unit isolated mode. These systems are discussed separately for each unit. Following the discussion of common systems, the discussion of the safe shutdown impact on unit 1 is provided, followed by the unit 2 discussion.

For each unit, the discussion first addresses essential AC and DC support systems. These are addressed first since the availability (or unavailability) of these systems can significantly impact the choice of individual components or trains of remaining safe shutdown systems which are to be credited for safe shutdown. Next, the following safe shutdown functions are discussed in order: RCS inventory control (including reactivity control), hot standby decay heat removal, essential support, and cold shutdown decay heat removal. For fire zones where essentially all of the components/cables are associated with only one unit, and the other unit is unaffected or minimally affected, the discussion for the unaffected/minimally affected unit is condensed into a single paragraph.

Finally, for fire zones whose boundaries deviate from BTP CMEB 9.5-1, either a deviation or Generic Letter 86-10 evaluation is discussed at the end of the subsection.

SECURITY - RELATED INFORMATION WITHHELD UNDER 10 CFR 2.390

TABLE 2.4-5

REMOTE SHUTDOWN PANEL (RSP) INSTRUMENTATION

A. PANEL 1PL04J

INSTRUMENT NO.	DESCRIPTION
1FI-AF011B*	Auxiliary Feedwater Pump 1A Flow to Steam Generator 1A
1FI-AF013B*	Auxiliary Feedwater Pump 1A Flow to Steam Generator 1B
1FI-AF015B*	Auxiliary Feedwater Pump 1A Flow to Steam Generator 1C
1FI-AF017B*	Auxiliary Feedwater Pump 1A Flow to Steam Generator 1D
1LI-501	Steam Generator 1A Level
1LI-502	Steam Generator 1B Level
1LI-503	Steam Generator 1C Level
1LI-504	Steam Generator 1D Level
*	Essential Service Water Pump 1A Discharge Temperature
*	Essential Service Water Return Header OA Temperature

TABLE 2.4-5 (Cont'd)

B. PANEL 1PL05J

INSTRUMENT NO.	DESCRIPTION
1FI-AF012B*	Auxiliary Feedwater Pump 1B Flow to Steam Generator 1A
1FI-AF014B*	Auxiliary Feedwater Pump 1B Flow to Steam Generator 1B
1FI-AF016B*	Auxiliary Feedwater Pump 1B Flow to Steam Generator 1C
1FI-AF018B*	Auxiliary Feedwater Pump 1B Flow to Steam Generator 1D
1TI-RC005A	Reactor Coolant Loop 1A Hot Leg Temperature
1TI-RC006A	Reactor Coolant Loop 1B Hot Leg Temperature
1TI-RC007A	Reactor Coolant Loop 1C Hot Leg Temperature
1TI-RC008A	Reactor Coolant Loop 1D Hot Leg Temperature
1TI-RC005B	Reactor Coolant Loop 1A Cold Leg Temperature
1TI-RC006B	Reactor Coolant Loop 1B Cold Leg Temperature
1TI-RC007B	Reactor Coolant Loop 1C Cold Leg Temperature
1TI-RC008B	Reactor Coolant Loop 1D Cold Leg Temperature

TABLE 2.4-5 (Cont'd)

B. PANEL 1PL05J (Cont'd)

INSTRUMENT NO.	DESCRIPTION
*	Essential Service Water Pump 1B Discharge Temperature
*	Essential Service Water Return Header OB Temperature

C. PANEL 1PL06J

INSTRUMENT NO.	DESCRIPTION
1PI-0514B	Steam Generator 1A Steam Pressure
1PI-0524B	Steam Generator 1B Steam Pressure
1PI-0534B	Steam Generator 1C Steam Pressure
1PI-0544B	Steam Generator 1D Steam Pressure
1LI-0459B	Pressurizer Level
1LI-0460B	Pressurizer Level
1PI-0455B	Pressurizer Pressure
1FT-0110*	Emergency Boron Injection Flow
*	Volume Control Tank Level
*	Charging Header Pressure
1FI-0121B	Charging Header Flow
1NI-NR001	Source Range Neutron Level Indicator
1NI-NR002	Source Range Neutron Level Indicator

TABLE 2.4-5 (Cont'd)

D. PANEL 2PL04J

INSTRUMENT NO.	DESCRIPTION
2FI-AF011B*	Auxiliary Feedwater Pump 2A Flow to Steam Generator 2A
2FI-AF013B*	Auxiliary Feedwater Pump 2A Flow to Steam Generator 2B
2FI-AF015B*	Auxiliary Feedwater Pump 2A Flow to Steam Generator 2C
2FI-AF017B*	Auxiliary Feedwater Pump 2A Flow to Steam Generator 2D
2LI-501	Steam Generator 2A Level
2LI-502	Steam Generator 2B Level
2LI-503	Steam Generator 2C Level
2LI-504	Steam Generator 2D Level
*	Essential Service Water Pump 2A Discharge Temperature
*	Essential Service Water Return Header OA Temperature

TABLE 2.4-5 (Cont'd)

E. PANEL 2PL05J

INSTRUMENT NO.	DESCRIPTION
2FI-AF012B*	Auxiliary Feedwater Pump 2B Flow to Steam Generator 2A
2FI-AF014B*	Auxiliary Feedwater Pump 2B Flow to Steam Generator 2B
2FI-AF016B*	Auxiliary Feedwater Pump 2B Flow to Steam Generator 2C
2FI-AF018B*	Auxiliary Feedwater Pump 2B Flow to Steam Generator 2D
2TI-RC005A	Reactor Coolant Loop 2A Hot Leg Temperature
2TI-RC006A	Reactor Coolant Loop 2B Hot Leg Temperature
2TI-RC007A	Reactor Coolant Loop 2C Hot Leg Temperature
2TI-RC008A	Reactor Coolant Loop 2D Hot Leg Temperature
2TI-RC005B	Reactor Coolant Loop 2A Cold Leg Temperature
2TI-RC006B	Reactor Coolant Loop 2B Cold Leg Temperature
2TI-RC007B	Reactor Coolant Loop 2C Cold Leg Temperature
2TI-RC008B	Reactor Coolant Loop 2D Cold Leg Temperature

TABLE 2.4-5 (Cont'd)

E. PANEL 2PL05J (Cont'd)

INSTRUMENT NO.	DESCRIPTION
*	Essential Service Water Pump 2B Discharge Temperature
*	Essential Service Water Return Header OB Temperature

F. PANEL 2PL06J

INSTRUMENT NO.	DESCRIPTION
2PI-0514B	Steam Generator 2A Steam Pressure
2PI-0524B	Steam Generator 2B Steam Pressure
2PI-0534B	Steam Generator 2C Steam Pressure
2PI-0544B	Steam Generator 2D Steam Pressure
2LI-0459B	Pressurizer Level
2LI-0460B	Pressurizer Level
2PI-0455B	Pressurizer Pressure
2FT-0110*	Emergency Boron Injection Flow
*	Volume Control Tank Level
*	Charging Header Pressure
2FI-0121B	Charging Header Flow
2NI-NR001	Source Range Neutron Level Indicator
2NI-NR002	Source Range Neutron Level Indicator

*Not identified as a safe shutdown instrument.

TABLE 2.4-6

REMOTE SHUTDOWN PANEL CONTROLS

A. PANEL 1PL04J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1AF005A	AFW Regulating Valve	1HK-AF031B	Position controller
1AF005B	AFW Regulating Valve	1HK-AF033B	Position controller
1AF005C	AFW Regulating Valve	1HK-AF035B	Position controller
1AF005D	AFW Regulating Valve	1HK-AF037B	Position controller
1AF013A	AFW Steam Generator Isolation Valve	1HS-AF071	Open-close switch
1AF013B	AFW Steam Generator Isolation Valve	1HS-AF073	Open-close switch
1AF013C	AFW Steam Generator Isolation Valve	1HS-AF075	Open-close switch
1AF013D	AFW Steam Generator Isolation Valve	1HS-AF077	Open-close switch
1AF01PA	AFW Pump 1A	1HS-AF003	On-off switch
1CV01PA	Centrifugal Charging Pump 1A	1HS-CV001	On-off switch
1CV01PA-A	CCP 1A Lube Oil Pump	1HS-CV013	On-off switch
0CC01P	Component Cooling Pump O	0HS-CC001	On-off switch
1CC01PA	Component Cooling Pump 1A	1HS-CC001	On-off switch
1MS001A,D	Main Steam Isolation Valves 1A, 1D	1HS-MS143	Open-close switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1MS018A	Main Steam Atmospheric Relief Valve 1A	1PK-MS041B	Setpoint controller
1MS018D	Main Steam Atmospheric Relief Valve 1D	1PK-MS044B	Setpoint controller
1RC01PA	Reactor Coolant Pump 1A	1HS-RC001	On-off switch
1RC01PD	Reactor Coolant Pump 1D	1HS-RC004	On-off switch
1SX01PA	ESW Pump 1A	1HS-SX003	On-off switch
0VC01CA	MCR Supply Fan 0A	0HS-VC111	On-off switch
0VC02CA	MCR Return Fan 0A	0HS-VC008	On-off switch
0VC18Y,19Y, 20Y	MCR Outside Air Dampers	0HS-VC118	Open-close switch
0VC21Y,22Y, 43Y	MCR Charcoal Filter Iso. Dampers	0HS-VC120	Open-close switch
1VP01CA	Reactor Cont. Fan Cooler high speed	1HS-VP011	On-off switch
1VP01CC	Reactor Cont. Fan Cooler high speed	1HS-VP013	On-off switch

B. PANEL 1PL05J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1AF005E	AFW Regulating Valve	1HK-AF032B	Position controller
1AF005F	AFW Regulating Valve	1HK-AF034B	Position controller
1AF005G	AFW Regulating Valve	1HK-AF036B	Position controller
1AF005H	AFW Regulating Valve	1HK-AF038B	Position controller

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1AF013E	AFW Steam Generator Iso. Valve	1HS-AF072	Open-close switch
1AF013F	AFW Steam Generator Iso. Valve	1HS-AF074	Open-close switch
1AF013G	AFW Steam Generator Iso. Valve	1HS-AF076	Open-close switch
1AF013H	AFW Steam Generator Iso. Valve	1HS-AF078	Open-close switch
1AF01PB	AFW Pump 1B	1HS-AF004	On-off switch
1CV01PB	Centrifugal Charging Pump 1B	1HS-CV002	On-off switch
1CV01PB-A	CCP 1B Lube Oil Pump	1HS-CV014	On-off switch
1CV8104	Emergency Boration Valve	1HS-CV005	Open-close switch
0CC01P	Component Cooling Pump 0	0HS-CC002	On-off switch
1CC01PB	Component Cooling Pump 1B	1HS-CC002	On-off switch
1MS001B,C	Main Steam Isolation Valves 1B, 1C	1HS-MS144	Open-close switch
1MS018B	Main Steam Atmospheric Relief Valve 1B	1PK-MS042B	Setpoint controllers
1MS018C	Main Steam Atmospheric Relief Valve 1C	1PK-MS043B	Setpoint controller
1RC01PB	Reactor Coolant Pump 1B	1HS-RC002	On-off switch
1RC01PC	Reactor Coolant Pump 1C	1HS-RC003	On-off switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1SXO1PB	ESW Pump 1B	1HS-SX004	On-off switch
1VP01CB	Reactor Containment Fan Cooler - high speed	1HS-VPO12	On-off switch
1VP01CD	Reactor Containment Fan Cooler - high speed	1HS-VP014	On-off switch

C. PANEL 1PL06J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
--	Plant Evacuation Alarm	1HS-CQ001	On switch
--	Plant-wide Fire Alarm	1HS-CQ002	On switch
--	Plant Evac. & Fire Alarm Reset	1HS-CQ003	Reset switch
1AB03P	Boric Acid Transfer Pump 1A	1HS-AB001	On-off switch
1CV8145	Pressurizer Auxiliary Spray Valve	1HS-CV039	Open-close switch
1CV8149A	Letdown Orifice Isolation Valve	1HS-CV007	Open-close switch
1CV8149B	Letdown Orifice Isolation Valve	1HS-CV009	Open-close switch
1CV8149C	Letdown Orifice Isolation Valve	1HS-CV011	Open-close switch
1CV02P	Position Displacement Charging Pump	1HS-CV017	On-off switch
1CV-LCV459	Letdown Isolation Valve	1HS-CV019	Open-close switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
1CV-LCV460	Letdown Isolation Valve	1HS-CV021	Open-close switch
1CV02P	P. D. Charging Pump	1SHC-459B	Pump speed controller
1CV-FCV121	Charging flow control valve	1FHC-121	Flow controller
--	Steam Generator 1A Level	1LSH-FW047	SG high level alarm
--	Steam Generator 1B Level	1LSH-FW048	SG high level alarm
--	Steam Generator 1C Level	1LSH-FW049	SG high level alarm
--	Steam Generator 1D Level	1LSH-FW050	SG high level alarm
0PW02A	Primary Water Pump 0A	0HS-PW011	On-off switch
--	Press. Heaters Backup Group A Breaker	1HS-RY001	On-off switch
--	Press. Heaters Backup Group B Breaker	1HS-RY002	On-off switch
--	Press. Heaters Backup Group A Contactor	1HS-RY005	On-off switch
--	Press. Heaters Backup Group B Contactor	1HS-RY006	On-off switch
1VP03CA	CRDM Exhaust Fan 1A	1HS-VP112	On-off switch
1VP03CB	CRDM Exhaust Fan 1B	1HS-VP114	On-off switch
1VP03CC	CRDM Exhaust Fan 1C	1HS-VP116	On-off switch
1VP03CD	CRDM Exhaust Fan 1D	1HS-VP118	On-off switch

TABLE 2.4-6

D. PANEL 2PL04J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
2AF005A	AFW Regulating Valve	2HK-AF031B	Position controller
2AF005B	AFW Regulating Valve	2HK-AF033B	Position controller
2AF005C	AFW Regulating Valve	2HK-AF035B	Position controller
2AF005D	AFW Regulating Valve	2HK-AF037B	Position controller
2AF013A	AFW Steam Generator Isolation Valve	2HS-AF071	Open-close switch
2AF013B	AFW Steam Generator Isolation Valve	2HS-AF073	Open-close switch
2AF013C	AFW Steam Generator Isolation Valve	2HS-AF075	Open-close switch
2AF013D	AFW Steam Generator Isolation Valve	2HS-AF077	Open-close switch
2AF01PA	AFW Pump 2A	2HS-AF003	On-off switch
2CV01PA	Centrifugal Charging Pump 2A	2HS-CV001	On-off switch
2CV01PA-A	CCP 2A Lube Oil Pump	2HS-CV013	On-off switch
0CC01P	Component Cooling Pump O	0HS-CC001	On-off switch
2CC01PA	Component Cooling Pump 2A	2HS-CC001	On-off switch
2MS001A,D	Main Steam Isolation Valves 2A, 2D	2HS-MS143	Open-close switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
2MS018A	Main Steam Atmospheric Relief Valve 2A	2PK-MS041B	Setpoint controller
2MS018D	Main Steam Atmospheric Relief Valve 2D	2PK-MS044B	Setpoint controller
2RC01PA	Reactor Coolant Pump 2A	2HS-RC001	On-off switch
2RC01PD	Reactor Coolant Pump 2D	2HS-RC004	On-off switch
2SX01PA	ESW Pump 2A	2HS-SX003	On-off switch
2VP01CA	Reactor Cont. Fan Cooler high speed	2HS-VP011	On-off switch
2VP01CC	Reactor Cont. Fan Cooler high speed	2HS-VP013	On-off switch

E. PANEL 2PL05J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
2AF005E	AFW Regulating Valve	2HK-AF032B	Position controller
2AF005F	AFW Regulating Valve	2HK-AF034B	Position controller
2AF005G	AFW Regulating Valve	2HK-AF036B	Position controller
2AF005H	AFW Regulating Valve	2HK-AF038B	Position controller
2AF013E	AFW Steam Generator Iso. Valve	2HS-AF072	Open-close switch
2AF013F	AFW Steam Generator Iso. Valve	2HS-AF074	Open-close switch
2AF013G	AFW Steam Generator Iso. Valve	2HS-AF076	Open-close switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
2AF013H	AFW Steam Generator Iso. Valve	2HS-AF078	Open-close switch
2AF01PB	AFW Pump 2B	2HS-AF004	On-off switch
2CV01PB	Centrifugal Charging Pump 2B	2HS-CV002	On-off switch
2CV01PB-A	CCP 2B Lube Oil Pump	2HS-CV014	On-off switch
2CV8104	Emergency Boration Valve	2HS-CV005	Open-close switch
0CC01P	Component Cooling Pump 0	0HS-CC004	On-off switch
2CC01PB	Component Cooling Pump 2B	2HS-CC002	On-off switch
2MS001B,C	Main Steam Isolation Valves 2B, 2C	2HS-MS144	Open-close switch
2MS018B	Main Steam Atmospheric Relief Valve 2B	2PK-MS042B	Setpoint controllers
2MS018C	Main Steam Atmospheric Relief Valve 2C	2PK-MS043B	Setpoint controller
2RC01PB	Reactor Coolant Pump 2B	2HS-RC002	On-off switch
2RC01PC	Reactor Coolant Pump 2C	2HS-RC003	On-off switch
2SX01PB	ESW Pump 2B	2HS-SX004	On-off switch
2VP01CB	Reactor Containment Fan Cooler - high speed	2HS-VPO12	On-off switch
2VP01CD	Reactor Containment Fan Cooler - high speed	2HS-VP014	On-off switch

TABLE 2.4-6

F. PANEL 2PL06J

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
--	Plant Evacuation Alarm	2HS-CQ001	On switch
--	Plant-wide Fire Alarm	2HS-CQ002	On switch
--	Plant Evac. & Fire Alarm Reset	2HS-CQ003	Reset switch
2AB03P	Boric Acid Transfer Pump 2A	2HS-AB001	On-off switch
2CV8145	Pressurizer Auxiliary Spray Valve	2HS-CV039	Open-close switch
2CV8149A	Letdown Orifice Isolation Valve	2HS-CV007	Open-close switch
2CV8149B	Letdown Orifice Isolation Valve	2HS-CV009	Open-close switch
2CV8149C	Letdown Orifice Isolation Valve	2HS-CV011	Open-close switch
2CV02P	Position Displacement Charging Pump	2HS-CV017	On-off switch
2CV-LCV459	Letdown Isolation Valve	2HS-CV019	Open-close switch
2CV-LCV460	Letdown Isolation Valve	2HS-CV021	Open-close switch
2CV02P	P. D. Charging Pump	2SHC-459B	Pump speed controller
2CV-FCV121	Charging flow control valve	2FHC-121	Flow controller

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
--	Steam Generator 2A Level	2LSH-FW047	SG high level alarm
--	Steam Generator 2B Level	2LSH-FW048	SG high level alarm
--	Steam Generator 2C Level	2LSH-FW049	SG high level alarm
--	Steam Generator 2D Level	2LSH-FW050	SG high level alarm
0PW02B	Primary Water Pump 0B	0HS-PW013	On-off switch
--	Press. Heaters Backup Group A Breaker	2HS-RY001	On-off switch
--	Press. Heaters Backup Group B Breaker	2HS-RY002	On-off switch
--	Press. Heaters Backup Group A Contactor	2HS-RY005	On-off switch
--	Press. Heaters Backup Group B Contactor	2HS-RY006	On-off switch
2VP03CA	CRDM Exhaust Fan 2A	2HS-VP112	On-off switch
2VP03CB	CRDM Exhaust Fan 2B	2HS-VP114	On-off switch
2VP03CC	CRDM Exhaust Fan 2C	2HS-VP116	On-off switch
2VP03CD	CRDM Exhaust Fan 2D	2HS-VP118	On-off switch

G. PANEL 1PL05JA

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
0VC01CB	MCR Supply Fan 0B	0HS-VC112	On-off switch

TABLE 2.4-6

EQUIPMENT NUMBER	DESCRIPTION	CONTROL NUMBER	CONTROL FUNCTION
0VC02CB	MCR Return Fan 0B	0HS-VC114	On-off switch
0VC03Y	MCR Outside Air Damper	0HS-VC122	Open-close switch
0VC05Y, 06Y, 44Y	MCR Charcoal Filter Isolation and Bypass Dampers	0HS-VC124	Open-close switch