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SUBJECT: Forwards Rev 44 to FSAR.Rev submitted as result of commitments contained in util 910426 ltr to revise FSAR to reflect design of isolation for Class 1E circuits from non-Class 1E circuits.

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AUG 29 1991

Director of Nuclear Reactor Regulation
Attention: Dr. W. R. Butler, Project Director
Project Directorate I-2
Division of Reactor Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
FINAL SAFETY ANALYSIS REPORT
REVISION 44
PLA-3642 FILES R41-2, A17-1

Docket Nos. 50-387
and 50-388

Dear Dr. Butler:

Pennsylvania Power & Light Company is submitting Revision 44 to the Susquehanna SES Final Safety Analysis Report (FSAR). The changes contained in Revision 44 are a result of commitments made in our letter PLA-3535 dated April 26, 1991 to revise the FSAR to reflect the design of the isolation for Class 1E circuits from non-Class 1E circuits.

If you have any questions, please contact Mr. C.T. Coddington at (215) 774-7915.

Very truly yours,

H. W. Keiser

H. W. Keiser

Attachments

cc: NRC Document Control Desk (original)
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Mr. G. S. Barber, NRC Sr. Resident Inspector
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50-387 Superseded Per Rev 44 to FSAR Dtd 8/29/91
#9109190083

Pennsylvania Power & Light Company
Two North Ninth Street • Allentown, PA 18101 • 215/770-5151

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2

FINAL SAFETY ANALYSIS REPORT

(FSAR)

THIS FSAR SET HAS BEEN UPDATED TO INCLUDE REVISIONS THROUGH 43 DATED 05/91.

CONTROLLED

CHAPTER 3.0

FIGURES

b) Battery Chargers

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

3.12.3.4.2.4 Distribution System

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 3.12.3.4.2.1 through 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 1B 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 3.13 (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.

<u>Regulatory Guide 1.70</u> - <u>STANDARD FORMAT AND CONTENT OF SAFETY ANALYSIS REPORTS FOR NUCLEAR POWER PLANTS-LWR EDITION (Revision 2, September 1975)</u>

The format of this FSAR complies with this regulatory guide.

<u>Regulatory Guide 1.71</u> - <u>WELDER QUALIFICATION FOR AREAS OF LIMITED ACCESSIBILITY (December 1973)</u>

Exceptions are taken to this regulatory guide as specified below:

(1) Reference: Position C.1. Performance qualifications for field personnel who weld under conditions of limited access, as defined in Regulatory Position C.1, are maintained in accordance with the applicable requirements of ASME Sections III and IX.

For the welder qualifications for the reactor coolant pressure boundary, see Subsection 5.2.3.3.2.3.

<u>Regulatory Guide 1.72</u> - <u>SPRAY POND PLASTIC PIPING (December 1973)</u>

Plastic piping is not used in safety related applications .

<u>Regulatory Guide 1.73</u> - <u>QUALIFICATION TESTS OF ELECTRIC VALVE OPERATORS INSTALLED INSIDE THE CONTAINMENT OF NUCLEAR POWER PLANTS (January 1974)</u>

The requirements of this regulatory guide are met as described in Section 3.11.

<u>Regulatory Guide 1.74</u> - <u>QUALITY ASSURANCE TERMS AND DEFINITIONS (February 1974)</u>

The Susquehanna SES construction quality program is described in PSAR Appendix D and amendments. Compliance of the Operational Ouality Assurance Program with this guide is described in Section 17.2.

Regulatory Guide 1.75 - PHYSICAL INDEPENDENCE OF ELECTRIC SYSTEMS (Revision 1, January 1975)

A. This Regulatory Guide endorses IEEE 384-1974 subject to the additions and clarifications delineated in Section C of the guide. Although there is no requirement for Susquehanna SES to comply with Regulatory Guide 1.75 and IEEE 384, Susquehanna SES follows this separation criteria, subject to the clarifications and exceptions below for the NSSS scope of supply. The paragraphs below reference sections of the IEEE standard in all cases and the specific paragraphs of the regulatory position statement where applicable.

(1) Reference: Regulatory Guide 1.75 and Section 4.5 of IEEE 384-1974

Certain power cables are subject to the same requirements as a Class 1E circuit. This applies to derating, environmental qualification, flame retardance, splicing restrictions, and raceway fill.

(2) Reference: Sections 4.5 and 4.6 of IEEE 384-1974

See Subsection 8.1.6.1q.

(3) Reference: Sections 5.1.3, 5.1.4, and 5.6.2 of IEEE 384-1974

All annunciator and computer input circuits are classified as non-Class 1E circuits. These non-Class 1E circuits are not separated from Class 1E control circuits within Class 1E panels in which the non-Class 1E circuit derives its input, i.e., circuit breaker auxiliary contact used for computer input, etc., nor are they separated in PGCC cable ducts. These non-Class 1E instrument circuits are considered to be low energy and the probability of these non-Class 1E circuits providing a mechanism of failure to the Class 1E circuits is extremely low.

(4) Reference: Position C.15 of Regulatory Guide 1.75 and Section 5.3.1 of IEEE 384-1974

See Subsection 8.1.6.1q.

(5) Reference: Sections 5.6.2 and 5.6.3 of IEEE 384-1974

In general, the circuits for redundant Class 1E systems and the circuits for non-Class 1E systems are located in separate panelboards, boxes, racks, and enclosures. Panels, racks, and boxes that contain wiring and devices for Class 1E circuits are labeled distinctly to externally identify the separation system and grouping. Internal to the enclosures, devices such operate under normal and abnormal conditions of environment, energy supply, malfunctions, and accidents.

The RPS trip logic, trip actuators, and trip actuator logic are designed to be operable under normal and abnormal conditions of environment, energy supply, malfunctions and accidents.

7.2.2.1.2.3.1.6 Channel Independence (IEEE 279-1971, Paragraph 4.6)

The four redundant trip channels for the following RPS trip variables are physically separated and electrically isolated from one another to meet this design requirement:

a) Scram discharge volume high water level trip

b) Turbine stop valve closure trip

c) Turbine control valve fast closure trip

d) Reactor vessel low water level trip

e) Main steamline high radiation trip

f) Drywell high pressure trip

g) Reactor vessel high pressure trip

The individual switch boxes for the turbine variables are physically separated.

The main steamline isolation valve closure trip is derived from 8 individual channels which are physically separated and electrically isolated to meet this design requirement.

The eight IRM and six APRM channels are electrically isolated and physically separated from one another so as to comply with this design requirement.

The manual scram pushbutton is a channel component. The trip channels are physically separated and electrically isolated to comply with this design requirement.

The mode switch banks are physically separated and electrically isolated to comply with this design requirement.

The circuitry for the RPS trip variable operating bypasses complies with this design requirement. Sufficient physical separation and electrical isolation exists to assure that the operating bypass channels are satisfactorily independent. Moreover, the conditions for bypass have been made quite stringent in order to provide additional margin.

The four RPS reset channels to the trip actuators are physically separated and electrically isolated. The RPS trip logic, trip actuators, and trip actuator logic are also physically separated and electrically isolated.

7.2.2.1.2.3.1.7 Control and Protection System Interaction (IEEE 279-1971, Paragraph 4.7)

The redundant channels for the RPS trip variables which are listed in Subsection 7.2.2.1.2.3.1.1 are electrically isolated from the plant control systems in compliance with this design requirement.

Each trip channel output relay uses one contact within the RPS trip logic. One additional contact on each relay is wired to a common annunciator in the main control room, and another contact on each relay is wired to the process computer cabinets to provide a written log of the channel trips. There is no single failure that will prevent proper functioning of any protective function when it is required.

The main steamline isolation valve and turbine stop valve limit switch contacts for RPS use are routed through separate totally enclosed metallic raceways connections relative to the other limit switches used for indicator lights in the control room. After the cabling emerges from the limit switch junction box associated with each main steamline isolation valve or turbine stop valve, it is routed separately from any other cabling in the plant to the RPS panels in the control room.

Turbine control valve fast closure pressure sensor outputs for RPS use are routed separately relative to other outputs used for indicator lights and turbine control purposes. After the cabling emerges from the junction boxes, it is routed in totally enclosed metallic raceways to the logic cabinets in the control room.

Within the IRM and APRM modules (i.e., prior to their output trip unit driving the RPS), analog outputs are derived for use with control room meters, recorders, and the process computer. Electrical isolation has been incorporated into the design at this interface to prevent any single failure from influencing the protective output from the trip unit. The trip unit outputs are physically separated and electrically isolated from other plant equipment in their routing to the RPS panels.

The manual scram pushbutton has no control interaction.

The reactor system mode switch is used for protective functions and restrictive interlocks on control rod withdrawal and refueling equipment movement. Additional contacts of the mode switch are used to disable certain computer inputs when the alarms would represent incorrect information for the operator. No control functions are associated with the mode switch. Hence, the switch complies with this design requirement. The system interlocks to control systems only through isolation devices such that no failure or combination of failures in the control system will have any effect on the reactor protection system.

The RPS scram discharge volume high water level trip variable operating bypass circuitry complies with this design requirement. For each trip channel bypass relay, four contacts are used in the bypass logic. One contact of each relay is also wired to a common annunciator in the control room and one contact is wired to the control rod block circuitry to prevent rod withdrawal whenever the trip channel bypass is in effect. There are no control system interactions with these bypass relay outputs. The system interlocks to control systems only through isolation devices such that no failure or combination of failures in the control system will have any effect on the RPS.

The main steamline isolation valve closure trip bypass has no interaction with any control system in the plant. One contact of each relay is used to initiate a control room annunciator for this bypass function.

Turbine stop valve and control valve trip bypasses have no interaction with any control system in the plant. Two output relay contacts in series are used in the RPS trip logic and one additional contact from each relay is used to initiate a control room annunciator for this bypass function.

Switch contacts of the RPS reset switch are used only to control auxiliary relays. Contacts from the relays are used only in the trip actuator coil circuit. Consequently, this RPS function has no interaction with any other system in the plant.

Reactor vessel high pressure switch contacts are routed in totally enclosed metallic raceways from the sensor to the RPS panels in the control room.

The four RPS trip logics are totally separate from all other plant systems. The RPS trip actuators utilize the power contacts of the scram relays to provide the trip actuator logic and the seal-in contact of the trip actuator, and utilize auxiliary contacts for control room annunciation, the process computer inputs, and initiation of the backup scram valves. Due to the design of this output and separation of the cabling, there is no interaction with control systems of the plant. The scram solenoids are physically separate and electrically isolated from the other portions of the control rod drive hydraulic control unit.

Reactor vessel low water level switch contacts for RPS use are routed through separate totally enclosed metallic raceways runs relative to the remaining switch contacts in these sensors.

7.2.2.1.2.3.1.8 Derivation of System Inputs (IEEE 279-1971, Paragraph 4.8)

The RPS trip variables are direct measures of:

a) Reactor vessel low water level trip

b) Main steamline high radiation trip

c) Neutron Monitoring (APRM) system trip

d) Neutron monitoring (IRM) system trip

e) Drywell high pressure trip

f) Reactor vessel high pressure trip

The measurement of scram discharge volume water level is an appropriate variable for this protective function. The desired variable is "available volume" to accommodate a reactor scram. However, the measurement of consumed volume is sufficient to infer the amount of remaining available volume, since the total volume is a fixed, predetermined value established by the design.

The measurement of main steamline isolation valve and turbine stop valve position is an appropriate variable for the reactor protection system. The desired variable is "loss of the reactor heat sink"; however, isolation or stop valve closure is the logical variable to infer that the steam path has been blocked between the reactor and the heat sink.

Due to the normal throttling action of the turbine control valves with changes in the plant power level, measurement of control valve position is not an appropriate variable from which to infer the desired variable, "rapid loss of the reactor heat sink". Consequently, a measurement of control valve closure rate is required.

Protection system design practice has discouraged use of rate sensing devices for protective purposes. In this instance, it was determined that detection of hydraulic actuator operation would be a more positive means of determining fast closure of the control valves.

Loss of hydraulic pressure in the EHC oil lines which initiates fast closure of the control valves is monitored. These measurements provide indication that fast closure of the control valves is imminent.

This measurement is felt to be adequate and a proper variable for the protective function taking into consideration the reliability of the chosen sensors relative to other available sensors and the difficulty in making direct measurements of control-valve fast-closure rate.

Since the mode switch is used to connect appropriate sensors into the RPS logic depending upon the operating state of the reactor, the selection of particular contacts to perform this logic operation is an appropriate means for obtaining the desired function.

Since the intent of the turbine stop valve closure trip and control valve fast closure trip operating bypass is to permit continued reactor operation at low power levels when the turbine stop or control valves are closed, the selection of turbine first stage pressure is an appropriate variable for this bypass function. In the power range of reactor operation, turbine first stage pressure is essentially linear with increasing reactor power. Consequently, this variable provides the desired measurement of power level.

Due to the manual action required for scram discharge volume high water level trip bypass, this design requirement is satisfied by operator interaction with a single bypass switch and the mode switch.

7.2.2.1.2.3.1.9 Capability for Sensor Checks (IEEE 279-1971, Paragraph 4.9)

During reactor operation, one sensor for each of the following RPS trip variables may be valved out-of-service at a time to perform testing under administrative control. During this test, operation of the sensor and the RPS trip channel may be confirmed. At the conclusion of the test, administrative control must be used to ensure that the sensor has been properly returned to service:

a) Scram discharge volume high water level trip

b) Reactor vessel low water level trip

c) Drywell high pressure trip

d) Reactor vessel high pressure trip

The scram discharge volume level sensors may be tested by using the locked instrument valves in proper sequence in conjunction with quantities of demineralized water. The test procedure is similar to the calibration procedure for this variable.

The main steamline isolation valve position switches are tested during valve movements which cause the limit switches to operate at the set point value of the valve position.

The logic of four MSIV instrument channel logics is as follows:

A1 (tripped) = Inboard or outboard valve partially closed in MS-A, and inboard or outboard valve partially closed in MS-B

A2 (tripped) = Inboard or outboard valve partially closed in MS-C, and inboard or outboard valve partially closed in MS-D

B1 (tripped) = Inboard or outboard valve partially closed in MS-A, and inboard or outboard valve partially closed in MS-C

B2 (tripped) = Inboard or outboard valve partially closed in MS-B, and inboard or outboard valve partially closed in MS-D

For any single valve closure test, two of the eight instrument channels will be placed in a tripped condition, but none of the channel logics will be tripped, and no RPS annunciation or computer logging will occur. This arrangement permits single valve testing without corresponding tripping of the RPS. The observation that no RPS trips result is a valid and necessary test result.

At reduced power levels, two valves may be tested in sequence to produce RPS trips, annunciation of the trips, and computer printout of the trip channel identification. For example, closure of one valve in Main Steamline A and another valve in Main Steamline B will produce an A1 Trip Logic trip and should not produce trips in B1 or B2 channel logic circuits. These observations are another important test result that confirms proper RPS operation.

In sequence, each possible combination of single valve closure and switch operation is performed to confirm proper operation of all eight instrument channels.

These test results confirm that the valve limit switches operate as the valves are manually closed.

The turbine stop valve position switches are also tested during valve movements which cause the limit switches to operate at the set point value.

The logic of the four turbine stop valve instrument channel logics is as follows:

A1 (tripped) = Turbine Stop Valve 1 partially closed, and Turbine Stop Valve 2 partially closed

A2 (tripped) = Turbine Stop Valve 3 partially closed, and Turbine Stop Valve 4 partially closed

B1 (tripped) = Turbine Stop Valve 1 partially closed, and Turbine Stop Valve 3 partially closed

B2 (tripped) = Turbine Stop Valve 2 partially closed, and Turbine Stop Valve 4 partially closed

For any single stop valve closure test, two of the eight instrument channels will be placed in a tripped condition, but none of the channel logics will be tripped, and no RPS annunciation or computer logging will occur. This arrangement permits single valve testing without corresponding tripping of the RPS, and the observation that no RPS trips result is a valid and necessary test result.

At reduced power levels, two valves may be tested in sequence to produce RPS trips, annunciation of the trips, and computer printout of the trip channel identification. These observations are another important test result that confirms proper RPS operation.

In sequence, each possible combination of single valve closure and switch operation is performed to confirm proper operation of all eight instrument channels.

The turbine control valve fast closure oil pressure sensors may be tested during the routine turbine system tests. During any control-valve fast-closure test, one RPS instrument channel will be tripped and will produce both control room annunciation and computer logging of the instrument channel identification.

The four RPS instrument logics are arranged as follows:

A1 (tripped) = Pressure Switch A loss of oil pressure

A2 (tripped) = Pressure Switch C loss of oil pressure

B1 (tripped) = Pressure Switch B loss of oil pressure

B2 (tripped) = Pressure Switch D loss of oil pressure

During plant operation, the individual pressure switches may be valved out-of-service, and the turbine control system may be used to operate the turbine bypass valves so as to perform a periodic test of the RPS inputs and channel logic.

Analog background gamma radiation is displayed on each of the four main steamline high radiation monitors.

Due to the normal one-out-of-two twice configuration of the trip logic for this variable, one main steamline radiation monitor channel may be removed from service at a time to perform the periodic tests. During reactor operation in the "Run" mode, the IRM detectors are stored below the reactor core in a low flux region. Movement of the detectors into the core will permit the operator to observe the instrument response from the different IRM channels and will confirm that the instrumentation is operable.

In the power range of operation, the individual LPRM detectors will respond to local neutron flux and provide the operator with an indication that these instrument channels are responding properly. The six APRM channels may also be observed to respond to changes in the gross power level of the reactor to confirm their operation.

Each APRM instrument channel may also be calibrated with a simulated signal introduced into the amplifier input and each IRM instrument channel may be calibrated by introducing an external signal source into the amplifier input.

During these tests, proper instrument response may be confirmed by observation of instrument lights in the control room and trip annunciators.

Operation of the mode switch may be verified by the operator during plant operation by performing certain sensor tests to confirm proper RPS operation. Movement of the mode switch from one position to another is not required for these tests since the connection of appropriate sensors to the RPS logic, as well as disconnection of inappropriate sensors, may be confirmed from the sensor tests.

7.5.2a.1.1 DESIGN CRITERIA

7.5.2a.1.1.1 Power Generation Control Complex Criteria

The applicable design criteria for the PGCC aspects of the ACR design are provided in General Electric Licensing Topical Report, NEDO-10466-A.

7.5.2a.1.1.2 Advance Control Room Design and Operational Criteria

7.5.2a.1.1.2.1 Design Criteria

(1) The implementation of the ACR design does not affect the ability of any system to meet the requirements of its design specification.

(2) In the implementation of the ACR design, instruments for the reactor protection system and the engineered safety features meet the system design requirements of the systems they serve. They are located at easily visible and accessible positions.

(3) The design employs modular techniques to implement distinct circuits so that separation and redundancy requirements are satisfied.

The interfacing circuitry between the Class 1E safety systems and the non-Class 1E non-safety Display Control System utilizes both digital and analog safety signals. Although there was no design requirement to provide Class 1E isolation between safety and non-safety systems there does exist a high degree of design protection on the safety interface signals. The digital signals from the safety systems are provided from Class 1E components. The analog signals from the safety systems are provided with current and voltage limiting circuit designs which provide protection for the safety circuit signals.

(4) All reactor protection system components incorporated by the ACR design are of at least comparable quality to the components that are integral to the design of related systems and have demonstrated operational reliability.

(5) The implementation of the ACR makes use of modular control and indication components. Plug-connected cables are used to facilitate removal of the modules. Cables and connectors are

easily accessible and identified. Connector separation requires deliberate action.

(6) Cabling is identified at each connection point, in the panels, wireways and termination cabinets so that visual verification of separation can be easily made. Connectors and cabling at connection points are clearly marked with system and reference designations.

(7) All plant system controls remain hard-wired. They are external to, and not dependent upon, the computer systems.

(8) Simplification of controls is restricted to manual functions operating independently from, but compatible with, the automatic protective functions.

(9) All safety system functions, either automatic protective or interlocking, including controls, displays and alarms remain hard-wired. These system functions can be changed only by physically modifying the wiring or equipment. They are independent from the computer systems.

7.5.2a.1.1.2.2 Operating Criteria

The implementation of the ACR design provides for planned operations or normal plant operation under planned conditions in the absence of significant abnormalities. Operations subsequent to an incident (transient, accident or special event) are not considered planned operations until the procedures being followed or equipment being used are identical to those used during any one of the defined planned operations. The established planned operations can be considered as a chronological sequence from refueling outage to refueling outage. The following planned operations are identified:

a. Refueling Outage
b. Achieving Criticality
c. Heatup
d. Reactor Power Operation
e. Achieving Shutdown
f. Cooldown

7.5.2a.2 Normal Operation

Subsection 7.5.1a.2 describes the basis for selecting ranges for instrumentation. Since abnormal, transient, or accident condition monitoring requirements exceed those for normal operation, the normal ranges are covered adequately. The

CHAPTER 8.0

ELECTRIC POWER

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TABLES

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FIGURES

in the non-Class 1E control raceways which contain cables of voltage level of 120 V AC, 125 V DC and 250 V DC.

Annunciator cables routed in a common pull/junction box with high energy cables are separated in accordance with the requirements of Table 8.3-25.

All instrumentation and annunciator cables have fire retardant insulation (See Subsection 8.3.3).

The raceways are of fire retardant materials. Instrumentation cables have grounded shields.

Analysis:

Annunciator and instrumentation circuits are low energy circuits. The annunciator circuits operate in 125 V dc high impedance (60 K) source. Most of the instrumentation systems operate on 1-5 V DC signals in high impedance circuits or 4-20 ma signals in low impedance circuits.

Since only low energy can be derived from instrumentation circuits, the probability of these non-Class 1E circuits providing a mechanism of failure to the Class 1E circuits inside Class 1E devices or enclosures is extremely low.

The worst credible event which could affect the Class 1E system through the non-Class 1E low energy circuits is a fire involving a control raceway containing annunciator cables. Assume in the worst case where annunciator cables from redundant class 1E equipment are both shorted to a 120 V AC, 125 V DC or 250 V DC cable due to the fire, further assume that the sensor contacts are both closed and that the overcurrent protective device of the 120 V AC, 125 V DC or 250 V DC cable does not trip. Then the class 1E devices could be damaged and therefore prevent the devices from performing their Class 1E function.

To summarize the above failure mode, the redundant Class 1E systems will fail only if all of the following conditions occur at the same time:

a. Annunciator cable from a Class 1E device is fused to the highest voltage circuit conductors (250 V DC).

b. Annunciator cable from a redundant Class 1E device is also fused to the highest voltage source (250 V DC)

c. The highest voltage (250 V DC) circuit conductors are not short circuited or grounded.

d. The highest voltage (250 V DC) circuit protective devices failed (breaker or fuse failed to perform its intended function)

e. Class 1E device contact closed (alarm state)

f. Redundant Class 1E device contact closed (alarm state)

g. In order for the Class 1E protective system, as designed, to fail due to fire the above six independent low probability events must happen simultaneously. This is considered extremely unlikely. Thus, the low energy non-Class 1E circuits, which are not separated from the Class 1E circuits at the input devices do not provide a mechanism of failure of the Class 1E system.

8) In addition to the minimum separation requirements as outlined in items 6 and 7 above; (a) there are no cable splices in raceways, (b) cables and raceways are flame retardant, (c) cable trays are limited to 30 percent fill and are not filled above the side rails.

9) Raceway and cable identifications are in compliance with Regulatory Guide 1.75. Detailed description is given in Subsection 1.8.6.

10) Diesel generators A,B,C and D are housed in separate rooms within a Seismic Category I structure with independent air supplies. The auxiliaries and local controls of each unit are also housed in the same room as the unit they serve. Diesel generator E is housed in a separate Seismic Category I structure with independent air supply. The auxiliaries and local controls for the diesel generator are housed within the same structure as the unit.

11) Redundant Class 1E batteries are located in separate rooms within a Seismic Category I structure; however, each battery room is exhausted by an individual ventilation duct to a common exhaust plenum. Two redundant Class 1E centrifugal exhaust fans service the common exhaust ductwork.

    Battery chargers of redundant load groups are physically separated in accordance with the requirements of Regulatory Guide 1.75.

12) All redundant Class 1E switchgear, motor control centers, and distribution panels are physically separated in accordance with Regulatory Guide 1.75.

13) Redundant Class 1E containment electrical penetrations are dispersed around the circumference of the containment and are physically separated in accordance with the requirements of Section 5.5 of IEEE 384-1974. Due to limited space, cable penetrations into the suppression pool contain both non-Class 1E and Class 1E circuits. These non-Class 1E circuits are for instrumentation, annunciation, and computer inputs and are not treated as affiliated circuits.

    The suppression pool area is serviced by three (3) electrical penetration assemblies: W300, W301, and W330B. Penetrations for Unit I, 1W300 and 1W301, each contains circuits of one division of the Class 1E systems and non-class 1E circuits. The third penetration, 1W330B, contains only non-Class 1E circuits. The Unit II penetrations 2W300 and 2W301 contain only circuits of one of the redundant Class 1E divisions and the third penetration 2W330B contains all the non-Class 1E circuits to the suppression pool area. Penetrations W300 and W301 are located in opposite quadrants of the suppression pool for each unit.

    Penetrations 1W300 and 1W301 also have non-Class 1E instrument and control circuits. Three of the non-Class 1E instrument circuits are for non-Class 1E RTD inputs (Except on affiliated RTD cable, RM1I9804E, which is routed together with non-Class 1E circuits since it cannot be accommodated by another penetration module). These are low energy and do not degrade the Class 1E circuits as discussed in Section 8.1.6.1.q-7). The non-Class 1E control circuits are used for annunciator inputs only. These annunciator circuits derive digital information from the same Class 1E equipment as the Class 1E control cables (i.e., PSV-15704A2, solenoid valve control and valve position annunciation). No other non-Class 1E circuit cables are routed in the same raceway with the annunciator cables from the Class 1E valve to the penetration inboard to the suppression pool. For further justification on annunciator circuits see Section 8.1.6.1.q-7). The remainder of non-Class 1E instrument and control circuits are used for the Integrated Leak Rate Test (ILRT). This testing is performed only when the reactor is in the cold shutdown mode and personnel access to the suppression pool is permitted. After the ILRT test are completed these circuits are isolated from the rest of the plant as all test instruments and sensors are disconnected and removed from both the suppression pool and the reactor building areas. The segments of the ILRT circuits not disconnected after testing are run in separate plant raceways used only for the ILRT system.

All future non-Class 1E circuits will be routed through the penetration 1W330B reserved for non-Class 1E only.

14) References: Section 5.6.2 and 5.6.3 of IEEE 384-1974.

In general, circuits for redundant Class 1E systems and circuits for non-Class 1E systems are located in separate enclosures such as, boxes, racks, and panels. However, in cases where redundant channel/division Class 1E circuits or Class 1E and non-Class 1E circuits, or RPS and other Class 1E and non-Class 1E circuits are located in the same enclosure, physical separation is achieved either by minimum of 6" horizontal and vertical separation, steel barriers, metallic enclosure, or metallic flexible conduit (exception to this separation requirement is taken for non-Class 1E low energy circuits discussed in paragraph 7 of this section). Where the above separation methods are not feasible, one of the separation group circuits except for RPS are to be covered with one of the following qualified nonflammable materials:

i Have Industries, siltemp sleeving type S and woven tape type WT65.

ii Carborundum, Fiberfrax sleeving type HP144T and woven tape type 3L144T.

These materials have been qualified to be used as separation barriers (Wyle Lab. Test Report No. 56669 dated May, 1980).

Applications of these materials are controlled and documented by the engineering office. Enclosures that contain wiring and devices for Class 1E circuits are labeled distinctively to identify externally the separations system and grouping (see Subsection 3.12.3.2). Internal to enclosures, terminal blocks and devices such as relays, switches and instruments are uniquely identified. In addition, external cables are color coded and marked to be readily identified (see Subsection 3.12.3.4.2). Wire bundles or cables internal to control boards are not distinctively or permanently identified.

15) Due to spatial limitation beneath the reactor vessel, the following is a description of electrical cable separation for the Neutron Monitoring System (NMS), Reactor Protection System (RPS), and Control Rod Drive System (CRD):

i. All Class 1E cables are routed through enclosed raceway such as enclosed wireways, rigid and flexible conduits except as noted in paragraph iv.

ii. Non-Class 1E cables are routed in open trays.

iii. Cables of different systems may be routed in some portion of raceway. But channel separation is maintained.

iv. Because of space limitation and need for flexibility, the flexible conduits end after the horizontal runs where cables drop down for connection to connectors.

v. The 1 inch minimum separation requirement of IEEE 384-1974 is not met for enclosed raceways beneath the reactor vessel. Also, the minimum separation requirements of IEEE 384-1974 Section 5.1.3 are 5.1.4 and not met for Class 1E enclosed raceways and non-Class 1E open trays.

All cables (Class 1E and non-Class 1E) beneath the reactor vessel are low energy instrumentations circuits. Fire hazard beneath the reactor vessel is described in Fire Protection Review Report Section 6.2.3 Fire Zone 1-1H.

16) Non-Class 1E circuits inside a Class 1E equipment, such as lighting, utility or space heater circuit, shall be considered affiliated unless a 6" minimum separation or physical barrier from the Class 1E circuits is provided or unless analysis or test shows that the non-Class 1E space heater circuits will not affect the Class 1E system. If power is supplied from a non-Class 1E distribution panel, an isolation device or system (Isolation Method V) is installed at or near the equipment to prevent failures in the non-Class 1E circuits from affecting redundant Class 1E circuits.

Alternatively, the non-Class 1E supply cables may be routed in separate raceways such that no common mode failure could affect redundant Class 1E circuits due to a single event.

17) The Safety Parameter Display System (SPDS) is a non-Engineered Safeguard system that derives digital and analog information from Safety-Related and non-Safety Related systems. The input cables for the SPDS are assigned the electrical groupings of the system from which the SPDS derives its input. The output information of the SPDS is totally non-Class 1E. SPDS cables routed in the Main Control Room, the Upper and Lower Cable Spreading Rooms, and all General Plant areas are separated as described in Section 8.1.6.1.q-6. SPDS cables, in part, are also routed through the Upper and Lower Relay Room floor modules. SPDS cables assigned the separation group of Division I and Affiliated are routed in the Upper Relay Room Floor, which primarily contains Division I and non-Class 1E Cables. SPDS cables assigned the separation group of Division II and Affiliated are routed in the Lower Relay Room Floor, which primarily contains Division II and non-Class 1E cables. The SPDS Divisionalized and Affiliated assigned cables share partial routings with non-Class 1E control and instrumentation cables in the respective Upper and Lower Relay Room Floor sections, particularly at the transitional intersections of the lateral and longitudinal floor ducts and at the cable convergence area

entering the bottom of the Relay Room panels. SPDS Divisionalized and Affiliated assigned cables deriving input from NSSS systems are routed the same as the existing respective Safety Related cables in the Relay Room floor ducts.

For Regulatory Guide compliance for NSSS scope of supply see Subsections 7.1.2.5.8, 7.2.2.1.2.1.10, 7.3.2a.1.2.1.10, 7.3.2a.2.2.1.9, 7.3.2a.3.2.1.2, 7.4.2.1.2.1.11, and 7.6.2 3.2.3.4.

SPDS Cables, assigned to Divisionalized and Affiliated separation groupings, deriving input from BOP systems are also routed the same as the existing respective safety related cables in the Relay Room floor ducts with additional requirement that: no non-Class 1E cable can share a common or partial routing with BOP SPDS cables of redundant safety related systems (i.e. Division I & II). In the unlikely event that the non-Class 1E control and instrument cables, routed with the BOP SPDS cables Divisionalized and Affiliated, assigned the separation groups that are in the Relay Room ducts, could provide a failure mechanism to the Class 1E system, this event could only affect one of the Redundant Divisions of the Class 1E systems. The cables and components of the unaffected Division will not be degraded and will be available to perform the required Safety Related functions(s).

18) Inside containment for low energy non-Class 1E instrumentation and control cables, where the separation requirements with class 1E/RPS circuits per IEEE 384-1974 is not met due to spatial limitations, for cables in transition from tray to conduit or conduit to tray or penetration box to tray; the effects of lesser separation are analyzed to demonstrate that class 1E/RPS cables are not degraded below an acceptable level to perform their intended function per IEEE 384-1974 section 4.6.1(3). The analysis is documented in specific calculations per requirements of section C-6 of Regulatory Guide 1.75.

Non-class 1E instrumentation cables are for Rod Position Indication System (RPIS), transient monitoring system, temperature sensor cables and Integrated Leak Rate System (ILRT).

Non-class 1E control cables are for SRV flow monitoring system instrumentation, Traversing Incore Probe indexing mechanisms, Drywell sump level sensors and area cooling flow switches, space heaters for Drywell area unit coolers, and annunciation and interlocks for Reactor Recirc. system components.

Analysis

The instrumentation systems operate on 1-5 Volt DC signals in high impedance circuits or 4-20 mA signals in low impedance circuits. ILRT cables are used for portable RTD connections during Integrated Leak Rate Testing performed when reactor is in cold shutdown mode and personnel access to suppression pool is permitted. After testing is completed, these circuits are isolated from the rest of the plant as all sensors and instruments are disconnected and removed from suppression pool and reactor building areas. Since only low energy can be derived from these instrumentation circuits, the probability of these non-Class 1E circuits providing a mechanism of failure to the class 1E/RPS cables with lesser separation is extremely low.

The control systems operate on 120V AC, or less, at relatively low current values. The two worst case scenarios analyzed involve Drywell area unit cooler space heater and flow switch control circuits. In both cases, assuming a short circuit at the locations where the Zetex wrap is removed, the calculated potential to damage other cables is significantly less than the calculated potential to damage other cables based on actual test results of faulted cables. The probability of these non-class 1E control circuits providing a mechanism of failure to the class 1E/RPS cables, based on their calculated potential to damage thee cables, is extremely low to non-existent.

The worst credible event which could affect the class 1E/RPS cables through the non-class 1E low energy instrumentation and control cables is fully analyzed based on actual test results applicable to specific locations. The analysis determined that there will be no effect on the functional capability of class 1E/RPS cables, with a conservative assumption of non-class 1E instrumentation and control cables having a damage potential equal to that of a highest damage potential cable; the maximum temperature to which class 1E/RPS cables could be subjected to were estimated to be far below the temperatures used during qualification testing of these cables.

r) Regulatory Guide 1.75 (9/78) (Diesel Generator E Only)

The requirements of Regulatory Guide 1.75 (9/78) are the same as the requirements of Regulatory Guide 1.75 (1/75). The compliance and exceptions to Regulatory Guide 1.75 (9/78) for the diesel generator E building and the connections to the transfer points in the diesel generator A,B,C and D rooms are the same as the compliance and exceptions to Regulatory Guide 1.75 (1/75) for the BOP circuits of the plant.

A transfer scheme for substituting diesel generator E for any of the channelized diesel generators A,B,C or D utilizes a double-break configuration as an isolation method to assure independency between redundant safety related load groups. Power, control and instrumentation circuits from the channelized diesel generators A,B,C and D that tie to diesel generator E have two normally open contacts in series for each circuit. The normally open contacts are located in two separate locations. One contact of each circuit is in the channelized diesel generator A,B,C or D room. The second normally open contact of each circuit is in the diesel generator E building. Substitution of diesel generator E is accomplished by closing the normally open contacts of the circuits from the channelized diesel generator for which Diesel Generator E is being substituted. The normally open contacts of the circuits from the other channelized diesel generators continue to be open thereby providing the double-break isolation and maintaining independency.

The Diesel Generator E Class 1E circuitry to the transfer scheme's normally open contacts in the Diesel Generator E Building is designated as a unique Channel H. Cable and raceway for Channel H are separated from non-class 1E and the other channelized Class 1E channel/division cable and raceway in the Diesel Generator E building. Whenever Diesel Generator E is substituted for a channelized diesel generator, Diesel Generator E and its auxiliaries are considered to be the channel to which Diesel Generator E is aligned. The channel H cables and raceway assimilate or are compatible with the channel/division of the substituted channelized diesel generator. The double-break configuration assures the independence of the Diesel Generator E and its auxiliaries from the three remaining channelized diesel generators which were not substituted. Whenever Diesel Generator E is not aligned, the double break configuration assures the independence of Diesel Generator E and its auxiliaries from the four channelized diesel generators.

When Diesel Generator E is aligned only those circuits of the transfer scheme to the substituted diesel generator are energized and operational. The circuits of the transfer scheme between the transfer points of the three remaining channelized diesel generators and Diesel Generator E are de-energized and isolated. Any creditable failure of the de-energized cables will not effect the Channel H cables due to the double break configuration. Likewise, a creditable failure on the channel H is restricted to the aligned channel by the double break configuration.

When Diesel Generator E is not aligned, the channelized circuitry of the transfer scheme is de-energized and isolated by the double break configuration. The channel H circuitry is operational but isolated from the channelized circuitry of the transfer scheme by the double break configuration.

The channel/divisional class 1E internal wiring to the transfer switches within the transfer points is isolated by 6 inches or a barrier except within the cover of the transfer switches. Inside the cover, the internal wiring is routed in separate bundles so as to maximize the distance. However, as indicated above, the transfer switch is either closed which results in the wiring on both sides of the switch assimilating the same separation group or the switch is open which is isolating energized, operable wiring from deenergized, inoperable wiring.

s) Regulatory Guide 1.81 (1/75)*

The design of the standby electric power systems meets Regulatory Guide 1.81.

The dc power systems are not shared between the two units.

The standby ac power supplies are shared between the two units. The standby ac power systems have the capability to concurrently supply the engineered safety feature loads of one unit and the safe shutdown loads of the other unit, assuming a total loss of offsite power and a single failure in the onsite power system, such as the loss of one diesel generator.

The standby ac power systems for the two units are designed with minimum interactions between each unit's safety feature circuit so that allowable combinations of maintenance and test operations in either or both units would not degrade the capability to perform the minimum required safety functions in any unit, assuming a total loss of offsite power.

t) Regulatory Guide 1.89 (11/74)*

Refer to Section 3.13 for compliance statement.

u) Regulatory Guide 1.93 (12/74)*

Redundant offsite and onsite power sources are provided to meet the "Limiting Conditions for Operation" as defined in Regulatory Guide 1.93. See Chapter 16 for plant operating restrictions after the loss of power sources.

v) Regulatory Guide 1.106 (11/75) (3/77)

The requirements of Regulatory Guide 1.106 are met.

The thermal overload protection devices for all safety related motors on motor-operated valves (MOV) are continuously bypassed except during testing. Continuous bypass is a normally closed (N.C.) contact from either a relay or switch which is connected in parallel across the thermal overload trip contact.

Continuous bypass is accomplished by the use of an operate/test or normal/test type selector switch located in Panel OC697 at rear section of control room:

A. Operate/Test Type Switches

1. In the operate position, a set of normally closed (N.C.) contacts for each MOV is connected in parallel across the thermal overload trip contacts, thus bypassing the overload trip.

2. In the test position, the above set of contacts open thus permitting the overload trip contacts to trip the motor on closing or opening should an overload condition occur.

B. Normal/Test Type Switches

1. In the normal position, a set of normally open (N.O.) contacts in series with one or more relays (designated as 95) deenergizes the 95 relays. A set of normally closed relay contacts is paralleled across the thermal overload trip contacts thus bypassing the overload trip. Loss of power to the relays will cause the overloads to be bypassed.

2. In the test position the above, N.O. contacts close, energizing the 95 relays, and thus opens the contact across the MOV overload trip contacts. This permits a motor overload to trip the motor during a closing or opening test operation.

A bypass indication system is provided to alert the control room operator when a safeguard MOV is in a disabled condition. Loss of power supply, such as when the breaker is tripped for maintenance, or loss of control power is indicated in the bypass indication panel C694 located behind the unit operating benchboard. A division I or II group alarm will then be made and this will be annunciated at the emergency core cooling benchboard C601.

Table 8.1-1 provides a listing of all MOV's with their thermal overload bypassed during plant operation (refer to Section 1.7 for changes).

w) <u>Regulatory Guide 1.106 (3/77)</u> (Diesel Generator E Only)

The requirements of Regulatory Guide 1.106 are met.

When Diesel Generator E is not aligned for Diesel Generator A, B, C or D, the thermal overload protection on the Loop A and B ESW supply and return valves to Diesel Generator E is automatically bypassed. Automatic bypass is a normally open (N.O.) contact of a relay connected in parallel across the thermal overload trip contact which changes state to a closed contact due to the relay energizing.

When Diesel Generator E is not aligned, automatic bypass is accomplished by a relay energized by a LOCA or LOOP signal.

8.1.6.2 Compliance with IEEE 338, 344, and 387

IEEE 338-1971, 344-1971 and 387-1972 are applicable to the plant except for the Diesel Generator E where IEEE 338-1977, 344-1975, 387-1977 are applicable.

a. IEEE 338

See response to Regulatory Guide 1.118 in Section 3.13 for compliance statement.

b. IEEE 344

Compliance with this standard is discussed in Section 3.10.

c. IEEE 387

The following paragraphs analyze compliance with the design criteria of IEEE 387.

Adequate cooling and ventilation equipment is provided to maintain an acceptable service environment within the diesel generator rooms during and after any design basis event, even without support from the preferred power supply.

Each diesel generator is capable of starting, accelerating, and accepting load as described in Subsection 8.3.1.4. The diesel generator automatically energizes its cooling equipment within an acceptable time after starting.

Frequency and voltage limits and the basis of the continuous rating of the diesel generator are discussed in the compliance statement to Regulatory Guide 1.9 in Subsection 8.1.6.1.

Mechanical and electric systems are designed so that a single failure affects the operation of only a single diesel generator.

Design conditions such as vibration, torsional vibration, and overspeed are considered in accordance with the requirements of IEEE 387.

Each diesel governor can operate in the droop mode and the voltage regulator can operate in the paralleled mode during diesel generator testing. If an underfrequency condition occurs while the diesel generator is paralleled with the preferred (offsite) power supply, the diesel generator will be tripped automatically.

When aligned to a Class 1E 4.16kv Bus, each diesel generator is provided with control systems permitting automatic and manual control. The automatic start signal is functional except when a diesel generator is not aligned. Provision is made for controlling the aligned diesel generators from the control room and from the diesel generator room/building. Subsection 8.3.1.4.10 provides further description of the control systems.

Voltage, current, frequency, and output power metering is provided in the control room for the aligned diesel generators to permit assessment of the operating condition of each diesel generator.

Surveillance instrumentation is provided in accordance with IEEE 387 as follows:

1) Starting System

   Starting air pressure low alarm

2) Lubrication System

   Lube oil pressure low trip and lube oil temperature high and low alarms. Lube oil pressure low trip is by coincident logic.

3) Fuel System

   Fuel oil level in day tank high and low, fuel oil pressure high and low, and fuel oil level in storage tank high and low alarms

4) Primary Cooling System

   Essential service water low pressure

5) Secondary Cooling System

   Jacket coolant temperature high and low, jacket coolant pressure low

6) Combustion Air Systems

Failure alarm is provided

7) Exhaust System

Pyrometers located at diesel generator local control panel

8) Generator

Generator differential, ground overcurrent, and reverse-power, underfrequency, and overvoltage trip and alarm. Neutral overvoltage and overcurrent alarm.

9) Excitation System

Low field current and overexcitation relay trip and alarm

10) Voltage Regulation System

Diesel generator overvoltage alarm

11) Governor System
Diesel generator underfrequency alarm and trip, and engine overspeed trip

12) Auxiliary Electric System

4.16 kV bus undervoltage relays initiate bus transfer and alarm.

A detailed list of trip and alarm functions and testing of the diesel generator is discussed in Subsection 8.3.1.4.

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