UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D C. 20666-0001
February 6, 1997

MEMORANDUM TO: John F. Stolz, Director
Project Directorate I-2
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

FROM: Ledyard B. Marsh, Chief
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: REGION I TASK INTERFACE AGREEMENT REGARDING THE NRC POLICY ON USING REPAIRS TO ACHIEVE APPENDIX R ALTERNATIVE SHUTDOWN CONDITIONS AND THE INTERPRETATION OF NRC GENERIC LETTER 86-10 GUIDANCE REGARDING SPURIOUS VALVE ACTUATION (TAC NOS. M87879 AND M87880).

Plant Name: Salem Nuclear Generating Station, Units 1 and 2
Licensee: Public Service Electric & Gas Co.
Review Status: Complete
Reviewer: Patrick Madden, 415-2854

By memorandum dated October 5, 1993, NRC Region I requested that the Office of Nuclear Reactor Regulation (NRR) provide technical assistance with the resolution of two issues identified during the fire protection and post-fire safe-shutdown inspection at Salem on May 17-21, 1993. The following summarizes the two issues:

1. During the May 1993 inspection, the NRC staff found that the Salem alternative shutdown methodology (used in the event of a fire that causes the evacuation of the control room) relied on repairs to provide electrical independence from the affected fire area (e.g., the control room or the cable spreading room) and to restore the operability of equipment needed to achieve hot shutdown.

2. In its associated circuit analysis, the licensee evaluated spurious signals and equipment operations. However, the licensee assumed that only one spurious operation could result from a fire in any fire area, regardless of the number of unprotected circuits present in the area. The licensee claimed that its analysis was consistent with the guidance provided in Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986. During the May 1993 inspection, the NRC questioned the licensee's interpretation of the GL 86-10 guidance.

The attachment to this memorandum provides the staff evaluation of the above issues and its conclusions regarding Salem's compliance with NRC fire

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absent adequate interim compensatory measures, the staff has no basis for recommending that Unit 2 be allowed to restart prior to full implementation of the required post-fire safe-shutdown modifications.

Docket Nos. 50-272
and 50-311

Attachment: As stated

cc w\attachment: L. Olshan

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EVALUATION OF TECHNICAL ISSUES RELATED TO THE POST-FIRE SAFE-SHUTDOWN CAPABILITY OF THE SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2

FIRE PROTECTION ENGINEERING SECTION
PLANT SYSTEMS BRANCH
DIVISION OF SYSTEMS SAFETY AND ANALYSIS
OFFICE OF NUCLEAR REACTOR REGULATION

1.0 BACKGROUND

On May 17-21, 1993, U.S. Nuclear Regulatory Commission (NRC) Region I conducted a fire protection and post-fire safe shutdown inspection at Salem Nuclear Generating Station, Units 1 and 2 (Salem). The Office of Nuclear Reactor Regulation (NRR) participated in the inspection.

In a memorandum to Steven Varga, Director, Division of Reactor Projects I/II, NRR, dated October 5, 1993, Richard W. Cooper, Director, Division of Reactor Projects, Region I, submitted a proposed Task Interface Agreement (TIA) and requested that NRR help resolve two alternative shutdown system issues identified during the inspection. The following summarizes the two issues:

a. During the May 1993 inspection, the NRC staff found that the Salem alternative shutdown methodology (used in the event of a fire that causes the evacuation of the control room) relied on repairs to provide electrical independence from the affected fire area (e.g., the control room or the cable spreading room) and to restore the operability of equipment needed to achieve hot shutdown.

b. In its associated circuit analysis, Public Service Electric & Gas Company (PSE&G), the licensee for Salem, evaluated spurious signals and equipment operations. However, the licensee assumed that only one spurious operation could result from a fire in any fire area, regardless of the number of unprotected circuits present in the area. The licensee claimed that its analysis was consistent with the guidance provided in Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986. During the May 1993 inspection, the NRC questioned the licensee's interpretation of the GL 86-10 guidance.

By letters dated August 2 and October 26, 1993, the licensee submitted additional information regarding the unresolved inspection items and its review of Information Notice (IN) 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," for staff review. In these submittals, the licensee stated its position that the technical concerns identified by IN 92-18 exceeded the original Salem design requirements for post-fire safe-shutdown capability.

In response to the Region I TIA, the NRR staff reviewed Salem's licensing basis as it relates to post-fire alternative shutdown capability and the associated analysis. By letter dated January 25, 1996, NRR forwarded its report "Safe Shutdown Capability Reassessment for Salem Nuclear Generating Station, Units 1 and 2" to the licensee. This was a Technical Evaluation

Report (TER) prepared by Brookhaven National Laboratory (BNL), the staff's technical assistance contractor. On the basis of this TER, the staff concluded that the Salem alternative shutdown system and methodology did not satisfy the regulatory requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50.

On February 7, 1996, the staff met with the licensee to discuss its concerns about the alternative shutdown system and the licensee's reliance on plant repairs in order to achieve and maintain hot shutdown. By letter dated June 19, 1996, the licensee submitted a formal response to the staff's letter of January 25, 1996, and the meeting on February 7, 1996. By letter dated October 30, 1996, the staff requested the licensee to provide certain clarifications and additional information relating to the elimination of hot shutdown repairs, fire-induced spurious signals, and the assurance that equipment or components needed for post-fire safe shutdown are not adversely affected by fire-induced circuit failures.

By letter dated December 2, 1996, the licensee committed to install isolation transfer switches which will eliminate the use of electrical jumpers, the lifting leads and the replacement of fuses as a method for achieving post-fire safe shutdown. For Unit 1, the licensee committed to complete MOV circuit modifications and to install isolation transfer switches prior to restart. For Unit 2, the licensee committed to complete MOV circuit modifications for 20 hot-standby valves and to install the remaining service water system isolation transfer switches during the next refueling outage (refueling outage 10). The licensee did not propose interim compensatory measures for the Unit 2 alternative shutdown design weaknesses nor did it describe how it will mitigate the potential adverse consequences of fire-induced hot shorts on the MOVs in question.

BNL, the staff's technical assistance contractor, reviewed the licensee's submittal dated December 2, 1996. BNL's reviewed the technical adequacy of the actions the licensee took to resolve the TIA issues. BNL's TER is included as an appendix to this report. The staff concurs with BNL's conclusions.

2.0 EVALUATION OF UNRESOLVED TECHNICAL ISSUES

2.1 Alternative Shutdown System Design Reliance on the Use of Repairs To Achieve and Maintain Hot Shutdown and its Related Licensing History

Section III.G.1.a to Appendix R of 10 CFR Part 50 requires that fire protection features be provided for structures, systems, and components important to safe shutdown. These features shall be capable of limiting fire damage so that one train of systems necessary to achieve and maintain hot-shutdown conditions from either the control room or emergency control station(s) is free of fire damage. In addition, Sections III.G.1.b and III.L.5 of Appendix R to 10 CFR Part 50 establish the criteria for cold-shutdown system repairs. Repairs (e.g., cutting or lifting leads, installing jumpers or new wires, pulling and replacing fuses) of post-fire safe-shutdown systems required for achieving and maintaining hot-shutdown or hot-standby are not allowed. In order to meet these requirements, the licensee would have to

systems required for achieving and maintaining hot-shutdown or hot-standby are not allowed. In order to meet these requirements, the licensee would have to demonstrate that the post-fire hot-shutdown component can perform its intended function without reliance on repairs. In addition, the licensee would have to demonstrate that fire-induced faults in electrical circuits such as hot shorts, shorts to ground, or open circuits would not cause maloperation or prevent the operation of a required safe-shutdown component.

In the event the licensee's analysis cannot demonstrate that one train of systems necessary to achieve and maintain hot shutdown remains free of fire damage (e.g., a fire in the control room), the provisions of Sections III.G.3 and III.L of Appendix R would be imposed. Section III.G.3, states: "Alternative or Dedicated shutdown capability and its associated circuits, independent of cables, system, or components in the area, room, or zone under consideration shall be provided: (a) Where the protection of systems whose function is required for hot shutdown does not satisfy the requirement of paragraph G.2 of this sections." Appendix R, Section III.L., "Alternative or Dedicated Shutdown," paragraph 3, requires that the equipment and components that comprise the alternative shutdown system be both physically and electrically independent of the area of concern (e.g., the control room and the cable spreading room). In addition, Appendix R, Section III.L.7, requires that the associated circuits in the fire-affected area of concern be isolated from safe-shutdown equipment and systems so that hot shorts, shorts to ground, or open circuits in the associated circuit will not prevent the operation of the shutdown equipment.

To provide reasonable assurance that the cabling required for or associated with the alternative shutdown capability is physically and electrically separated from (i.e., independent of) the effects of fire in either the control room or the cable spreading room, alternative shutdown system designs incorporate the use of isolation/transfer switches. These devices enable the plant operators to manually and systematically transfer control and/or monitoring of required shutdown equipment and functions to an area of the plant that is physically and electrically independent of the fire-affected area of concern.

The original alternative shutdown system design at Salem did not incorporate the use of isolation/transfer switches. Rather, the licensee's shutdown methodology relied on abnormal operating procedures that directed operators to perform repairs as necessary to isolate potentially affected circuits and to establish local control and monitoring capability for required shutdown systems. During the initial licensing of Salem Unit 2, the staff had accepted the use of repairs on an interim basis during the plant's startup testing program. In its May 1981 safety evaluation report (NUREG-0517, Supplement No. 6, "Safety Evaluation Report Related to the Operation of Salem Nuclear Generating Station, Unit No. 2," and its Report on PSE&G Cable Separation Study, which was included as Attachment G to the May 1981 SER), the staff approved this approach as a short-term temporary measure, with long-term compliance pending future staff review.

In a memorandum dated June 4, 1981, a copy of which was forwarded to the licensee, the staff summarized the meeting held on April 13, 1981, with the

licensee to discuss the design of its alternative shutdown capability. The staff in this memorandum stated that the installed alternative shutdown system does not satisfy the designs that were approved by the staff. The staff requested the licensee to submit a more detailed description of this system and indicated that this response should justify the acceptability of substituting manual actions and repair procedures for a hard-wired control system with transfer switches. In its submittal of July 17, 1981, the licensee provided its response to this request and indicated that its alternative shutdown design did not use transfer switches, that some physical modifications may be required to restore equipment circuitry to its original condition, and that these actions are administratively controlled.

On September 18, 1981, the licensee submitted its final interim fire protection program safe-shutdown and interaction report to the staff for review. The staff completed its review of this report and documented its results in its letter to the licensee dated April 20, 1982. The staff concluded that the licensee should analyze all non-safety-related associated power, control, and instrumentation circuits to ensure that they meet the requirements of Section III.L of Appendix R and that they are isolated from the alternative shutdown systems by the fire protection measures listed in Section III.G.2 or by suitable isolation devices. In its letter, the staff also indicated that the licensee's alternative shutdown procedure requires installation of electrical jumpers and pneumatic bypasses and that these repair actions were not acceptable. It was the staff's position that systems and components used to achieve and maintain hot-standby conditions must be free of fire damage. In addition, the staff stated its position regarding alterative shutdown equipment and the necessity for this equipment to be independent of the cables, equipment, and associated circuits of the redundant systems damaged by the fire.

In its submittal of June 16, 1982, the licensee informed the staff that its alternative shutdown procedures for Salem did not require the use of electrical jumpers or pneumatic bypasses. On the basis of this submittal, the staff stated in its SER of May 31, 1983, that "no repairs or modifications are required to effect hot or cold shutdown utilizing the alternate shutdown methods." In addition, in its SER, the staff recognized that the alternative shutdown method used would be accomplished by procedural means, with actions being performed at local control stations or locally at the equipment. The staff also noted that this method could achieve cold-shutdown conditions within 72 hours after the fire without the need for plant repairs.

By letter dated March 2, 1984, the NRC staff provided the results of its Appendix R compliance inspection of Salem Unit 1. During this inspection, the NRC staff concentrated on determining the overall acceptability of the alternative shutdown capability design by conducting a sample audit of the design and related procedures. This audit included verification that there was no dependency on repairs for achieving hot shutdown. This inspection revealed that hot-shutdown repairs were required for local start of the emergency diesel generator. The staff concluded that these repairs were unacceptable. In a letter dated January 26, 1988, the NRC staff provided the licensee with the results of its Appendix R compliance inspection of Salem Units 2. During this inspection, the NRC inspection team observed the

operators performing some of the steps in the alternative shutdown procedure and determined that some of the operator actions involved repairs. The repairs involved the use of pneumatic jumpers to prevent spurious actuations of valves. The acceptability of hot-shutdown repair activities was an unresolved item. The staff, in its letter dated January 25, 1996, provided the licensee with BNL's TER which addressed the technical issues associated with this unresolved item.

During the May 17-21, 1993, NRC Appendix R compliance inspection of Salem Units 1 and 2, the NRC staff confirmed that in lieu of providing an isolation transfer switch capability in the design of the alternative shutdown system, Salem operators are procedurally directed to perform numerous complex repair activities. These included lifting and cutting electrical leads, installing electrical jumpers and removing fuses in order to isolate potentially fire-affected circuits and to regain control of post-fire safe-shutdown equipment. The inspection team considered this inspection item to be unresolved.

By letters dated August 2 and October 26, 1993, the licensee submitted additional information regarding the unresolved items from the May 1993 inspection and its review of IN 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," for staff review.

In response to the Region I TIA, the Fire Protection Engineering Section (FPES), Plant Systems Branch, Division of Systems Safety and Analysis, NRR, reviewed Salem's licensing basis as it relates to the post-fire alternative shutdown capability and the associated analyses. By letter dated January 25, 1996, NRR forwarded the BNL TER, "Safe Shutdown Capability Reassessment for Salem Nuclear Generating Station, Units 1 and 2," to the licensee. The TER included a review of Salem's licensing basis with respect to Sections III.G and III.L of Appendix R to 10 CFR Part 50. On the basis of this review, the staff concluded that the Salem alternative shutdown system and methodology did not satisfy the regulatory requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50. Specifically, the staff concluded that; (1) the staff did not accept as permanent compliance strategy the post-fire alternative shutdown system design reliance on repairs to achieve and maintain hot-standby conditions; (2) the licensee's assumption of one spurious operation per fire event is not consistent with established staff guidance and does not satisfy the regulatory requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50; and (3) the licensee's evaluation and disposition of staff concerns described in IN 92-18 are not consistent with established staff guidance and do not satisfy the regulatory requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50.

On February 7, 1996, the staff met with the licensee to discuss the three issues described above. At this meeting, the licensee characterized its perspective of the above issues and described evaluations and design changes being implemented at Salem to address these concerns. By letter dated June 19, 1996, the licensee submitted a formal response to the staff's letter of January 25, 1996, and the meeting on February 7, 1996. The staff reviewed this response and determined that clarifications were needed before it could complete its review. By letter dated October 30, 1996, the NRC staff requested additional information concerning the licensee's actions to

eliminate the use of repairs to achieve and maintain hot standby; the plant's ability to cope with and mitigate fire-induced spurious signals; and the plant's ability to ensure that equipment or components needed for post-fire safe shutdown are not adversely affected by fire-induced hot shorts.

By letter dated December 2, 1996, the licensee provided its response to the request for additional information. The licensee has committed to ensure electrical independence of the post-fire alternative safe-shutdown functions from the control room and to eliminate the need to perform post-fire safe-shutdown repairs by installing isolation transfer switches for the required alternative shutdown equipment and components. In addition, the licensee has evaluated the adverse impact fire-induced hot shorts could have on the plant's post-fire alternative shutdown capability to perform its intended function. The licensee has determined that the thermal overload protection (TOL) was adequate for certain shutdown-related MOVs to protect them against mechanical valve damage, thus maintaining their ability to be manually manipulated by plant operators. The licensee determined that other MOVs could be damaged by a fire-induced hot short. The licensee committed to perform wiring/control circuit logic modifications for these valves. These modifications will preclude fire-induced hot shorts from initiating a spurious signal that would initiate valve movement and bypass the valve's torque and limit switches, thus preventing mechanical valve damage.

2.2 Analysis Assumptions Pertaining to the Plant's Ability to Cope With Fire-Induced Spurious Signals

During the May 1993 inspection, the NRC staff concluded that the licensee's associated circuit analysis did not adequately consider the potential adverse affects of fire-initiated spurious signals caused by hot shorts, shorts to ground, or open circuits on the plant's ability to achieve and maintain safe shutdown.

Appendix R, Section III.G, "Fire Protection of Safe Shutdown Capability," paragraph 1.a, requires that "one train of systems necessary to achieve and maintain hot shutdown conditions from either the control room or emergency control station(s) [be] free of fire damage." In addition, Section III.G, paragraph 2, requires that "where cables or equipment, including associated non-safety circuits that could prevent operation or cause maloperation due to hot shorts, open circuits, or shorts to ground, of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area, a means be provided for ensuring that one train of the redundant safe shutdown trains is free of fire damage." The safety concerns associated with fire-induced hot shorts, open circuits, or shorts to ground in safe shutdown and associated circuits, which could prevent operation or cause maloperation of redundant shutdown trains, were predicated on the conditions that occurred during the Browns Ferry fire of March 25, 1975. (Reference: NUREG-0050, "Recommendations Related to Browns Ferry Fire," February 1976.)

Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986, provided an interpretation of the term free of fire damage. Interpretation 3, "Fire Damage," of Enclosure 1, "Interpretations of Appendix R," of GL 86-10, states: "the Commission has provided methods

acceptable for assuring that necessary structures, systems and components are free of fire damage (see Sections III.G.2.a, b, and c), that is, the structure, system, or component under consideration is capable of performing its intended function during and after the postulated fire as needed."

Where redundant safe-shutdown trains are susceptible to fire damage, Appendix R, Section III.G, paragraph 3, states that "alternative or dedicated shutdown capability and its associated circuits, independent of cables, systems, or components in the area, room, or zone under consideration shall be provided." Appendix R, Section III.L, "Alternative or Dedicated Shutdown Capability," paragraph 1, specifies that "the alternative and dedicated shutdown capability provided for a specific fire area shall be able to: (a) achieve and maintain subcritical reactivity conditions in the reactor; (b) maintain reactor coolant inventory; (c) achieve and maintain hot standby for a PWR [pressurized-water reactor] (hot shutdown for a BWR [boiling-water reactor]); (d) achieve cold shutdown within 72 hours, and (e) maintain cold shutdown conditions thereafter."

Appendix R, Section III.L, paragraph 3, states; "The shutdown capability for specific fire areas may be unique for each such area, or it may be one unique combination of systems for all such areas." In addition, this paragraph specifies in part that "the alternative shutdown capability shall be independent of the specific fire area(s)." Section III.L, paragraph 7, states, "The safe shutdown equipment and systems for each fire area shall be known to be isolated from associated non-safety circuits in the fire area so that hot shorts, open circuits, or shorts to ground in the associated circuits will not prevent the operation of the safe shutdown equipment."

In Enclosure 3 of GL 81-12, "Fire Protection Rule," dated February 20, 1981, the staff stated, "In evaluating alternative shutdown methods, associated circuits are circuits that could prevent the operation or cause the maloperation of the alternative train which is used to achieve and maintain hot shutdown conditions due to the fire-induced hot shorts, open circuits, or shorts to ground." The guidance of GL 81-12 recognized that a fire is capable of inducing multiple hot shorts, shorts to ground, or open circuits. Therefore, in order for the alternative shutdown capability to perform its intended function, the equipment that it relies on must be capable of performing its functions after it has been electrically isolated from the fire area of concern (e.g., the control room and the cable spreading room). If there is a potential for required post-fire safe-shutdown components to be damaged by fire-induced faults before electrical isolation at local control stations outside the control room, then there is not reasonable assurance that the alternative shutdown capability would be able to perform its intended function.

In its original post-fire safe-shutdown methodology analysis for Salem, the licensee assumed only one spurious actuation as a result of fire in any area, regardless of the number of unprotected circuits that may be susceptible to fire damage and the potential for this damage to cause spurious operation or maloperation of safe-shutdown equipment. This assumption is not supported by either engineering judgement or the requirements Sections III.G or III.L of Appendix R. To the contrary, Appendix R requires that: (1) any and all hot

shorts, open circuits, shorts to ground in cables that could prevent operation or cause maloperation of redundant trains of systems necessary to achieve and maintain hot shutdown conditions within the same fire area be identified and the appropriate fire protection be provided such that one train of hot shutdown systems remains free of fire damage, or (2) the safe shutdown equipment and systems for each fire area be isolated from associated non-safety circuits so that hot shorts, open circuits, or shorts to ground will not prevent operation of the safe shutdown equipment.

The licensee based its single spurious actuation or signal assumption on its interpretation of the NRC staff response provided to Question 5.3.10, "Design Basis Plant Transient," of GL 86-10. To limit the scope of the equipment needed to meet the reactor performance goals of Section III.L of Appendix R, this guidance specified the plant transient that should be considered in determining the design capacity and the capabilities of the alternative or dedicated shutdown system and established the design input limits for the reactor coolant inventory loss, flow diversion affecting systems needed to perform the reactor coolant makeup function, and onsite power sequencing logic. The plant transient specified in GL 86-10 was as follows:

> Loss of offsite power shall be assumed for a fire in any fire area concurrent with the following assumptions:
>
> a. The safe shutdown capability should not be adversely affected by any one spurious actuation or signal resulting from a fire in any plant area; and
>
> b. The safe shutdown capability should not be adversely affected by a fire in any fire area which results in the loss of all automatic function (signals, logic) from the circuits located in the area in conjunction with one worst case spurious actuation or signal resulting from the fire; and
>
> c. The safe shutdown capability should not be adversely affected by a fire in any plant area which results in spurious actuation of the redundant valves in any one high-low pressure interface line.

The staff intended that licensees would use this guidance to determine the capacity and capability of the alternative or dedicated safe-shutdown system (e.g., sizing of pumps and the support systems needed to maintain reactor coolant inventory, define the scope of onsite electrical power distribution and power needs, establish an operational baseline and a set of plant conditions that would define the scope of initial manual actions needed to restore those systems necessary to accomplish the required reactor performance goals). Application of this staff guidance is based on the alternative shutdown system: (1) being physically and electrically independent of the fire area of concern; and (2) being isolated from associated circuits so that hot shorts, shorts to ground, and open circuits in these circuits will not prevent the operation of safe shutdown equipment or components.

The ability to isolate fire-damaged circuits from the control room, mitigate spurious actuations, and ensure functionality of safe-shutdown equipment after

its transfer of control to the remote shutdown stations and emergency control stations is also supported by the responses the staff made to other GL 86-10 questions. In its response to Question 3.8.4, "Control Room Fire Considerations," the staff provided guidance regarding the level of control room damage conditions and the capability to ensure that safe shutdown can be maintained from outside the main control room. The staff stated: "The damage to the systems in the control room cannot be predicted. A bounding analysis should be made to assure that safe shutdown conditions can be maintained from outside the control room." In addition, this response stated: "The analysis should demonstrate that the capability exists to manually achieve safe shutdown conditions from outside the control room by restoring ac power to designated pumps, assuring that valve lineups are correct, and assuming that any malfunctions of valves that permit the loss of reactor coolant can be corrected before unrestorable conditions can occur" (emphasis added). The staff's response to this question clearly acknowledged that the fire will induce signals that will cause operational changes (e.g., valves changing position) to the plant.

In its response to Question 5.2.1, "Shutdown and Repair Basis," of GL 86-10, the staff addressed post-fire shutdown and repair procedures. The staff stated "Safe shutdown capabilities including alternative shutdown capabilities are all designed for some maximum level of fire damage (system unavailabilities, spurious actuations). Since the extent of the fire cannot be predicted, it seems prudent to have the post-fire shutdown procedures guide the operators from full system availability to the minimum shutdown capability." In this response, the staff indicated that fire damage can cause multiple system unavailabilities and spurious system or component actuations and that methods for restoring the needed system and mitigating spurious actuations should be documented in a procedure.

In its response to Question 5.3.1, "Circuit Failure Modes," of GL 86-10, the staff answered the following industry question: "What circuit failure modes must be considered in identifying circuits associated by spurious actuations?" The staff's response stated: "Sections III.G.2 and III.L.7 of Appendix R define the circuit failure modes as hot shorts, open circuits, and shorts to ground. For consideration of spurious actuations, all possible functional failure states must be evaluated, that is, the component could be energized or deenergized by one or more of the above failure modes. Therefore, valves could fail open or closed; pumps could fail running or not running; electrical breakers could fail open or closed" (emphasis added). In this response, the staff made it clear that multiple spurious actuations caused by fire-induced hot shorts, shorts to ground, or open circuits must be considered and evaluated. The staff's response indicated that components could be energized or deenergized by hot shorts, shorts to ground or open circuits and could result in valves failing open or closed; pumps failing running or not running, and so on. The intent of this staff response was to ensure that licensees performed analyses of sufficient depth to determine the adverse impacts of hot shorts, shorts to ground, or open circuits on safe-shutdown-related control circuits and their associated logic (e.g., spurious pump start without injection or minimum-flow path; spurious opening or closings of MOVs by signals that bypass the valve's protective features).

In its letter of June 19, 1996, the licensee stated that it had reanalyzed all fire areas for which it applied the single spurious actuation assumption. For areas other than those requiring alternative shutdown capability, the licensee concluded that the cabling in each application either met separation requirements, was adequately protected, or its function for the component(s) served would not lead to spurious actuations, and, therefore, dependence on the single spurious actuation assumption was not necessary. With regard to its application of the single spurious actuation assumption in areas requiring an alternative shutdown capability, the licensee's position is that its interpretation of GL 86-10, Question 5.3.10, that is, that only one spurious operation needs to be assumed, is correct. For the reasons stated above, it is the staff's position that the licensee's interpretation is not correct.

Despite its stated position, the licensee has reevaluated the alternative shutdown systems needed to achieve and maintain hot-standby conditions. In its letter of June 19, 1996, the licensee stated that it had developed a design change to install isolation/transfer switches. By letter dated December 2, 1996, the licensee indicated that it had completed the isolation transfer switch modifications on Unit 2 for the hot standby equipment and that it would complete the Unit 1 modifications before restart. In addition, as a result of its spurious actuation reanalysis, the licensee committed to install isolation transfer switches for certain service water valves related to maintaining cooling water for the emergency diesel generator. For Unit 2, the licensee committed to install the remaining service water system isolation transfer switches during the next refueling outage (refueling outage 10). The licensee did not propose interim compensatory measures for the Unit 2 alternative shutdown design weaknesses nor did it describe how it will mitigate the potential adverse consequences of fire-induced spurious operations of the service water MOVs in question.

2.3 Evaluation and Disposition of NRC Concerns Regarding the Potential for Loss of Remote Shutdown Capability Following a Control Room Fire (IN 92-18)

On February 28, 1992, the NRC issued IN 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," to alert licensees of conditions that could result in a loss of ability to maintain the reactor in a safe-shutdown condition in the event of a control room fire. Specifically, IN 92-18 alerted licensees to the potential for a control room fire to cause an electrical short circuit between normally energized conductors and conductors associated with the control circuitry of MOVs required to achieve and maintain post-fire safe-shutdown conditions from outside the main control room. Such an event could cause the valve to spuriously actuate. Because of the location of the circuit fault, the MOV torque and limit switches could be ineffective in stopping valve operation. Additionally, TOL protection has been bypassed at some facilities. Given these conditions, there is a potential for a fire-initiated spurious valve actuation to result in mechanical damage sufficient to prevent reactor operators from manually operating the affected valve. Such fire-induced damage could adversely affect the ability to achieve and maintain safe shutdown.

During the May 1993 Appendix R inspection, the licensee stated that the

conditions described in IN 92-18 were not credible. Therefore, it did not perform an evaluation. By letter dated October 26, 1993, the licensee forwarded to the staff for review its response to IN 92-18 in a document titled, "Engineering Evaluation of Salem Generating Station, Units 1 and 2, Control Room Evacuation for Fire-Induced MOV Hot Shorts as Discussed in NRC Information Notice 92-18," dated August 20, 1993. This evaluation identified 65 valves needed to support the control room evacuation procedure and the safe shutdown analysis. As part of its evaluation, the licensee reviewed the schematics and wiring diagrams for the 65 valves to determine which cables associated with the valves were routed in areas in which control room evacuation may be required in the event of a fire. Of the 65 valves, the licensee found that 51 were susceptible to the hot-short conditions described in IN 92-18. However, the licensee concluded that "due to system/component redundancies at Salem Generating Station, Units 1 and 2, failure of any one of these valves would not preclude a post-fire safe-shutdown condition."

The licensee predicated its disposition of this concern on the basis of its interpretation of the staff guidance contained in GL 86-10. As detailed in Section 2.2 above, the licensee had assumed that the evaluation of the post-fire alternative shutdown capability need only consider one spurious valve actuation, irrespective of the number or the post-fire shutdown significance of the potentially affected circuits. This interpretation of its evaluation of issues described in IN 92-18 led the licensee to conclude, without technical justification, that only 1 of the 51 potentially affected valves would spuriously actuate.

During the meeting of February 7, 1996, the licensee described a design change to preclude mechanical valve damage by reinstalling the previously bypassed TOL protection on certain MOVs. In its letter dated June 19, 1996, the licensee stated that this modification resolved for Salem the issues identified in IN 92-18, and that the TOL protection for these MOVs had been installed.

By letter dated October 30, 1996, the staff requested that the licensee describe the methodology and criteria it used to ensure that the TOL protection was properly sized and that it would adequately protect the subject MOVs from mechanical damage. The staff also asked the licensee to verify that tripping of the TOL protection devices would not render the subject MOVs inoperable, and that after the MOVs are electrically isolated, they can be operated remotely from emergency control stations located outside the control room.

In a letter dated December 2, 1996, the licensee provided the results of its MOV evaluation and confirmed that MOVs protected by TOLs can be reset (at their respective motor control centers [MCCs]) and controlled locally (from their respective MCCs) after their control circuits have been isolated from the fire-affected area of concern by their isolation/transfer switches.

During its TOL review, the licensee identified 13 hot-standby valves that had marginal values for motor torque capability (at full voltage) versus the valve assembly torque limit and 7 valves whose TOLs do not fully provide motor protection. In its letter of December 2, 1996, the licensee committed to

modify the control circuits for these valves. The proposed circuit modification will prevent a hot short from bypassing the limit and torque switches.

For Unit 1, the licensee committed to complete MOV circuit modifications and to install isolation transfer switches prior to restart. For Unit 2, the licensee committed to complete MOV circuit modifications for 20 hot-standby valves and to install the remaining service water system isolation transfer switches during the next refueling outage (refueling outage 10). The licensee did not propose interim compensatory measures for the Unit 2 alternative shutdown design weaknesses nor did it describe how it will mitigate the potential adverse consequences of fire-induced spurious operations of the MOVs in question.

3.0 CONCLUSION

Section III.G.1.a of Appendix R to 10 CFR Part 50 requires that fire protection features be provided for structures, systems and components important to safe shutdown. It also requires that these features be capable of limiting fire damage so that one train of systems necessary to achieve and maintain hot-shutdown conditions from either the control room or emergency control station(s) is free of fire damage. In the event that it cannot be demonstrated that one train of systems necessary to achieve and maintain hot shutdown remains free of fire damage, compliance with the provisions of Sections III.G.3 and III.L of Appendix R would be required. In order to meet the requirements of Section III.L of Appendix R, the alternative shutdown system and its post-fire hot-shutdown components must perform their intended function without reliance on repairs. In addition, fire-induced faults in electrical circuits, such as hot shorts, shorts to ground, or open circuits shall not cause the maloperation or prevent the operation of a required safe-shutdown component.

The regulatory requirements and the guidance of GL 81-12 and GL 86-10 recognize that it is necessary to provide electrical independence for the alternative shutdown system and its post-fire safe-shutdown components and that a fire is capable of inducing multiple hot shorts, shorts to ground, or open circuits. In addition, it is recognized that fire-induced faults in electrical circuits shall not prevent the operation or cause the maloperation of required post-fire safe-shutdown components.

On the basis of its review of the regulatory documents and its evaluation of the alternative shutdown system at Salem as documented above, the staff concludes that the alternative shutdown system design at Salem does not provide the independence required by Section III.L.3 of Appendix R in that it relies on procedures that direct operators to perform numerous complex repair activities, such as lifting and cutting electrical leads, installing electrical jumpers, and removing fuses in order to isolate potentially fire-affected circuits and regain control of post-fire hot shutdown equipment. In addition, the staff concluded that in order for the alternative shutdown capability to perform its intended function, the shutdown equipment that it relies on must be capable of performing its functions after it has been electrically isolated from the fire-affected area of concern. The staff found

that certain safe-shutdown equipment used by the alternative shutdown system was not adequately isolated, as required by Section III.L.7 of Appendix R, from the associated circuits in the fire area and that fire-induced hot shorts, open circuits, or shorts to ground in these circuits could have prevented the operation of this required safe-shutdown equipment.

On the basis of the findings it made during the May 1993 inspection, the staff also concludes that these design weaknesses do not provide reasonable assurance that the minimum and limited shutdown functions controlled by the alternative shutdown system can be performed as specified by Section III.L, paragraphs 1 and 2 of Appendix R. Therefore, the staff concluded that Salem Nuclear Generating Station Unit 1 is not in compliance with the alternative shutdown system requirements of Appendix R to 10 CFR Part 50 and Unit 2 is not in compliance with its Operating License, Condition 2.C.10.

The licensee committed to implement certain modifications to resolve the post-fire alternative shutdown system design concerns. The licensee has committed to install isolation transfer switches for the required safe-shutdown functions controlled by the alternative shutdown system and to modify the control circuits for certain MOVs in order to eliminate the concern about hot-short spurious operation damage.

For Unit 1, the licensee committed to complete MOV circuit modifications and to install isolation transfer switches prior to restart. For Unit 2, the licensee committed to complete MOV circuit modifications for 20 hot-standby valves and to install the remaining service water system isolation transfer switches during the next refueling outage (refueling outage 10). The staff finds the Unit 1 modification implementation schedule acceptable. However, the schedule for Unit 2 is not unacceptable. The licensee did not propose interim compensatory measures for the Unit 2 alternative shutdown design weaknesses nor did it describe how it will mitigate the potential adverse consequences of fire-induced hot shorts on the MOVs in question. Therefore, absent adequate interim compensatory measures, the staff has no basis for recommending that Unit 2 be allowed to restart prior to full implementation of the required post-fire safe-shutdown modifications.

Appendix

BROOKHAVEN NATIONAL LABORATORY

DEPARTMENT OF ADVANCED TECHNOLOGY
ENGINEERING TECHNOLOGY DIVISION

TECHNICAL EVALUATION OF
PUBLIC SERVICE ELECTRIC AND GAS COMPANY (PSE&G)
RESPONSES DATED JUNE 19, 1996 AND DECEMBER 2, 1996
TO
NRC OFFICE OF NUCLEAR REACTOR REGULATION REPORT
"SAFE SHUTDOWN CAPABILITY REASSESSMENT FOR SALEM NUCLEAR GENERATING STATION UNITS 1 AND 2." DATED JANUARY 25, 1996

Revision 1
January 23, 1997

Prepared By: K. Sullivan

Prepared For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

1. Background

By letter dated January 25, 1996, the NRC Office of Nuclear Reactor Regulation (NRR) forwarded its report "Safe Shutdown Capability Reassessment for Salem Nuclear Generating Station, Units 1 and 2," to the licensee, Public Service Electric and Gas (PSE&G). This evaluation incorporated the results of an independent assessment performed by Brookhaven National Laboratory (BNL), as documented in BNL Technical Evaluation Report (TER) dated November 9, 1995. The scope of the BNL evaluation concentrated on a review of the licensing basis of the Salem Nuclear Power Station with respect to Section III.G and L of Appendix R to 10 CFR 50. Specific issues evaluated by BNL during this review include:

(1) The level of approval granted by NRR regarding the current alternative shutdown system design's reliance on the use of repairs to achieve and maintain safe shutdown capability; and

(2) The licensee's assumptions and methodology pertaining to the plant's ability to cope with spurious equipment actuations that may occur as a result of fire damage in accordance with the guidance presented in Generic Letters 81-12 and 86-10; and

(3) PSE&G evaluation of staff concerns for the potential loss of alternative shutdown capability due to fire-induced circuit faults as described in Information Notice 92-18.

As a result of an evaluation of the fire protection licensing basis of the Salem Nuclear Generating Station, the BNL TER concluded:

1. The post-fire alternative shutdown system design reliance on repair activities to achieve and maintain hot standby conditions, does not appear to have been accepted by NRR for use as a long-term compliance strategy.

2. The licensee's assumption of one spurious operation per fire event is inconsistent with established guidance disseminated by the staff and does not appear to satisfy the regulatory intent of Sections III.G. and III.L of Appendix R to 10 CFR 50.

3. The licensee's evaluation and disposition of staff concerns described in IN 92-18 is inconsistent with established guidance disseminated by the staff, and does not appear to satisfy the regulatory intent of Sections III.G. and III.L of Appendix R to 10 CFR 50.

On February 7, 1996, each of the issues described above was discussed in detail at a public meeting held between NRC, BNL and PSE&G representatives at NRC Headquarters, Rockville, Maryland. At the meeting PSE&G characterized its perspective of each issue and described evaluations and design changes being implemented at Salem to address staff concerns.

By letter dated June 19,1996 PSE&G provided a formal response to the staff's January 25, 1996 report and issues discussed during the February 7, 1996 meeting at NRC Headquarters. A review of this submittal determined that certain clarifications and additional information would be necessary in order to complete the review. Accordingly, by letter dated October 30, 1996, the staff forwarded a request for additional information (RAI) to the licensee, and by letter dated December 2, 1996 the licensee provided its response. The following paragraphs provide the results of the BNL assessment of resolutions proposed by PSE&G to address each of the issues described in the staff's January 25, 1996 report.

2. Evaluation of Issues

2.1 Alternative Shutdown System Design Reliance on the Use of Repairs to Achieve and Maintain Hot Shutdown Conditions

2.1.1 Discussion

To provide assurance that cabling required for or associated with the alternative shutdown capability can be made to be physically and electrically separated (independent) from the affects of fire, alternative shutdown system designs typically incorporate the use of isolation/transfer switches. Once activated, these devices, which are located outside of the fire affected area, enable the control and/or monitoring of required shutdown systems to be transferred to an area of the plant that is independent (physically and electrically) of the fire affected area(s).

At Salem the alternative shutdown system design did not incorporate the use of isolation/transfer switches. In lieu of providing this capability, the licensee had developed abnormal operating procedures which direct operators to perform repair activities (e.g. cutting/lifting leads, installing jumpers, and fuse replacement) as necessary to isolate potentially affected circuits and establish local control and monitoring capability for required shutdown systems.

Section III.G.1.b and III.L.5 of Appendix R to 10 CFR 50 establishes the criteria for cold shutdown system repairs. Repairs (e.g., cutting or lifting leads, installing jumpers, pulling and replacing fuses) of post-fire safe shutdown systems required for achieving and maintaining hot shutdown or hot standby are not allowed.

During the initial licensing process for Salem Unit 2, the NRC had accepted the use of such repair actions on an interim basis during the plant's startup testing program. A May 1981 Safety Evaluation (SE) documents the staff's approval of this approach as a short-term temporary measure, with long-term compliance pending staff review of the licensee's compliance with Appendix R (Ref.:NUREG-0517, Supplement No.6, "Safety Evaluation Report Related to the Operation of Salem Nuclear Generating Station, Unit No. 2" and NRC's "Report on PSE&G Cable Separation Study," included as Attachment G to the May 1981 SER).

2.1.2 Evaluation

In its June 16, 1982 submittal, the licensee informed the staff that Salem's alternative shutdown procedures do not require the use of electrical jumpers or pneumatic bypasses. In a subsequent Safety Evaluation Report (SER), dated May 31, 1983, the staff stated the following: *"No repairs or modifications are required to effect hot or cold shutdown utilizing the alternate shutdown methods."* With regard to this statement, in its June 19, 1996 submittal, the licensee states: *"PSE&G has interpreted this to refer to repairs in the fire zone and to exclude the replacement of fuses, the installation of jumpers, and lifting of leads."* In this submittal, PSE&G also requested the staff to revise the 1983 SER as follows:

From: *"No repairs or modifications are required to effect hot or cold shutdown utilizing the alternate shutdown methods."*

To: *"No repairs or modifications in the fire zone are required to attain hot standby utilizing the alternate shutdown methods."*

The requested change in wording of this statement represents a significant change in the level of protection provided. Specifically, the staff was concerned that the proposed change could be interpreted as allowing the licensee to make repairs necessary to achieve and maintain hot shutdown in areas other than the fire affected area and allow repair activities in the fire affected zone as necessary to maintain hot shutdown conditions. On this basis, the staff determined that the licensee's request to revise the Safety Evaluation Report was not acceptable.

In its June 19, 1996 response, the licensee further states that it has initiated a design change to install isolation/transfer switches. PSE&G states that the installation of these devices will *"eliminate the use of jumpers as a method for achieving and maintaining post-fire hot standby conditions,"* and *"the design input for the change considered NRC guidance documents such as Generic Letter 81-12 and 86-10."*

In its response to the staff's October 30, 1996 request for additional information (Ref: PSE&G letter dated December 2, 1996), the licensee states that the post-fire safe shutdown analysis for normal

shutdown from within the control room (where the fire analysis is governed by the requirements of Section III.G.2 of Appendix R to 10 CFR 50) does not employ any repair activities to achieve and maintain hot-standby conditions. With regard to the alternative shutdown capability, PSE&G states that pneumatic jumpers are not required to achieve and maintain post-fire hot-standby conditions and that design changes to install isolation/transfer switches will eliminate the need for repairs to electric circuits (e.g., electrical jumpers, lifting leads, and replacing fuses) in order to achieve and maintain post-fire hot-standby conditions. The licensee states that following the installation of proposed design changes, no repairs will be required to achieve and maintain hot-standby conditions when either normal shutdown systems controlled from the control room, or the alternative shutdown capability, controlled from the emergency control stations outside the control room, are used to accomplish post-fire safe shutdown conditions.

2.1.3 Conclusion

For fire events which do not require implementation of the alternative shutdown capability, the licensee states that hot shutdown conditions can be achieved and maintained from the control room without repairs. For fire events requiring control room evacuation and implementation of the alternative shutdown capability, the licensee states that its proposed modifications (i.e., installation of isolation/transfer switches) will eliminate the need for repairs to achieve and maintain hot shutdown conditions. This approach provides an appropriate means of conforming to the requirements of Appendix R to 10 CFR 50, and is, therefore, acceptable.

2.2 Analysis Assumptions Pertaining to the Plant's Ability to Cope with Fire-Initiated Spurious Signals

2.2.1 Discussion

During the period of May 17 through May 21, 1993, the NRC conducted an inspection of Salem Nuclear Power Plant for compliance with Sections III.G, J., L., and O., of Appendix R to 10 CFR 50. As a result of its review, the inspection team concluded that the licensee's analysis of the potential effect of fire-initiated spurious signals was not sufficiently conservative, to the extent that the analysis, and the resulting post-fire shutdown methodology, assumed only one spurious actuation to occur as a result of fire in any area, regardless of the number, or operational significance, of unprotected circuits that may be susceptible to common-cause damage due to fire. In response to the inspection team's concern, the licensee stated that this assumption was based on its interpretation of the NRC response provided to Question 5.3.10(a) of Generic Letter 86-10, which states, in part: "*The safe shutdown capability should not be adversely affected by any one spurious actuation or signal resulting from a fire in any plant area.*"

The licensee's application of the single spurious actuation assumption was found to be applied in its evaluation of all fire areas. That is, this assumption was applied in the evaluation of fire areas requiring alternative shutdown capability as well as areas where it had determined that the level of protection provided was sufficient to ensure that one train of systems necessary to achieve and maintain hot shutdown conditions would remain free of fire damage (i.e., fire areas satisfying the separation and protection criteria of Section III.G.2).

During the February 1996 meeting and in its October 1996 Request for Additional information (RAI) the staff informed PSE&G that its assumption of one spurious operation per fire event was inconsistent with established guidance and does not appear to satisfy regulatory intent of III.G. and III.L.

2.2.2 Evaluation

Appendix R to 10 CFR 50 establishes fire protection features deemed necessary to provide reasonable assurance that one train of systems necessary to achieve and maintain hot shutdown conditions remains free of fire damage. On February 20, 1981 the NRC forwarded Generic Letter 81-12 (GL 81-12) to all reactor licensees with plants licensed to operate prior to January 1, 1979. With regard to the protection of systems and equipment required for hot standby, GL 81-12 provides the following staff positions:

1) The equipment and systems used to achieve and maintain hot standby should be free of fire damage and capable of maintaining such conditions for an extended time period if equipment required to achieve and maintain cold shutdown is not available due to fire damage; and,

2) Wiring, including power sources for the control circuit and equipment operation for the alternate shutdown method, must be independent of equipment wiring in the area to be avoided; and

3) Cabling required for or associated with the alternative method of hot shutdown for each fire area, must be physically separated by the equivalent of a three-hour rated fire barrier from the fire area.

As a result of its review of licensee submittals following the issuance of GL 81-12, the staff developed and promulgated additional clarifying information (Ref: Enclosure 1 of NRC memorandum dated March 22, 1982, from R. J. Mattson to D. G. Eisenhut). This document was forwarded to PSE&G as Enclosure 3 of an NRC letter dated April 20, 1982. With regard to circuits of equipment whose spurious operation could affect the alternative safe shutdown capability, the clarification provided by the staff states that an adequate level of protection may be achieved through implementation of one of the following methods:

1. Provide protection for circuits of concern per Section III.G.2 of Appendix R, or

2. Provide a means to isolate the equipment of concern from the fire area prior to the fire (an example of this approach is pre-fire strategies which de-energize equipment whose fire-initiated spurious operation could adversely affect safe shutdown); or,

3. Provide electrical isolation that prevents spurious operation (e.g., isolation/transfer switch schemes); or

4. Provide a means to detect spurious operations and then procedures to defeat the maloperation of equipment (an example would be procedural guidance to establish manual control of a Motor Operator Valve that may spuriously operate as a result of a fire-induced failures in its control circuitry).

In April 1986, the staff issued Generic Letter 86-10, "Implementation of Fire Protection Program Requirements." This document presents the Commission's position on certain specific issues in the form of responses to questions posed by the industry during a series of Regional Workshops on the implementation of NRC fire protection requirements at nuclear power plants. In Section 5 of this document, the NRC provides responses to specific questions related to Alternative and Dedicated Shutdown Capability. In Question 5.3.10 the staff is requested to define the plant transients that must be considered in the design of the alternative shutdown system. Inherent in the staff's response to this question, is the expectation that potential spurious equipment operations have been identified, and a suitable method of protection, as required by regulatory criteria (Appendix R Sections III.G.1, III.G.3, III.L.3 and III.L.7), has been provided.

The guidance of GL 86-10 is design basis transient criteria for determining the capacity and capability of the alternative shutdown system and its application is based on the system being physically and electrically independent of the fire area of concern and that hot shorts, shorts to ground, and open circuits in associated circuits will not prevent the operation of safe shutdown equipment. In order for the alternative shutdown capability to perform its design function, the shutdown equipment that it relies on must be capable of performing its function once it has been electrically isolated from the control room or the cable spreading room.

The licensee's assumption that only one spurious actuation would occur as a result of any fire is not consistent with the regulatory requirements of Appendix R to 10 CFR 50 and guidance established by the staff in Generic Letter 81-12, and its subsequent clarification which was forwarded to the licensee as Enclosure 3 of NRC letter dated April 20, 1982.

In its June 19, 1996 response the licensee states that it has reanalyzed all fire areas where the single spurious actuation assumption was applied. For areas other than those requiring alternative shutdown

capability, this evaluation concluded that because the cabling in each application either met separation requirements, was adequately protected, or its function for the component(s) served would not lead to spurious actuation, dependence on the single spurious actuation assumption was no longer necessary. With regard to its application of the single spurious actuation assumption in areas requiring an alternative shutdown capability, in its December 1996 response PSE&G states that it has re-evaluated alternative shutdown systems necessary to achieve and maintain hot standby conditions, and as a result of this review, has initiated design modifications to provide isolation/transfer capability for components necessary to satisfy post-fire, alternative shutdown, functions. The specific components provided with isolation/transfer switches are depicted in the following tables:

SALEM UNIT 1 EQUIPMENT	SALEM UNIT 2 EQUIPMENT
1 AFW Room Cooler	2 AFW Room Cooler
11 Charging pump aux lube oil pump	21 Charging pump aux lube oil pump
11 Charging pump room cooler	21 Charging pump room cooler
11 Chiller	21 Chiller
11 Chilled Water Pump	21 Chilled Water Pump
11 Service Water Intake Vent Fan	21 Service Water Intake Vent Fan
11 Component Cooling Room Cooler	21 Component Cooling Room Cooler
12 Charging Pump Aux Lube Oil Pump	22 Charging Pump Aux Lube Oil Pump
12 Charging Pump room Cooler	22 Charging Pump room Cooler
12 Chiller	22 Chiller
12 Chilled Water Pump	22 Chilled Water Pump
12 Service Water Intake Vent Fan	22 Service Water Intake Vent Fan
12 Component Cooling Room Cooler	22 Component Cooling Room Cooler
13 Charging Room Cooler	23 Charging Room Cooler
13 Service Water Intake Vent Fan	23 Service Water Intake Vent Fan
13 Chiller	23 Chiller
14 Service Water Intake Vent Fan	24 Service Water Intake Vent Fan
1CV139 11 and 12 Charging pump mini-flow isolation valve	2CV139 21 and 22 Charging pump mini-flow isolation valve
1CV140 11 and 12 Charging pump mini-flow isolation valve	2CV140 21 and 22 Charging pump mini-flow isolation valve
1CV40 Charging pump suction from VCT isolation valve	2CV40 Charging pump suction from VCT isolation valve
1CV41 Charging pump suction from VCT isolation valve	2CV41 Charging pump suction from VCT isolation valve
1CV68 Charging Pump discharge to REGEN HX isolation valve	2CV68 Charging Pump discharge to REGEN HX isolation valve
1CV69 Charging Pump discharge to REGEN HX isolation valve	2CV69 Charging Pump discharge to REGEN HX isolation valve

SALEM UNIT 1 EQUIPMENT		SALEM UNIT 2 EQUIPMENT	
1PR6	Pressurizer relief stop valve	2PR6	Pressurizer relief stop valve
1PR7	Pressurizer relief stop valve	2PR7	Pressurizer relief stop valve
1SJ1	Charging pump suction from RWST isolation valve	2SJ1	Charging pump suction from RWST isolation valve
1SJ12	BIT isolation valve	2SJ12	BIT isolation valve
1SJ13	BIT Isolation valve	2SJ13	BIT Isolation valve
1SJ2	Charging pump suction from RWST isolation valve	2SJ2	Charging pump suction from RWST isolation valve
1SW26	Non-nuclear Service Water Isolation Valve	2SW26	Non-nuclear Service Water Isolation Valve

By facsimile dated 12/6/96, (From: B. Thomas, PSE&G, To: L. Olshan, NRC) PSE&G informed the staff that Unit 2 valves listed above have been provided with isolation/transfer switches. In addition, the following Unit 2 valves will have isolation/transfer switches installed by the end of the next refueling outage:

21SJ44	21 SI CONTMT sump isolation valve
22SJ44	22 SI CONTMT sump isolation valve
2CC30	CCW System cross-tie valve
2CC31	CCW System cross-tie valve
21SW21	Diesel Generator Header Isolation Valve
21SW22	Service Water Header Isolation Valve
21SW23	Service Water Header Crossover Valve
22SW21	Diesel Generator Header Isolation Valve
22SW22	Service Water Header Isolation Valve
22SW23	Service Water Header Crossover Valve
22SW20	Service Water Header Isolation Valve

The design for motor-operated valves (MOV's) at Salem utilizes 230V AC motor control centers (MCC's). Each MCC contains pans which hold the control circuitry for an MOV. Within each pan are such items as the main contactors, thermal overload (TOL) relay, auxiliary relay, control fuses, and field wiring terminal blocks. The typical MOV transfer circuit scheme utilizes two switches and two valve position indicating lights mounted within the pan. The first switch isolates wiring routed from the MCC to the fire area(s) of concern, inserts new fuses into the control circuit, and provides permissives to operate the MOV via the second switch. The second switch serves as an operate switch to open or close the valve. For motors, such as room coolers, one switch and one indicating light are used. The switch performs the function of isolating wiring routed from the MCC to the fire area(s) of concern, inserting new fuses into the control circuit, inserting an indicating light into the control circuit (to identify operation in the remote shutdown mode) and operating the motor.

2.2.3 Conclusion

The licensee has reanalyzed fire areas where the single spurious actuation assumption was applied. For areas other than those requiring an alternative shutdown capability, this re-evaluation has determined that because the cabling in each application either met separation requirements, was adequately protected, or its function for the component(s) served would not lead to spurious actuation, dependence on the single spurious actuation assumption was no longer necessary. With regard to areas where fire may require implementation of the alternative shutdown capability, PSE&G has initiated design modifications to provide isolation/transfer capability for components necessary to satisfy post-fire, alternative shutdown, functions.

The licensee's evaluation, in conjunction with its proposed modifications to provide electrical isolation from areas requiring an alternative shutdown capability, provide assurance that potential fire-induced spurious operations that could adversely affect the post-fire shutdown capability have been appropriately identified, evaluated and dispositioned. The licensee's approach satisfies Appendix R to 10 CFR 50 and is, therefore, acceptable.

2.3 PSE&G Evaluation and Disposition of Staff Concerns Regarding The Potential for Loss of Remote Shutdown Capability Following a Control Room Fire. (Information Notice (IN) 92-18)

2.3.1 Discussion

On February 28, 1992 the NRC Office of Nuclear Reactor Regulation (NRR) issued Information Notice (IN) 92-18 to alert licensees of conditions that could result in a loss of ability to maintain the reactor in a safe shutdown condition in the event of a control room fire. Specifically, IN 92-18

cautions licensees of the potential for a control room fire to cause an electrical short circuit between normally energized conductors and conductors associated with the control circuitry of motor-operated valves (MOVs) required to achieve post-fire safe shutdown conditions from outside the main control room. Such an event could cause the valve to spuriously actuate. Due to the electrical location of the circuit fault, the MOV torque and limit switches would be ineffective in stopping valve operation. Additionally, thermal overload protection has been bypassed at many facilities. Given these conditions, there is a potential for a fire-initiated spurious valve actuation to result in mechanical damage sufficient to prevent reactor operators from manually operating the valve.

At the time of the May 1993 Appendix R compliance inspection the licensee expressed its opinion that since in its view the conditions described in Information Notice 92-18 were not credible, no further evaluation was performed. However, during a June 3, 1993 telephone conference between the licensee and the staff the licensee committed to provide a formal response to the concerns described in the Information Notice.

2.3.2 Evaluation

By letter dated October 26, 1993, the licensee forwarded its response in a document titled: "Engineering Evaluation of SGS 1&2 Control Room Evacuation for Fire Induced MOV Hot Shorts as Discussed in NRC Information Notice 92-18", dated August 20, 1993. The evaluation identified a total of 65 valves as being specifically addressed within the Salem Control Room evacuation procedure and Safe Shutdown Analysis. As a part of its evaluation the schematics and wiring diagrams for all 65 valves were reviewed to determine which cables associated with the valves were routed in areas where control room evacuation may be required due to fire (i.e., the Control Room, Relay Room, or Ceiling of the 460V Switchgear Room). Of the 65 valves evaluated, 51 were found to be susceptible to the hot short conditions described in the Information Notice. However, the evaluation was found to conclude: *"due to system/component redundancies, at SGS 1&2, failure of any one (emphasis added) of these valves would not preclude a post-fire safe shutdown condition."*

The licensee's disposition of this concern was found to be predicated on its interpretation of staff guidance contained in Generic Letter 86-10. Specifically, the licensee had assumed that the evaluation of post-fire alternative shutdown capability need only consider one spurious valve actuation, irrespective of the number or post-fire shutdown significance of the potentially affected circuits. This interpretation was then extended to its evaluation of staff concerns described in IN 92-18. This led the licensee to conclude, without providing any further technical justification, that only one of the 51 potentially affected valves would spuriously actuate.

During the February 7, 1996 meeting, the licensee described a design change to preclude mechanical valve damage by reinstalling the previously bypassed thermal overload (TOL) protection on MOV's.

In its letter dated June 19, 1996, the licensee stated that this modification eliminates the concerns of IN 92-18 for Salem and that the thermal overload protection for these MOVs had been installed.

In its October 30, 1996 request for additional information the staff requested the licensee to demonstrate that the methodology and criteria for assuring that the TOL protection is sized properly and that it will adequately protect the subject MOVs from mechanical damage (e.g., deep seating and binding of the valve). In addition, the staff requested PSE&G to describe the typical isolation transfer circuit scheme for these MOVs and confirm that the tripping of the TOL protection devices does not render the subject MOVs inoperable and that once electrically isolated from the fire area of concern that they can be operated remotely from emergency control stations outside the control room.

In its December 1996 response, the licensee states that all safety related motor-operated valves (MOV's) at Salem have thermal overload relays in their circuitry which are designed to protect the power feed to the MOV while providing maximum protection of the valve operator motor. The methodology for determining thermal overload sizing takes into account the voltage and ambient temperature variations when plotting protection points for current at twice nominal torque and locked rotor withstand characteristics. The thermal overloads are sized to ensure that the MOVs will not spuriously trip while providing the maximum amount of motor protection. Upon further review of the TOL design change for mechanical valve damage, PSE&G noted that the TOLs for several valves have marginal values for motor torque capability at full voltage versus the valve assembly torque limit. The valves identified by this review which are required to achieve hot-standby are as follows: CV40; CV41; CV68; CV69; CV139; CV140; PR6; PR7; SJ1; SJ2; SJ13; and SW26. Also identified by this review were several valves whose TOL do not fully provide valve motor protection. These valves are as follows: CC30, CC31, SW21, SW22, SW23, 12/22SW20, and 14/24SW20.

The licensee states that it has initiated design changes to modify the circuits of the above referenced valves. Specifically, the control circuits of these valves will be modified to prevent hot-shorts from bypassing the torque and limit switches by electrically relocating the switches between the control room and MCC as recommended by the staff in Information Notice 92-18.

2.3.3 Conclusion

Based on the above, the licensee's stated methodology for resolving concerns identified in Information Notice 92-18, is directed at preventing mechanical damage to required MOVs by reinstalling the previously bypassed thermal overload (TOL) protection on MOV's. Where reliance on thermal overload protection was found to provide insufficient protection, the licensee has initiated modifications which will prevent hot-shorts from bypassing MOV torque and limit switches as recommended by the staff in Information Notice 92-18. Should valves spuriously actuate, operators would establish local control, and manual positioning of the MOV would not be precluded. This approach conforms to the requirements of Appendix R to 10 CFR 50 and is therefore, acceptable.

3. Overall Summary

As a result of its evaluation of the fire protection licensing basis of the Salem Nuclear Generating Station, the staff concluded in its report dated January 25, 1996:

1. The post-fire alternative shutdown system design reliance on repair activities to achieve and maintain hot standby conditions, does not appear to have been accepted by NRR for use as a long-term compliance strategy.

2. The licensee's assumption of one spurious operation per fire event is inconsistent with established guidance disseminated by the staff and does not appear to satisfy the regulatory intent of Sections III.G. and III.L of Appendix R to 10 CFR 50.

3. The licensee's evaluation and disposition of staff concerns described in IN 92-18 is inconsistent with established guidance disseminated by the staff, and does not appear to satisfy the regulatory intent of Sections III.G. and III.L of Appendix R to 10 CFR 50.

To resolve these issues in a manner consistent with established staff guidance, the licensee has performed engineering evaluations and, where necessary, has developed and scheduled additional plant modifications necessary to bring the plant into compliance.