

U.S. NUCLEAR REGULATORY COMMISSION  
REGION I

Report No. 50-311/87-29

Docket No. 50-311

License No. DPR-75

Licensee: Public Service Electric and Gas Company  
P. O. Box 236  
Hancocks Bridge, New Jersey 08038

Facility Name: Salem Unit 2

Inspection At: Hancocks Bridge, New Jersey

Inspection Conducted: September 14-18, 1987 and December 15-18, 1987

Inspector: A. Krasopoulos 1/22/88  
A. Krasopoulos, Reactor Engineer date

Also participating in the inspection and contributing to the report were:

- J. Petrosino, Engineer, NRR, Vendor Inspection Branch
- D. Kubicki, Fire Protection Engineer, NRR
- R. Hodor, Mechanical Systems Specialist, BNL
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Approved by: C. J. Anderson 1/22/88  
C. J. Anderson, Chief, Plant Systems date  
Section, EB, DRS

Inspection Summary: Inspection on September 14-18, 1987 and December 15-18, 1987  
(Report No. 50-311/87-29)

Areas Inspected: A special, announced team inspection was conducted to verify compliance with the requirements of 10 CFR 50, Appendix R, Section III.G, J, L and O concerning fire protection features to ensure the ability to achieve and maintain safe shutdown in the event of a fire.

Results: Four apparent violations and one deviation were identified. Three items remained unresolved. At the conclusion of the inspection the licensee submitted to the NRC a justification for continuing operations in consideration of the inspection findings. See Attachment 1 for a Summary of Findings.

Additional commitments were made by the licensee during a management meeting held at the Region I offices on October 7, 1987 to discuss the findings of this inspection. During the follow up inspection the inspector verified that the commitments made by the licensee were being implemented adequately.

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## DETAILS

### 1.0 Persons Contacted

#### 1.1 Public Service Electric and Gas (PSE&G)

- \*M. L. Bursztein, Principal Offsite Safety Review Engineer
- \*R. S. Miltenberger, Vice President, Nuclear Operations
- \*\*B. A. Preston, Manager, Licensing
- \*P. A. Moeller, Manager, Site Protection
- \*J. F. Kerin, Senior Nuclear Fire Protection Supervisor
- \*P. J. Eldreth, Nuclear Fire and Safety Manager
- \*\*R. Bashal, Senior Engineer
- \*C. P. Johnson, G.M., NQA
- \*J. M. Zupko, Jr., General Manager, Salem Operations
- \*L. A. Reiter, General Manager, Licensing and Reliability
- J. T. Boettger, Assistant Vice President Nuclear
- \*L. K. Micca, Manager, Nuclear Engineering Services
- \*R. A. Burricelli, General Manager, Engineering and Plant Betterment
- \*M. J. Pollack, Salem LER Coordinator
- \*D. A. Perkins, Manager, Station QA
- \*D. P. Shumaker, Plant Engineering
- \*J. S. Hodson, Offsite Safety Review Engineer
- \*\*R. B. Swartzwelder, Licensing, Senior Engineer
- \*G. A. Roggio, Station Licensing Engineering - Salem
- \*M. K. Gray, Licensing Engineer
- R. Braddick, Fire Protection Staff Engineer
- \*C. Lambert, Nuclear Engineering Science Manager
- W. M. Reiber, Senior Engineer
- K. Ewell, Consultant (Vice President, Proto Power Company)
- N. Fiorovanti, Consultant, (Tenera Corporation)
- R. Eberly, Consultant, (Tenera Corporation)
- R. J. Diaz, Nuclear Systems
- M. J. Cavalier, Site Representative (Ace Company)

#### 1.2 Nuclear Regulatory Commission (NRC)

- T. Kenny, Senior Resident Inspector
- \*K. Gibson, Resident Inspector
- \*E. C. Weñzinger, Sr., Branch Chief, Reactor Projects
- \*J. Durr, Deputy Director (Acting), Division of Reactor Safety
- S. Pullani, Section Chief (Acting), Plant Systems Section
- +R. Summers, Project Engineer

\*Denotes those present at the exit interview on September 18, 1987.

+Denotes those present at the exit interview on December 18, 1987.

\*\*Denotes those present at the exit interviews on September 18, 1987 and December 18, 1997.

## 2.0 Purpose

This inspection was performed to ascertain licensee conformance with 10 CFR 50, Appendix R, Sections III.G, J, and L with the exemptions approved by the Office of Nuclear Regulation (NRR).

## 3.0 Background

The licensee, by a License Condition, is required to comply with the requirements of 10 CFR 50, Appendix R, Sections III.G, J, L, and O.

Section III.G of Appendix R requires that fire protection be provided to ensure that one safe shutdown train remains available in the event of a fire. Section III.J requires that emergency lights are installed in all areas required for safe shutdown purposes and Section III.L specifies the requirements for alternate shutdown capability. Section III.O requires an oil collection system for the Reactor Coolant Pumps. Licensee compliance with III.O was not reviewed during the course of this inspection.

## 4.0 Post-Fire Safe Shutdown Capability

### 4.1 Systems Required for Safe Shutdown

The licensee has specified that the following systems will be used for safe shutdown in the event of a fire concurred with loss of offsite power.

- Component Cooling Water (CCW)
- Service Water (SW)
- Auxiliary Feedwater (AFW)
- Chemical and Volume Control (CVCS)
- Containment Ventilation (Fan Coolers)
- Diesel-Generators/Electrical Power Distribution
- Control Air (Emergency Air Compressor)
- Residual Heat Removal (RHR)
- Primary System Instrumentation:
  - Steam Generator Level and Pressure
  - Pressurizer Level and Pressure
  - Reactor Coolant System Temperature and Pressure

Safe shutdown of the reactor is normally accomplished by the insertion of control rods from the control room. Control rod insertion can also be accomplished by removing power to the motor generator sets in the switchgear room. Reactor coolant inventory and reactor shutdown margin are maintained by one of three chemical and volume control system (CVCS) charging pumps taking suction from the volume

control tank, boric acid tank or the refueling water storage tank (RWST). Primary system pressure can be maintained by the pressurizer heaters and pressurizer spray or by use of the charging pumps combined with letdown. Decay heat removal can be accomplished by releasing steam from the steam generators via the atmospheric dump valves. Makeup to the steam generators can be provided by the auxiliary feedwater system, which takes suction from the auxiliary feedwater storage tank.

Cold shutdown conditions can be achieved and maintained through the use of the residual heat removal (RHR) system. Cooling is provided to the RHR heat exchanger by component cooling water which is in turn, cooled by service water in the component cooling heat exchanger. Reactivity control during cold shutdown is maintained by the CVCS.

#### 4.2 Areas Where Alternate Shutdown is Required

The licensee has provided alternate shutdown capability in case of a fire occurring either in the main control room or the relay room. Abnormal operating procedure AOP-EVAC-2 entitled "Control Room Evacuation Due to a Fire in the Control Room or Relay Room" has been developed by the licensee to implement safe shutdown from outside the control room.

For shutdown from outside the control room the process monitoring instruments to be used are the reactor  $T_{hot}$  and  $T_{cold}$  temperature indicators located at the Alternate Shutdown Process Rack, the Steam Generator (SG) Level and Pressure indicators, the Pressurizer Level and Pressure indicators and the Source Range monitors located at Hot Shutdown Panel (HSD) 213. The Auxiliary Feedwater (AFW) Tank and RWST Tank Level Indication is located on a panel near each storage tank.

The Nuclear Shift Supervisor controls alternate shutdown activities from the HSD Panel. The Auxiliary Feedwater is initiated locally at the Turbine Driven Auxiliary Feedwater Pump Panel (Panel 207). If the Turbine Driven Pump is not available, the operator can start either one of the two Motor Driven Pumps at their respective local panels. Charging flow can be initiated by starting the charging pumps from the switchgear room. Charging flow control is accomplished from the charging system panel, 216, by manipulating charging flow control valve CV55.

Other systems that are available for alternate shutdown are Component Cooling (CCW), Service Water (SW), Containment Ventilation, Diesel Generator (DG), Control Air (Emergency Air Compressor), and Residual Heat Removal (RHR).

#### 4.3 Remaining Plant Areas

All plant areas other than the Relay Room, the ceiling of the Cable Spreading Room and the Control Room, for which alternate shutdown capability has been provided, must comply with the requirements of Section III.G.2 of Appendix R, unless an exemption request has been approved. A number of exemption requests from the Appendix R requirements have been submitted and are under review by NRC.

#### 5.0 Inspection Methodology

The inspection team examined the separation and protection of equipment, cabling and associated circuits necessary to achieve and maintain hot and cold shutdown conditions. This inspection sampled selected fire areas which the licensee had identified as being in compliance with Section III.G.

The following functional requirements were reviewed for achieving and maintaining hot and cold shutdown:

- Reactivity control
- Pressure control
- Reactor coolant makeup
- Decay heat removal
- Support systems
- Process monitoring

The inspection team examined the licensee's capability to achieve and maintain hot shutdown and the capability to bring the plant to cold shutdown conditions in the event of a fire in various areas of the plant. The examination included a review of drawings, safe shutdown procedures and other documents. Drawings were reviewed to verify electrical independence from the fire areas of concern. Procedures were reviewed for general content and feasibility.

Also inspected were fire detection and suppression systems and the degree of physical separation between redundant trains of Safe Shutdown Systems (SSSs). The team review included an evaluation of the susceptibility of the SSSs to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems.

The inspection team examined the licensee's fire protection features provided to maintain one train of equipment needed for safe shutdown free of fire damage. Included in the scope of this effort were fire area

boundaries (including walls, floors and ceilings), and fire protection of openings such as fire doors, fire dampers, and penetration seals.

The inspection team also examined the licensee's compliance with Section III.J, Emergency Lighting.

#### 6.0 Inspection of Protection Provided for Safe Shutdown Systems

The team reviewed all fire areas containing safety-related or safe shutdown-related systems except the containment. In addition, the fire pump house and the turbine building were inspected. This inspection identified the following unacceptable conditions:

##### Potential Disabling of All Three Emergency Diesels Due to CO<sub>2</sub> Discharge

The team observed that a fire in the vestibule of the Diesel Generator Control rooms or the Relay room fire area FA-AB-100A, and Fire Areas FA-AB-100B and FA-AB-100C has the potential to cause shorting of control circuits associated with the carbon dioxide fire suppression system and cause the simultaneous injection of carbon dioxide in all three Emergency Diesel rooms and all three Diesel Control rooms. This potential inadvertent actuation of the carbon dioxide system will cause the loss of the three diesel generators required for shutdown. This determination was made by the review of a safety evaluation performed by the licensee titled, "Diesel Operation in a carbon dioxide Environment" SGS/M-SE-067 dated October 16, 1980. This evaluation addressed the specific concern of the ability of the diesels to function in a carbon dioxide atmosphere. The analysis concluded that a diesel should be declared inoperable if the carbon dioxide system for the specific diesel discharged in the room because the diesel may overheat under this condition.

The licensee in operating procedure IV-16.3.1, Emergency Power-Diesel Operation, requires that the affected diesel be immediately stopped to prevent overheating if a carbon dioxide actuation occurs during Diesel Generator operation. The licensee in the safety evaluation and in the operating procedure referenced above, did not consider the possibility that a simultaneous injection of carbon dioxide could occur in all three diesel generator rooms.

In addition to the diesels being declared inoperable because of overheating concerns, the team observed that the emergency shutdown procedure requires that an operator be in the Emergency Diesel Control room to start and synchronize the Diesels in the event of a fire in the Relay room.

The carbon dioxide atmosphere will prevent operators from entering these rooms and thus prevent the start of the Diesels.

The possible fire related loss of all three emergency diesels from overheating or their loss due to inaccessibility represents a potential violation of 10 CFR 50 Appendix R Section III.G which stipulates that fire protection features shall be provided to safe shutdown systems so that at least one train of systems necessary for safe shutdown remains free of fire damage. (50-311/87-29-01)

#### Lack of Fire Detection in Seven Locations

The licensee in the Salem Fire Hazard Analysis, dated September 11, 1987, stated that automatic fire detectors have been installed throughout the Reactor Plant Auxiliary Equipment area and the Radwaste Storage areas. The team observed that in six locations of the reactor Plant Auxiliary Equipment area and in the control console room of the Radwaste Storage area, detectors were not provided.

The six locations not provided with detectors in the Reactor Plant Equipment area are:

1. East end of the corridor outside of the counting room;
2. The corridor to the mechanical penetration area;
3. The storage area behind the counting room;
4. The ventilation room on elevation 113 ft. over the counting room;
5. The boric acid evaporator room; and
6. The Inservice Inspection (ISI) calibration storage room.

The lack of detectors in the zones identified above represents a deviation from the commitment in the Salem 2 Fire Hazard Analysis Report. (50-311/87-29-02)

#### Fire Barrier Penetration Seals

The team reviewed the fire barrier penetration seal installation and documentation and determined that for the seals installed in the relay room and other fire areas, the licensee does not have fire test documentation.

This documentation is required to assure seal adequacy. The lack of the fire test documentation is a concern that has been addressed by the licensee. The licensee performed an assessment of the as-found condition of the seals and determined that in the absence of any obvious damage to the seals, the seals are adequate to withstand a one-hour fire. The

licensee placed fire watches in areas such as the relay room or where the fire loading exceeded the capability to withstand a one-hour fire as a compensatory measure. In addition, the licensee is in the process of performing a comprehensive review of the penetration seals to verify their adequacy.

The licensee committed to provide the implementation schedule for the penetration seal verification program within 30 days upon receipt of this report. This is an Unresolved Item (50-311/87-29-03).

#### 7.0 Review of Fire Protection Appendix R Related Licensee Event Reports (LERs)

The licensee has employed a consultant firm to perform reviews and to assist in the Appendix R Safe Shutdown program. The reviews performed jointly by the licensee and their consultant identified several non-conforming conditions which the licensee promptly reported via three different LERs. The team reviewed the licensee's activities related to these LERs which are 87-09 Revision 4 and 87-10 for Salem Unit 2. Salem Unit 1 LER 87-10 was also reviewed since it identified a nonconforming condition at Salem Unit 2. The Salem Unit 2 LER 87-09, Revision 4, identified several instances where the 10 CFR 50 Appendix R requirements were not met. The Salem Unit 1 LER-87-10 identified one example of a nonconformance with 10 CFR 50 Appendix A criterion 17 regarding a single failure causing the loss of the onsite electric power supplies (in both units). Salem Unit 2 LER 87-10 identified a deficiency of minor safety significance, involving a personnel error. Review of the licensee actions concerning the Unit 2 LER 87-10 did not identify any unacceptable conditions.

With regard to LER 87-09, the review identified that in the following areas, shutdown in the event of a fire could not be accomplished in accordance with the 10 CFR 50 Appendix R requirements:

- A) There is a potential to lose all service water (SW) supply systems if a fire were to occur in the SW pipe tunnel Fire Area FA-PT-84. This is because cable trays Nos. 2PT01, 2PT03, 2PT05, 2PT07, 2PT10 and 2PT12 containing power and control cables for all six service water pumps are located in this area. The Service Water system is a system required for safe shutdown because SW provides the cooling for the Emergency Diesel generators. Therefore, loss of SW will cause the loss of the Emergency A.C. power required for shutdown .
- B) Two out of three Emergency Diesel Generators are required to be operable in the event of a plant fire to support the shutdown loads. The power feeds from the Emergency Diesel Generators "B" and "C" to the 4160 volt switchgear are both located in the Fuel Oil Storage Room, Fire Area FA-AD-84D.

A fire in this area has a potential to damage both of these feeder cables and disable diesels B and C, causing loss of the Emergency Power required for shutdown.



- C) A fire in the carbon dioxide Equipment Room, Fire Area FA-DG-84F, has a potential to cause the loss of all Emergency AC Power required for shutdown since a fire in this area could damage the power cables of both diesel fuel oil transfer pumps A and B routed through this area. These pumps are essential for safe shutdown because they are used to transfer the diesel fuel oil from the main diesel fuel oil storage tank to the individual diesel day tanks. Each day tank has about one hour of fuel capacity. Therefore, if the transfer pumps become inoperable, there is no assurance that the diesels would run for more than one hour and the resulting loss of the emergency diesel generators would prevent shutdown.
- D) The following inadequacies also have a potential to affect safe shutdown equipment adversely.
1. Redundant RHR room cooler cables are located on a common panel in the Reactor Plant Auxiliary Equipment area, Elevation 64, Fire Area 2FA-AB-64B. A fire in this area has the potential to damage these cables resulting in the loss of both RHR room coolers. Without the RHR room coolers, the operability of RHR Pumps 21 and 22 cannot be assured because of the increased ambient room temperatures. The RHR pumps are required during cold shutdown.
  2. In the Upper Electrical Penetration area, Fire Area 2FA-EP-100G, there are redundant RHR room cooler cables and Charging Pump Room cooler cables. A fire in this area, has a potential to cause the loss of the RHR room coolers and the charging pump room coolers.

The room coolers ensure that the ambient room temperatures do not exceed the RHR pump or charging pump design limits.

Regarding LER 87-10 of Units 1 and 2, the review of the installed systems determined that in fire areas FA-06-100D-1, FA-DG-100E-1 and FA-DG-100F-1 a fire has the potential of disabling the fuel oil transfer pumps and thus preventing shutdown.

The circuits and relays required for the operation of both pumps are located in each of these areas without separation or protection. A fire in such areas has a potential to cause a short in the circuitry and disable both pumps. These pumps are essential for shutdown because they provide the fuel oil for the Emergency Diesel day tanks. The day tanks hold enough fuel for approximately one hour of diesel operation. Thus loss of the transfer pumps will cause the loss of the diesels after about one hour of operation.

The items identified in the LERs and described above were determined to be a violation of 10 CFR 50, Appendix R, Section III.G.1.a which requires

that Fire Protection features shall be provided for structures systems and components important to safe shutdown, capable of limiting the fire damage so that one train of systems necessary to achieve and maintain hot shutdown conditions is free of fire damage. (50-311/87-29-04)

## 8.0 Safe Shutdown Procedures

### 8.1 Procedures Review

The team reviewed Procedure No. AOP-EVAC-2, titled "Control Room Evacuation Due to Fire in the Control Room or Relay Room." This procedure provides instructions to maintain the unit in hot standby or to proceed to cold shutdown in the event of a fire in the control room or relay room.

The scope of this review was to ascertain that the shutdown could be attained in a safe and orderly manner, to determine the level of difficulty involved in operating equipment, and to verify that there was not dependence on repairs for achieving hot shutdown. For review purposes, a repair may include installing electrical or pneumatic jumpers, wires or fuses, to perform an action required for hot shutdown. For cold shutdown, repairs are allowed using in place procedures and materials available onsite with the provision that cold shutdown be achievable within 72 hours.

The procedure, which would be used in event of a fire in the control room or the cable spreading room, was issued on September 8, 1987 and was not reviewed by the Station Operations Review Committee (SORC). This lack of SORC review represents a violation of T.S. 6.5.1.6.e which requires that the SORC shall be responsible for the review of the Fire Protection Program and implementing procedures. (50-311/87-29-05).

The procedure is written in a two-column format. The first column lists the operator actions and the second column provides comments and contingency actions. The comments in this column are mostly references to the Fire Hazard Analysis Books which provide detailed explanations on how to perform the Emergency Equipment Operations.

The team observed that all of the references such as Fire Hazard Analysis Book Number and Section Number included in this procedure were in error. The licensee explained that this error occurred during the editing of the procedure. However, the operators using the index of the Fire Hazard Analysis were able to find the appropriate procedure references. The team noted that reliance on the operator to recognize the procedure errors and use the index to find the proper references is inappropriate. The inspector determined that the licensee initiated an effort to correct this deficiency of incorrect procedure references.

## 8.2 Procedure Walk-Through

The team observed a walk through by licensee operators of several portions of procedure AOP-EVAC-2, "Control Room Evacuation Due to Fire in the Control Room or Relay Room," to determine by simulation that shutdown from outside the Control Room is possible in an orderly and timely fashion.

The procedure implementation required the use of the Nuclear Shift Supervisor (NSS), three Nuclear Control Operators (NCO) and an Equipment Operator (EO). Following a simulated reactor trip and evacuation of the Control Room, the NSS took control of the plant shutdown from the Hot Shutdown Panel. From there, instructions were given to the operators by the use of hand-held radios.

The team in observing the operators perform some steps in the procedure determined that some of the operator actions are repairs by NRC definition and, therefore, are not allowed during the hot shutdown phase. The repairs in question involve the use of pneumatic jumpers to prevent spurious actuation of valves. The licensee explained that an alternative to the use of pneumatic jumpers exists in the procedure but using the jumpers is the preferred way. The licensee also explained that the NRC has specifically reviewed the use of jumpers and has found it acceptable. This issue remains unresolved pending review of the pertinent documentation to confirm previous NRC approval of the use of jumpers. (50-311/87-29-06)

During the procedure walk-through, the team also reviewed the effectiveness of communications using hand-held radios, since this is the communication method used by the licensee. The operators communicated effectively using the radios, despite the background noise levels. The team also reviewed the availability of this type of communication system for a fire in the control room or the relay room. This review determined that the 115VAC vital instrument bus 2A, which is the power source of the radio transmitter, is located in the relay room and, therefore, a fire in this area could disable the radio communications. Reliable radio communication is essential for the orderly safe shutdown of the plant since the NSS must communicate with the NCOs and EO to provide instructions for actions necessary for safe shutdown of the plant.

The possible loss of all communications during the hot shutdown phase represents a violation of the 10 CFR 50 Appendix R, Section III.L.3 requirement which stipulates that the alternative shutdown capability provided for a fire area be able to achieve and maintain hot standby conditions. (50-311/87-29-07)

Other observations made during the procedure walk-through are:

- A) The licensee is using a toolchest to store tools, jumpers, repair materials and manuals. The team observed that the organization of the items within the toolchest was poor in that the items stored in the toolchest were in disarray. The licensee committed to improve the placement/storage of the material and tools required for shutdown.
- B) The procedure steps, make reference to valve and instrument numbers. The team observed that some of the numbering tags on the valves were missing and some were too small to read under the existing lighting conditions and tag location. Some valves were also tagged using magic markers. The licensee agreed to review the equipment identification concern.

## 9.0 Protection for Associated Circuits

Appendix R, Section III.G requires that protection be provided for associated circuits that could prevent operation or cause maloperation of redundant trains of systems necessary for safe shutdown. The circuits of concern are generally associated with safe shutdown circuits in one of three ways:

- Common bus concern
- Spurious signals concern
- Common enclosure concern

The associated circuits were evaluated by the team for these concerns. Power, control, and instrumentation circuits were examined on a sampling basis for potential problems.

### 9.1 Common Bus Concerns

The common bus concern may be found in circuits, either safety-related or non-safety-related, where there is a common power source with shutdown equipment and the power source is not electrically protected from the circuit of concern.

The team examined, on a sampling basis, 4160V, 460V, 230VAC, 120VAC, 125VDC and 28VDC bus protective relay coordination. The licensee presented sample coordination curves dated September 4, 1987, at the time of the audit. The team also examined, on a sampling basis, the protection for specific instrumentation, controls, and power circuits, including the coordination of fuses and circuit breakers. The licensee's schedule is to perform checks of relay settings at approximately 24-month intervals.

The review of the common bus concern identified the following unacceptable condition:

#### Inadequate Circuit Breaker Coordination

The team reviewed the licensee's draft "Appendix R Breaker Coordination Study" dated September 4, 1987, to evaluate the protective relaying of the vital buses required for safe shutdown in the event of a fire. Although the review of this study identified many examples of unsatisfactory circuit breaker coordination on all distribution buses, the team could not identify any instances where the lack of breaker coordination of associated circuits could prevent shutdown. The team, however, informed the licensee that such a possibility exists in areas housing safe shutdown components from one division and associated circuits of concern from the redundant division. A fire in such an area could cause the loss of the safe shutdown equipment located therein and in addition cause the loss of the redundant train because the vital buses of the redundant train located elsewhere are not electrically protected from their associated circuits located in this fire area. The licensee agreed with the team that this possibility may exist given the fact that proof to the contrary could not be found.

The licensee reported this finding to NRC via LER 87-11 and immediately established interim compensatory measures. These measures were described to NRC in a letter dated September 18, 1987. Within this letter the licensee also committed to meet with the Region I management to discuss this and the other findings of this inspection.

The licensee committed to provide the NRC with either the conclusions of the study undertaken to verify that the breaker coordination "as found" was acceptable or a description of the modifications made to the associated circuits to achieve compliance with Appendix R within 60 days upon receipt of this report.

Pending completion and review of this study, the breaker coordination issue as it relates to Appendix R is unresolved. (50-311/87-29-08)

#### 9.2 Spurious Signals Concern

Spurious signals are a concern because of the following:

- Fire initiated grounds, short or open circuits can cause false motor control and instrument indications, such as those encountered during the 1975 Browns Ferry fire.

- Spurious operation of safety-related or non-safety-related components can occur that would adversely affect shutdown capability (e.g., RHR/RCS isolation valves).

The team examined, on a sampling basis, the following areas to ascertain that no spurious signal concern exists:

- Current transformer secondaries
- High/low pressure interfaces
- General fire instigated spurious signals

For the current transformer secondaries review, the team selected the current transformers associated with the Emergency Diesel Generators.

The current transformer circuits reviewed were found to have their secondary circuits protected from the effects of fire by the installation of Westinghouse "teleductor" transducers on the current transformer secondaries. A review of the manufacturers literature found these devices to provide ample isolation in the event of a fire induced open circuit on the current transformer secondaries.

The high/low pressure interface control method, the controls for fire instigated spurious signals, and common enclosures will be the subject of a future NRC inspection.

## 10.0 Emergency Lighting

10 CFR 50, Appendix R, Section III.J, requires that emergency lighting units with at least an 8-hour battery power supply shall be provided in all areas needed for operation of safe shutdown equipment and in access and egress routes thereto.

The team examined the plant emergency lighting systems to ascertain the licensee's compliance with the above requirements. The team observed that the licensee in their most recent surveillance of the lights had identified a number of lights as degraded or inoperable.

The licensee stated that the reason repairs to these lights were not made was the long lead time required to obtain parts from the manufacturers. During the follow up inspection on December 15-18, 1987, the inspector verified that these degraded lights were made operable.

Except for the above licensee identified concerns, the review of the emergency lights did not identify any other unacceptable conditions.

### 11.0 Unresolved Items

Unresolved items are matters for which more information is required in order to ascertain whether they are acceptable, violations, or deviations. Unresolved items are discussed in Sections 6.0, 8.2 and 9.1.

### 12.0 Exit Interview

The inspection team met with the licensee representatives, denoted in Section 1.0, at the conclusion of the inspection on September 18, 1987, and the team leader summarized the scope and findings of the inspection at that time. Licensee management made a commitment to provide the NRC a justification for continuing operations with compensatory measures and a commitment to meet with Regional Management to discuss the findings identified in the report.

At no time during this inspection was written material provided to the licensee by the team.

### 13.0 Management Meeting

A Management Meeting was held on October 7, 1987 at the NRC Region I offices between NRC and the licensee's management representatives. A list of attendees at the meeting appears as Attachment 2 to this report.

This meeting was held because some of the findings described in this report were significant enough to require that the licensee submit to the NRC a Justification for Continued Operation (JCO). Also, the licensee via a letter transmitted to NRC committed to interim actions prior to the issuance of the JCO to provide assurance of safe operation. The interim actions committed to by the licensee included the posting of continuous and roving fire watches, the monitoring at the containment temperature, provisions to detect fires in high radiation areas where posting of fire watches is not possible, and reduce any backlog of maintenance requests on fire protection equipment.

The JCO was transmitted to the NRC via a letter dated October 1, 1987, subject "10 CFR 50 Appendix R, Safety Evaluation Salem Generating Station, Unit Nos. 1 and 2, Docket No. 50-272/50-311."

The purpose of the meeting was to discuss the contents of the JCO, deficiencies identified during the inspection, the adequacy of interim compensatory measures and the licensee's long-term plans for full compliance.

The major deficiencies identified are described in detail in Sections 6.0, 7.0, 8.2 and 9.1 of this report. They are the deficiencies described in LERS 87-09 and 87-10, the lack of breaker coordination and the possible loss of all communications required during hot shutdown if a fire occurred in the Relay Room.

While all aspects of the JCO were discussed at the meeting, the major topic was the lack of breaker coordination when offsite power is lost for the 460V loads and lower voltage levels and the lack of documentation to assure that breaker coordination exists when offsite power remains available at the 4KV level.

The licensee made a presentation explaining why the deficiencies occurred. The licensee's presentation material is included as Attachment 3 to this report.

During the meeting the licensee made the following commitments:

- 1) The licensee would resubmit a JCO by October 16, 1987. This submittal would include the assurance that breaker coordination of the 4KV vital buses exists when the offsite power remains available and that non-safety-related associated circuits have either been physically or electrically protected.
- 2) The licensee would transmit to the NRC by November 20, 1987 a letter with the schedule for the implementation of the corrective actions for the deficiencies identified in LERS 87-09 and 87-10.
- 3) As a result of questions probing beyond the scope of Appendix R, the licensee committed to submit to the NRC by October 23, 1987 another JCO addressing breaker coordination with respect to external and internal hazards. Specifically:
  - The effects of moderate energy line breaks on Unit No. 1
  - The effects of high energy line breaks inside and outside Containment
  - Confirm that breaker coordination exists at the 4KV level and above
  - Address the potential hazards on associated circuits.
- 4) The licensee would complete the breaker coordination study by December 31, 1987.-
- 5) The licensee would provide a schedule for the completion of the modifications for the breaker coordination work by January 31, 1988 and complete the relay setpoint changes by April 1, 1988.



ATTACHMENT 1

SUMMARY OF FINDINGS

<u>ITEM</u>	<u>CATEGORY</u>	<u>ITEM DESCRIPTION</u>
87-29-01 Section 6.0	Violation	A Fire in Fire Areas FA-AB-100A, 100B and 100C may cause the inadvertent actuation of the CO <sub>2</sub> system in all three diesel generator rooms thus degrading the diesels and causing the loss of all emergency power.
87-29-02 Section 6.0	Deviation	Lack of detection in locations identified in the fire hazard as having detectors.
87-29-03 Section 6.0	Unresolved item	Lack of Fire test documentation for the Penetration seals.
87-29-04 Section 7.0	Violation	LER 87-09 Revision 4 and LER 87-10 Unit 1 and 2 identify several instances where a fire could damage safe shutdown systems and prevent a safe shutdown.
87-29-05 Section 8.1	Violation	Lack of SORC review of the Control Room Evacuation Procedure represents a T.S. Violation.
87-29-06 Section 8.6	Unresolved item	The licensee is performing repairs during hot shutdown as action normally not allowed. The licensee stated that NRC has reviewed these actions.
87-29-07 Section 8.2	Violation	A fire in the Relay Room may cause the loss of radio communications required to achieve safe shutdown.
87-29-08 Section 9.1	Unresolved item	Lack of adequate circuit breaker coordination could prevent safe shutdown.

ATTACHMENT 2

MANAGEMENT MEETING ATTENDEE LIST

PSE&G

C. McNeill	Senior Vice President Nuclear
J. Zupko, Jr.	General Manager, Salem
J. Boettger	Assistant Vice President
W. Gailey	Manager, Projects
W. Pavincich	Principal Engineer
L. Miller	Manager, Nuclear Engineering Services
B. Preston	Manager, Licensing and Regulation
R. Basha	Principal Engineer
C. Lambert	Manager, Engineering Sciences
R. Skwarek	Project Manager, Special Projects

USNRC

A. Krasopoulos	Reactor Engineer
F. Rosa	Branch Chief, SELB
D. Chopra	SELB, Reviewer
T. Koshy	Reactor Engineer
W. Kane	Director, Division of Reactor Projects
W. Johnston	Director (Acting), Division of Reactor Safety
J. Durr	Deputy Director (Acting), Division of Reactor Safety
P. Swetland	Chief, RPS 2B, Region I
T. Kenny	Senior Resident Inspector
E. Wenzinger, Sr.	Chief, Reactor Projects Branch 2, Region I
R. Keller	Chief, Operator Licensing Section
L. Bettenhausen	Chief, RPB 1, Region I

**Agenda**  
**NRC/PSE&G Meeting**  
**Appendix R and Electrical**  
**October 7, 1987**

1. Opening Remarks C. A. McNeill
2. Response to NRC questions on October 2,  
Safety Evaluation C. W. Lambert
3. Fire Protection Program status/schedule C. W. Lambert
4. Maintenance/operational program L. K. Miller
5. Electrical
  - Internal/external hazards C. W. Lambert
  - Procedures L. K. Miller
  - August 1986 electrical event and  
resultant program R. W. Skwarek
6. Management Overview C. A. McNeill
  - Fire Protection Program
  - Design Bases Programs

**SALEM GENERATING STATION  
UNITS 1 & 2  
FIRE PROTECTION  
IMPROVEMENT PROGRAM**

# **FIRE PROTECTION IMPROVEMENT PROGRAM PROJECTS**

- Fire Protection Commitment Verification Program
- Update of Systems Interaction Analysis
- Re-verification of the Fire Hazards Analysis
- Appendix R - Breaker Coordination Program
- Fire Barrier Penetration Seal Program
- Incorporation of Hope Creek Documentation

# **FIRE PROTECTION IMPROVEMENT PROGRAM PROPOSED PRODUCTS**

- Fire Protection Program Plan
- Control Procedure

SALEM APPENDIX R

ACTION PLAN

MANAGEMENT TEAM

LYNN MILLER  
MANAGER - NUCLEAR ENGINEERING SERVICES

° ENGINEERING

C. LAMBERT

R. BASHALL

R. SKWAREK

L. CORLETO

R. DIAZ

D. SHUMAKER

TENERA LP

° SITE PROTECTION

J. KERIN

R. BRADDICK

° OPERATIONS

B. CONNORS

° LICENSING

B. PRESTON

R. SWARTZWELDER

## ACTIVITIES COMPLETED TO DATE

- ° MANAGEMENT TEAM IN PLACE
- ° FIRE WATCHES ESTABLISHED IN BOTH UNITS
- ° DETECTION/MONITORING/SURVEILLANCE FOR AREAS OF HIGH RADIATION CONDITIONS ESTABLISHED
- ° OUTSTANDING WORK ORDERS ON FIRE PROTECTION ITEMS MINIMIZED
- ° EMERGENCY LIGHTING ASSOCIATED WITH APPENDIX R REPAIRED
- ° SAFETY EVALUATION ADDRESSING MEASURES TO JUSTIFY SAFE OPERATION OF SALEM UNITS 1 & 2 REGARDING APPENDIX R DEFICIENCIES COMPLETE
- ° OPERATIONS DEPARTMENT COGNIZANT OF PROCEDURES/GUIDELINES TO BE IMPLEMENTED WITH RESPECT TO RESTORATION OF VITAL POWER SUPPLIES



"APPENDIX R" ACTION PLAN  
CALENDER OF EVENTS  
\*\*\*\*\*  
sorted by date

MILESTONE DESCRIPTION	KEY DATE	STATUS	REMARKS
APPENDIX "R" FIRE PROTECTION EVALUATION PROGRAM	01/01/87	ONGOING	
APPENDIX "R" NRC AUDIT	09/15/87	COMPLETE	
APPENDIX "R" TASK TEAM FORMED	09/18/87	WORKING	
ADDITIONAL COMPENSATORY MEASURES IMPLEMENTED	09/18/87	COMPLETE	
SUBMITTAL OF JUSTIFICATION FOR CONTINUED OPERATION (JCO)	10/01/87	COMPLETE	
MEETING WITH N.R.C.	10/07/87		MTG. SET FOR 1:30 P.M.
BREAKER COORDINATION STUDY - VITAL BUSS	10/30/87	WORKING	
SUBMITTAL OF APPENDIX "R" EXEMPTION REQUEST	10/30/87	WORKING	REQUIRES NRR INSPECTOR WALKDOWN ON SITE
BREAKER COORDINATION & LONG TERM ELECTRICAL DISTRIBUTION STUDY COMPLETE (BOP)	12/31/87		
DCP MODIFICATIONS INSTALLED	/ /		TO BE DETERMINED

**FIRE PROTECTION  
IMPROVEMENT PROGRAM SCHEDULE**

**FIRE HAZARDS ANALYSIS UPDATE**

CONSISTENCY WITH PLANT CONFIGURATION	10/31/87
ADDITIONAL CHANGES PER DCPS, ETC.	12/31/87

**REVISED EXEMPTION REQUESTS**

NRR WALKDOWN	LATE OCT. 1987
FORMAL SUBMITTAL	LATE NOV. 1987

**PENETRATION SEAL PROGRAM**

BEGIN WALKDOWNS	12/4/87
COMPLETE PROGRAM (OUTAGE COORDINATION REQ'D.)	JULY 1989
CLOSE OUT PAPERWORK	SEPT. 1989

**IMPROVEMENT PROGRAM**

FINALIZE UNIT 2 INTERACTION ANALYSIS-DRAFT REPORT	10/28/87
FINAL REPORT	12/1/87
FINALIZE UNIT 1 INTERACTION ANALYSIS-DRAFT REPORT	11/25/87
FINAL REPORT	12/31/87
COMMITMENT VERIFICATION PROGRAM	10/31/87
PROGRAM PLAN	11/15/87
CONTROL PROCEDURE	12/1/87

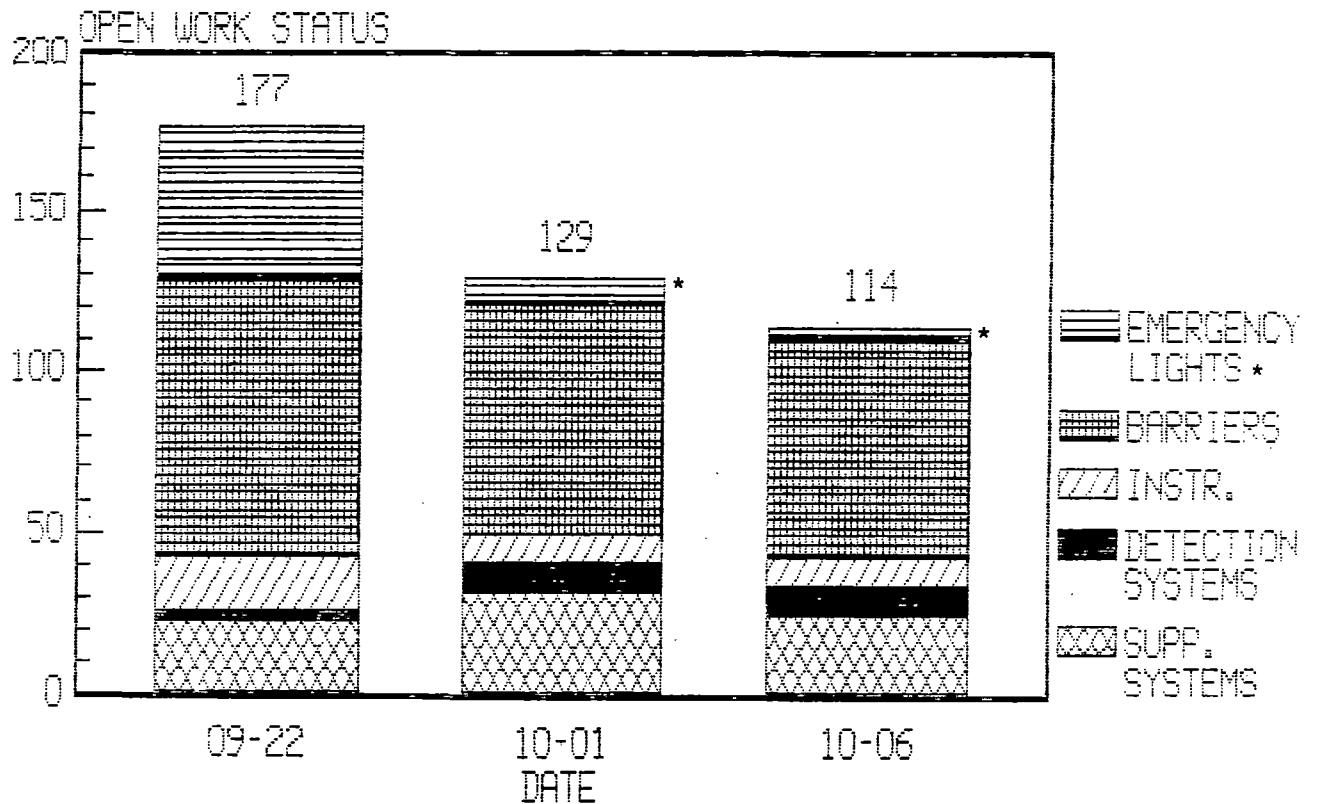
**BREAKER COORDINATION**

VERIFY DRAFT REPORT	10/31/87
BALANCE OF PLANT EVALUATIONS	12/31/87

**APPENDIX R PLANT MODIFICATIONS**

SUBJECT TO EXEMPTION  
REQUEST APPROVAL

# CORRECTIVE MAINTENANCE STATUS



\* DEPICTS NON APPENDIX "R" FIXTURES

**INTERNAL AND EXTERNAL  
HAZARD CONSIDERATIONS**

° **EXTERNAL CONDITION**

- EARTHQUAKE
- FLOOD
- TORNADO
- TURBINE MISSILES

**BREAKER COORDINATION CONSIDERATION**

- NO IMPACT
- NO IMPACT, WATERTIGHT EXTERNAL ENCLOSURES
- NO IMPACT
- NO IMPACT, RISK ANALYSIS AND INSPECTION PRECLUDE FAILURE

° **INTERNAL CONDITION**

- SEISMIC II/I
- INTERNAL MISSILES  
(VALVE STEMS, CONTROL  
ROD DRIVE MECHANISM, ETC)
- MODERATE ENERGY PIPE  
FAILURE (SPRAY/FLOOD)
- HIGH ENERGY LINE BREAK (HELB)  
(OUTSIDE CONTAINMENT)
- HELB/LOCA  
(INSIDE CONTAINMENT)

- NO IMPACT, PLANT DESIGN MEETS INTENT OF R.G. 1.29
- NO IMPACT
- NOT A LICENSE BASIS
- UNIT 2 ANALYZED/PROTECTED SUCH THAT SAFE SHUTDOWN CAPABILITY IS NOT JEOPARDIZED
- LIMITED CONSIDERATION; EXTREMELY LOW PROBABILITY OF OCCURRENCE
- SAFETY RELATED ELECTRICAL EQUIPMENT QUALIFIED FOR CONDITION
- HIGH ENERGY LINES ENCAPSULATED IN VARIOUS COMPARTMENTS
- YES; EXTREMELY LOW PROBABILITY OF OCCURRENCE
- EOP'S AND OPERATIONS PROCEDURES FOR RESTORATION OF VITAL POWER AVAILABLE

STATUS OF LOSS OF ALL AC POWER PROCEDURES

WESTINGHOUSE OWNERS GROUP EMERGENCY RESPONSE GUIDELINES (ERGs)

- ERGs CURRENTLY REVISION 1 - ISSUED SEPTEMBER 1, 1983
- ERG UPGRADE TO REVISION 1A - ISSUED JULY 1, 1987
- ERG REVISION 1 APPROVED BY NRC - JULY 1986
- ERG REVISION 1A - PRESENTLY BEING REVIEWED BY NRC FOR APPROVAL

SALEM EMERGENCY OPERATING PROCEDURES (EOPs)

- EOPs CURRENTLY REVISION 1 - ISSUED JUNE 1, 1987
- EOP REVISION 1 INCLUDED UPGRADE OF ERGs REV 1A

EOPs ASSOCIATED WITH LOSS OF ALL AC POWER

- EOP-LOPA-1 - LOSS OF ALL AC POWER
- EOP-LOPA-2 - LOSS OF ALL AC POWER  
RECOVERY/SI NOT REQUIRED
- EOP-LOPA-3 - LOSS OF ALL AC POWER  
RECOVERY/SI REQUIRED

CURRENT STATUS

- EOPs ARE CURRENT TO LATEST GUIDELINE

### EMERGENCY OPERATING PROCEDURES

EOP-TRIP-1	- REACTOR TRIP OR SAFETY INJECTION
EOP-LOPA-1	- LOSS OF ALL AC POWER
EOP-LOPA-2	- LOSS OF ALL AC POWER RECOVERY/SI NOT REQUIRED
EOP-LOPA-3	- LOSS OF ALL AC POWER RECOVERY/SI REQUIRED

### ABNORMAL OPERATING PROCEDURES

AOP-ELEC-4KV-A	- LOSS OF 2A 4KV VITAL BUS
AOP-ELEC-460/230V-A	- LOSS OF 2A 460/230V VITAL BUS
AOP-ELEC-VIB-A	- LOSS OF 2A 115V VITAL INSTRUMENT BUS
AOP-ELEC-125V-A	- LOSS OF 2A 125VDC BUS
AOP-ELEC-28V-A	- LOSS OF 2A 28VDC BUS
AOP-ELEC-4KV-B	- LOSS OF 2B 4KV VITAL BUS
AOP-ELEC-460/230V-B	- LOSS OF 2B 460/230V VITAL BUS
AOP-ELEC-VIB-B	- LOSS OF 2B 115V VITAL INSTRUMENT BUS
AOP-ELEC-125V-B	- LOSS OF 2B 125VDC BUS
AOP-ELEC-28V-B	- LOSS OF 2B 28VDC BUS
AOP-ELEC-4KV-C	- LOSS OF 2C 4KV VITAL BUS
AOP-ELEC-460/230V-C	- LOSS OF 2C 460/230V VITAL BUS
AOP-ELEC-VIB-C	- LOSS OF 2C 115V VITAL INSTRUMENT BUS
AOP-ELEC-125V-C	- LOSS OF 2C 125VDC BUS
AOP-ELEC-21MAC	- LOSS OF 21 MAC 115V DISTRIBUTION CABINET
AOP-ELEC-22MAC	- LOSS OF 22 MAC 115V DISTRIBUTION CABINET

ACTIONS TAKEN

SEPTEMBER 1986

° DEVELOPED DETAIL EVALUATION TO DEFINE ROOT CAUSE OF PROBLEM.

DECEMBER 1986

° CONTRACTED PTI TO DEVELOP TRANSIENT VOLTAGE PROFILE. RESULTS INDICATED RECOVERY VOLTAGE AT 92.9% WORST CASE.

JANUARY 1987

° INSTALLED TEMPORARY FEED FROM HOPE CREEK SUB-STATION TO REMOVE APPROXIMATELY 6 MVA LOAD FROM EACH SALEM UNITS ELECTRICAL DISTRIBUTION SYSTEM. THREE CIRCULATING WATER PUMPS FROM EACH SALEM UNIT WAS POWERED FROM THIS TEMPORARY FEED. THIS ALLOWED TO RETURN TO 100% POWER.

FEBRUARY 1987

° DEVELOPED SHORT TERM FIX TO ADJUST SECOND LEVEL UNDER VOLTAGE PROTECTION RELAY FROM 95% TO 92.6%. THIS RESOLVED THE FLIP-FLOP ISSUE.

MARCH 1987

° TASK FORCE DEVELOPED LONG TERM PROGRAM TO ASSURE A SAFE AND RELIABLE DISTRIBUTION SYSTEM.

SALEM GENERATING STATION  
ELECTRICAL DISTRIBUTION SYSTEM IMPROVEMENT STUDY

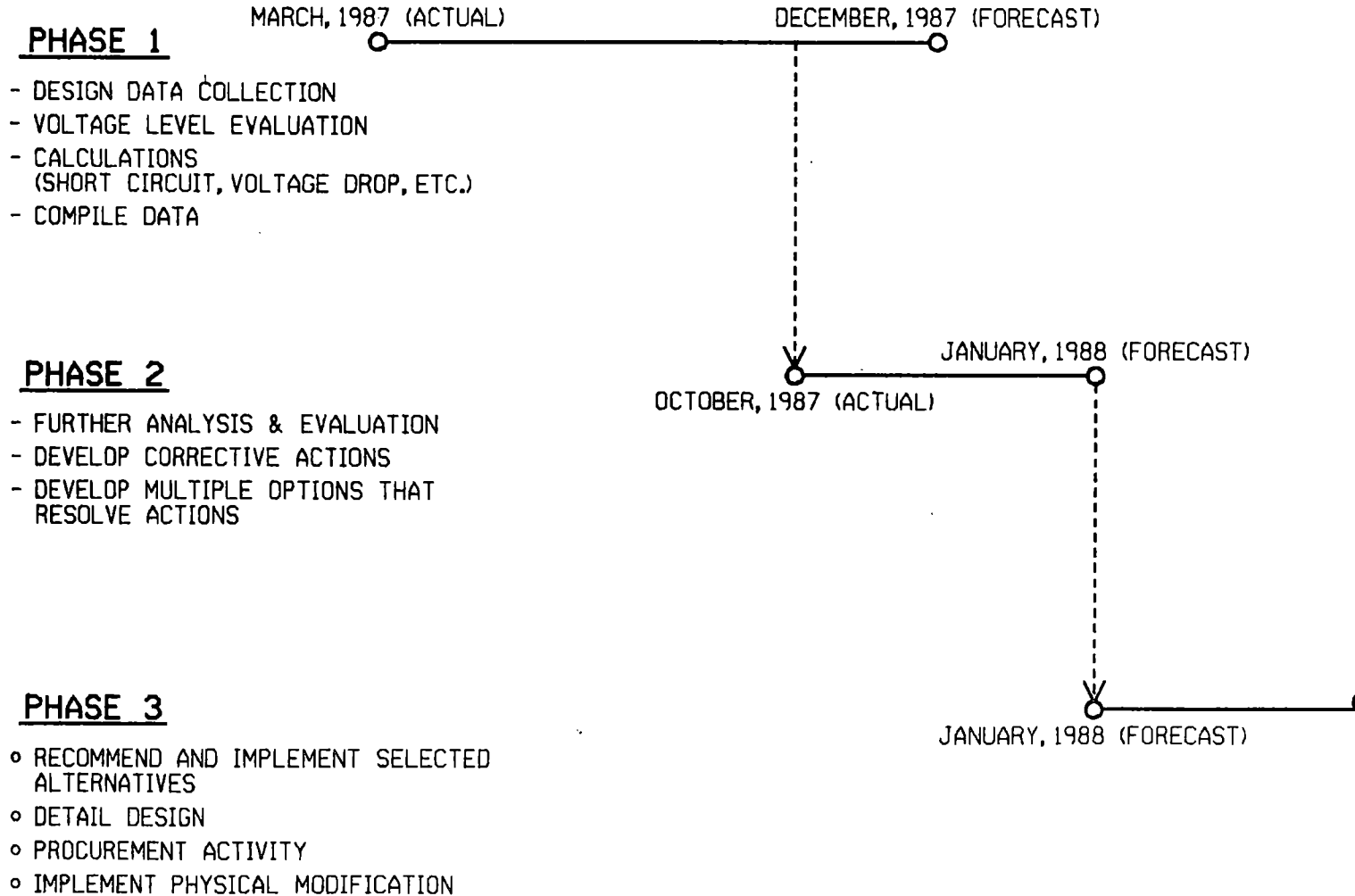
GOAL: ASSURE A SAFE AND RELIABLE ELECTRICAL DISTRIBUTION SYSTEM

OBJECTIVES:

- 1) DEVELOP A COMPREHENSIVE DESIGN BASIS INCLUDING:
  - A) DESIGN DOCUMENTS
  - B) CALCULATIONS
  - C) PROCEDURES
  - D) NRC LICENSING ISSUES
- 2) ANALYZE SYSTEM DEFICIENCIES/WEAKNESSES
- 3) DEVELOP FEASIBILITY STUDIES FOR SYSTEM IMPROVEMENT OPTIONS



# SALEM ELECTRICAL DISTRIBUTION SYSTEM IMPROVEMENT PROGRAM



PHASE 1

DEVELOP A COMPREHENSIVE DESIGN BASIS INCLUDING:

°DESIGN DATA COLLECTION

DRAWINGS

EQUIPMENT SPECIFICATIONS

EXISTING DESIGN CALCULATIONS

°VOLTAGE SYSTEMS ANALYZED

25KV, 13KV, 4KV, 480, 230, 115vac 250, 125,  
28vdc (VITAL/NON VITAL)

°CALCULATIONS/COMPUTER PROGRAMS

VOLTAGE PROFILE

SHORT CIRCUIT

VOLTAGE DROP

COORDINATION

MOTOR STARTING

EQUIPMENT SIZING

°COMPILE DATA

DEVELOP HARD COPY DATA BASE

IDENTIFY POTENTIAL DEFICIENCIES

IDENTIFY DRAWING DISCREPANCIES

PHASE 2

° FURTHER ANALYSIS AND EVALUATION REQUIRED

° CORRECTIVE ACTION REQUIRED

ANALYZE FOR IMPACT TO SAFETY SYSTEMS  
(SAFETY EVALUATION)

° DEVELOP OPTIONS TO ADDRESS LOAD GROWTH

PHASE 3

° IMPLEMENT DESIGN OF APPROVED LONG TERM OPTION  
DESIGN, PROCUREMENT, INSTALLATION

# ELECTRICAL POWER SYSTEM ANALYSIS PROCESS

