U.S. NUCLEAR REGULATORY COMMISSION
HEADQUARTERS

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Facility:	St. Lucie Units 1 and 2
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EXECUTIVE SUMMARY

St. Lucie Units 1 and 2
Fire Protection Functional Inspection
Report 50-335/98-201 and 50-389/98-201

St. Lucie Units 1 and 2 are two separate nuclear power plants of a similar design that share a common site. Both units are Combustion Engineering pressurized-water reactors and each unit has a rated output of 890 MWe. St. Lucie Unit 1 began commercial operation in December 1976 and Unit 2 in August 1983. During the weeks of March 9-13 and March 30-April 4, 1998, a team of U.S. Nuclear Regulatory Commission (NRC) inspectors and Brookhaven National Laboratory engineers conducted a Fire Protection Functional Inspection (FPFI) at the St. Lucie Plant (PSL).

In February 1997, the NRC informed the licensee, Florida Power and Light (FPL) Company, of its intent to perform an FPFI at Unit 1. In a letter dated December 15, 1998, FPL requested the NRC to delay the FPFI planned for March of 1998 and reschedule it to the June-July 1998 time frame. The NRC denied this request and, in a letter dated January 14,1998, advised FPL that it would conduct the FPFI as scheduled. Subsequent to the February 1997 notification, as documented in licensee-identified condition reports (CRs) reviewed during the inspection, FPL had initiated a comprehensive re-evaluation of its fire protection program for both units and a revalidation of the Unit 1 SSA (Document No. 8770-B-048, Revision 3, dated February 13, 1986) and Volume 9.5A of the UFSAR. This effort resulted in the generation of a significant number of CRs related to the fire protection program and post-fire safe-shutdowns. In response to these various fire protection/post-fire safe shutdown program weaknesses, FPL instituted compensatory measures.

Although this inspection included a risk-informed evaluation of the fire protection program developed by FPL, the inspection team focused on assessing the fire protection defense-in-depth at Unit 1 and the plant's ability to achieve and maintain post-fire safe-shutdown conditions in the event of a fire in any area of the plant. This inspection consisted of a comprehensive evaluation of the fire protection program, fire safety features, and the post-fire safe-shutdown capability developed by FPL for Unit 1 as required by Section 50.48 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.48).

Section 50.48 requires that all operating nuclear power plants have a fire protection plan that satisfies General Design Criterion (GDC) 3 of Appendix A to Part 50. The PSL fire protection program requirements are established by Unit 1 Operating License DPR-67, Condition 2.C(3), and Unit 2 Operating License NPF-16, Condition 2.C.20. These operating license conditions specify that FPL implement and maintain in effect all provisions of the NRC approved fire protection program as described in the Updated Final Safety Analysis Report (UFSAR) for the facilities and as approved by various NRC Safety Evaluation Reports (SERs). Since Unit 1 was licensed to operate prior to January 1, 1979, it is required to meet Sections III.G, III.J, and III.O of Appendix R to 10 CFR Part 50

Specific areas reviewed by the FPFI team included the following:

- The licensee's compliance with Sections III.G, III.J, and III.O of Appendix R to 10 CFR Part 50.
- The adequacy of the licensee's separation and/or protection provided for redundant trains of equipment and cables required to achieve and maintain safe-shutdown conditions in the event of fire.
- The scope of the analysis performed by the licensee and the adequacy of the protection provided for non-essential associated circuits that can prevent the operation or cause the mal-operation of the plant's post-fire safe-shutdown capability.
- The licensee's post-fire alternative shutdown analysis methodology and the adequacy of procedures developed to implement this methodology.
- Whether the plant's fire protection program has been fully implemented and maintained in accordance with the plant's Operating License.
- The 10 CFR 50.59 change process as applied to the fire protection program and how the process ensures that the NRC-approved fire protection program is maintained.

In addition, the FPFI team reviewed fire safety considerations that are not expressly addressed by the fire protection regulation. For example, the team assessed the plant fire protection program and the licensee's initiatives to implement improvements in state-of-the-art fire detection, control, and extinguishment technology.

Summary of Findings

The licensee's administrative combustible control procedures adequately implemented the approved fire protection program. Implementation of the fire inspection program by the Protection Services Department was good; however, the various plant departments had not consistently implemented their responsibilities, as specified by these procedures, for the control of combustible fire hazards. The plant departments' implementation of the combustible control procedures and operational practices were not consistent with the PSL fire protection program in that plant personnel failed to follow combustible control procedures used to manage temporary storage of transient combustibles in safety-related areas. This failure to follow the combustible control procedures which manages the use and temporary storage of transient combustibles in safety-related areas was identified as an unresolved item (see Section F1.1).

Backup (emergency) lighting was not provided by the licensee for the fire brigade equipment and dressout lockers. This situation, under certain conditions, could delay the response of the fire brigade and the logistics for deployment of its equipment. This was considered an area requiring licensee attention. The licensee evaluated this situation during the inspection and took corrective actions to establish backup lighting in these areas. Also, during the fire brigade drill, the team noted that the personal protective firefighting equipment provided to the brigade and used to cope with onsite fire emergencies did not provide the level of safety needed to protect fire brigade members from being exposed directly to the hazards associated with interior firefighting (see Section F2.1.1).

Generally, the licensee's fire protection surveillance and inspection requirements (for fire protection systems selected by the team) were found to be satisfactory and properly implemented. However, two examples of fire protection surveillance program problems were identified during the inspection: (1) the failure to include any administrative requirements governing surveillance testing, operability, and compensatory measures for the Appendix R post-fire safe-shutdown equipment and features in the fire protection program, and (2) the failure of the fire hose station surveillance program to confirm coverage in accordance with requirements of the UFSAR. These examples are considered to be failures of the licenses's fire hose station surveillance program to confirm hose station coverage in accordance with the UFSAR and have been identified as an unresolved item (see Section F2.2).

The licensee has developed firefighting strategies for all Unit 1 and Unit 2 fire areas. However, these strategies, which provide important fire and smoke control information to the fire brigade, do not reflect (1) manual actions to ensure ventilation requirements as specified by the SSA, (2) radiological controls for firefighting water runoff, and (3) manual smoke removal methods for maintaining the post-fire operator habitability of shutdown-related spaces adjacent to the fire area of concern. These are examples of a failure to update the firefighting strategies to reflect the requirements of the approved fire protection plan and Appendix R. This has been identified as an unresolved item (see Section F3.1).

The team noted that the fire brigade did not fully use the self-contained breathing apparatus (SCBA) during the drill. The partial use of the SCBA did not expose the fire brigade personnel to the stresses and limitations created by its full use. The team concluded that the importance of the full use of the SCBA was not recognized. This has been identified as a failure to perform fire brigade drill in accordance with the requirements of the approved fire protection program and Appendix R. This has been identified as an unresolved item (see Section F3.3).

On the basis of a review of the PSL Fire Protection Plan and its referenced procedures, the team determined that no specific criteria or guidelines had been established for determining when either the plant fire protection or the post-fire safe-shutdown features are inoperable or outside their design basis. In addition, the plan does not establish controls that govern the operability or availability of post-fire safe-shutdown equipment such that power operations can be conducted with the assurance that a train of systems needed for safe-shutdown will be free of fire damage, or when conditions of inoperability exist, the plan does not ensure that appropriate measures have been established to compensate for the post-fire safe-shutdown system deficiency. The fire protection plan failed to address Appendix R post-fire safe-shutdown capability and govern its operability. This has been identified as an unresolved item (see Section F5.1).

On the basis of a review of the PSL Fire Protection Plan and the licensee's identified weaknesses associated with the SSA and its translation into post-fire safe-shutdown procedures and operator actions, it was not clear who was fundamentally responsible for overall compliance with fire protection requirements. This lack of program ownership was viewed by the inspection team as a significant contributor to the fire protection and post-fire safe-shutdown program weaknesses identified by the PSL reevaluation (see Section F6.2).

The Quality Assurance Department at PSL has been conducting detailed, critical, and insightful quality assurance audits in the fire protection and post-fire safe-shutdown areas. On the basis of Nuclear Quality Assurance Report 98-0141, PSL made a change to its procedures to ensure proper characterization of problems (as findings rather than technical recommendations) and automatic entry of those problems into a system structured to result in timely corrective action.

The inspection team recognized that the effort of the PSL Quality Assurance Department since 1995, to identify problems in the fire protection/post-fire safe-shutdown area is a notable strength. However, this strength has been diminished by slow corrective action on the part of the PSL Engineering Department. Failure to conduct timely corrective actions for identified post-fire safe-shutdown procedural deficiencies has been identified as an unresolved item (see Section F6.3).

The lack of onsite Appendix R fire protection engineering expertise in the PSL Engineering Department has become apparent to the team. This was supported by the identified concerns in the modification review process to focus on maintaining the post-fire safe-shutdown design. This was identified as an area where further program performance improvements could be made (see Section F6.4).

Section III.L of Appendix R to 10 CFR Part 50 states that support functions shall be capable of providing the process cooling necessary to permit the operation of equipment used for safe-shutdown functions and that alternative shutdown capability shall accommodate post-fire conditions when offsite power is and is not available for 72 hours. Not including heating, ventilation, and air conditioning for the hot-shutdown control panel room represents a lack of incorporation of Appendix R fire effects in the safe-shutdown required analyses This is an example of a failure of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.1.1).

For the sample of circuits selected by the team for review during the inspection, the FPFI team found that the level of protection provided for redundant trains of post-fire shutdown systems did not satisfy the technical requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50. Specifically, a fire in Fire Zones 57 (the cable spreading room), 70 (control room), 55W, or 27 may initiate spurious valve operations that could adversely affect the post-fire safe-shutdown capability. The FPL/PSL safe-shutdown reevaluation has identified instances in which equipment relied on to achieve and maintain safe-shutdown conditions may not have been capable of performing its intended post-fire safe-shutdown function due to (1) inadequate fire protection (charging pump 1A, and lack of radiant energy shields in containment), (2) inadequate separation distances (cables in containment), or (3) SSA deficiencies (Fire Area J and the effect of fire on non-credited equipment). This is another example of a failure of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.1.2).

On the basis of a sample of circuits, the team concluded that the FPL evaluation of circuit breaker, relay, and fuse coordination for low-impedance faults satisfied Section III.G of Appendix R to 10 CFR Part 50. However, the licensee had not developed a controlled procedure to govern the replacement of fuses. Additionally, the licensee's reliance on generic procedural guidance that directed operators to restore operability of power sources that may be lost as a result of fire-induced high-impedance faults did not satisfy Section III.G of Appendix R or the guidance contained in Generic Letter 86-10. In response to the team's findings regarding "time critical" alternative shutdown loads, the licensee has developed operator actions to prevent the loss of power sources whose operation is immediately required to support the accomplishment of alternative shutdown from outside the main control room. This is another example of a failure of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.1.5).

The licensee's analysis and method of protection for fire-induced spurious equipment operations does not satisfy 10 CFR Part 50, Appendix R, Section III.G or III.L. Specific deficiencies include (1) an analysis methodology that assumed only one spurious operation would occur as a result of fire in any area without any further consideration of the number, type, or specific location of potentially affected cables and circuits; (2) a potential for fire to cause a breach of pressurizer power-operated relief valve and reactor coolant system gas vent system high/low-pressure interface boundaries; (3) lack of an analysis of the effect of fire on instrument sense lines; and (4) inadequate evaluation of the potential for fire to cause damage to motor-operated valves relied on to accomplish post-fire safe-shutdown functions as described in Information Notice 92-18. These are additional examples of failures of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.1.5).

Post-fire safe-shutdown procedures 1-ONOP-100.01 and 1-ONOP-100.02 exhibited omissions in that they did not properly address isolation of the main feedwater system and its regulating valves, the main steam bypass valves, and the reactor head vent valves. This was identified as an area where procedure enhancements could decrease the likelihood that fire induced electrical failures could affect shutdown implementation (see Section F7.2.1).

FPL Thermo-Lag fire testing demonstrated that the upgraded fire wall would provide a fire-resistive rating for 1-hour and 48 minutes. However, this qualification rating may be questionable considering the failed hose stream testing. The FPL engineering evaluation of the cable loft wall could not adequately demonstrate to the team that it could protect one train of post-fire safe-shutdown capability and keep it free from fire damage. In the case of the Unit 1 cable loft, the evaluation was further weakened by the lack of any automatic fire suppression. This issue was considered significant since the Thermo-Lag fire wall was not designed or rated to bound the in situ fire loading and the lack of diverse fire protection (i.e., no automatic sprinklers installed in the area). These fire barriers walls are not qualified to meet the plant's licensing basis and the requirements. This has been identified as an unresolved item (see Section F7.3.1).

FPL's identification of detection system design errors and deficiencies was appropriate. Before this identification was made, the team noted numerous missed opportunities (e.g., main control room ceiling tiles, annunciator level) to recognize problems associated with the detection system. In addition, it was not clear that the licensee has demonstrated that the system design deficiencies will not have an impact on the system's defense-in-depth ability to rapidly detect a fire. This is an example of design condition where a fire mitigation system design does not meet plant licensing basis requirements or commitments to minimum industry codes and standards and is identified as an unresolved item (see Section F7.4.1).

FPL's procedures for testing the preaction sprinkler system's deluge valve do not meet the National Fire Protection Association Standard 25 or the vendor's requirements for testing the automatic water-based fire suppression systems. This is an example of a design condition where a fire mitigation system does not meet plant licensing basis requirements or commitments to minimum industry codes and standards for system testing. This has been identified as an unresolved item (see Section F7.4.3).

The results of the licensee's recent self-assessment identified problems with the Unit 1 cable spreading room Halon 1301 system. However, the question of the minimum required concentration and the minimum soak time has not been addressed by the licensee. The licensee considers the system to be "operable;" however, the licensee could not produce design-basis tests for the concentrations and soak times of the system, nor could it demonstrate operability to the inspectors. This issue was considered significant since the system was not designed to extinguish the expected hazard (i.e., a "deep-seated" cable fire). This is another example of a design condition where a fire mitigation system design does not meet plant licensing basis requirements or commitments to minimum industry codes and standards and has been identified as an unresolved item (see Section F7.4.4).

Problems were discovered by FPL with the standpipe and hose stations. All areas of the plant are required to have a minimum of two hose stations accessible to them. These problems have not been addressed by the licensee and was considered significant since the "primary protection" hose stations have been determined to possess certain design weaknesses. This issue brings into question the ability of the "backup" hose station (i.e., second hose station) to provide adequate coverage. This is another example of a condition where a fire mitigation system design does not meet plant licensing basis requirements or commitments to minimum industry codes and standards. This has been identified as an unresolved item (see Section F7.4.5).

The licensee found that the oil collection system for the reactor coolant pumps was not catching and collecting oil leaking from the reactor coolant pump motor's lubrication system as required by 10 CFR Part 50, Appendix R, Section III.O. This is another example of a failure of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.4.7).

As part of its ongoing safe-shutdown analysis revalidation effort, FPL has identified deficiencies in Appendix R emergency lighting and the post-fire safe-shutdown communications system. This is identified as another example of a failure of the fire protection program and post-fire safe shutdown analysis to demonstrate compliance with Appendix R. This has been identified as an unresolved item (see Section F7.5).

As result of the fire protection program and post-fire safe shutdown discrepancies identified by the FPL re-evaluation program, FPL established compensatory measures in the Reactor Auxiliary Building (RAB). A 30-minute roving fire watch patrol was established throughout the RAB. At the time of this inspection, the licensee was in the analysis and discovery mode of its re-evaluation and had not fully determined the scope of the corrective actions needed to resolve the fire protection program and post-fire safe shutdown discrepancies. The compensatory measures and their adequacy to compensate for the known program discrepancies will be routinely reviewed by the licensee and revised as necessary to assure an adequate level of fire safety is being maintained.

In response to the fire protection issues or concerns arising from this inspection and FPL's re-assessment program, the licensee implemented compensatory measures in addition to those that it had established prior to the FPFI. The purpose of the compensatory measures was to further reduce the likelihood of potential fire hazard conditions and to provide reasonable assurance that prompt fire mitigation measures could be taken in the event of a fire. On the basis of all the fire protection issues, the licensee implemented the following additional compensatory measures for the Unit 1 "A" cable loft penetration room:

1. Fire doors for the "A" cable loft penetration room extension were closed.

2. Direction was given to PSL Construction Department to halt further removal of Thermo-Lag panels pending approval by the Engineering Department.

3. Fire Protection and Operations directed that no new fire breach impairments be implemented without engineering approval.

4. FPL temporarily installed additional firefighting equipment at strategic locations to enhance firefighting capabilities for the cable loft.

5. PSL Engineering Department provided a drawing depicting Thermo-Lag fire barriers and gave the location of supplemental firefighting equipment to the Nuclear Plant Supervisor to enhance fire brigade awareness.

6. A continuous roving fire watch will be established in the area where work is being performed.

7. Fire barrier breach permits have been placed under control of the Engineering Department.

The team concluded that these additional compensatory actions, in addition to those FPL had implemented prior to the FPFI, were adequate and provide the assurance needed to further reduce the likelihood that a potential fire hazard conditions will exist or that prompt fire mitigation measures could be taken in the event a fire were to occur in the various RAB fire areas of concern.

Report Details

IV. Plant Support

F1 Control of Fire Protection Activities

F1.1 Combustible Material Controls/Fire Hazards Reduction

a. Inspection Scope

The team reviewed the licensee's administrative procedures (AP), AP 1800022, "Fire Protection Plan," Revision 20, dated January 28, 1998, and AP 0010434, "Plant Fire Protection Guidelines," Revision 35, dated January 14, 1998, to determine if they satisfied the objectives established by the licensees to implement its NRC-approved fire protection program. The team toured selected plant areas to inspect the licensee's implementation of these procedures. The team also reviewed the results of the licensee's periodic fire protection plant inspections and the CRs to verify that transient combustible fire hazards issues and corrective actions were identified.

b. Observations and Findings

The team observed that controls were being maintained for transient combustibles in areas containing potential lubrication oil and diesel fuel leaks, such as the diesel generator rooms. Lubricants and oils were properly stored in Underwriter's Laboratory (UL)/Factory Mutual (FM)-approved safety containers. Fire retardant treated wood, plastic sheeting, and film materials were also being used in safety-related areas. Staged combustible materials, such as radiation protection clothing, were in non-combustible storage containers and located away from potential ignition sources.

The team concluded that, overall, the licensee's procedures for the control of combustible materials adequately implemented the NRC-approved fire protection program. AP 010434 requires that the site fire protection staff approve storage locations for combustible materials that are needed to support work activities. AP 0010434, Section 8.2, charges each department's foreman/supervisor with the responsibility (1) to review work activities involving transient combustibles in excess of 100 pounds of solids or 10 gallons of combustible liquids, and (2) to contact plant fire protection personnel in the Protection Services Department for an evaluation of the impact of combustible materials needed to support work activities on the maximum allowed total combustible fire loading for the fire zone as described in the UFSAR, Section 4.0, "Fire Hazards Analysis," and in the plant's Fire Hazard Analysis (FHA) report.

The team noted an instance in which work-related combustible transient materials were left in the plant, unattended, without the appropriate notification of plant fire protection personnel in the Protection Services Department or the required evaluation of its possible impact on the area's fire loading. This instance was observed on March 10, 1998, in the "1B" electrical penetration room to which licensee health physics (HP) personnel had moved a metal cabinet containing an excessive amount of combustible paper supplies, step-off pads, and radiological tape. The cabinet was placed inside the electrical penetration room but outside the designated HP calibration storage cubicle. Some of these materials had been stored on top of the metal cabinet. Upon discovery, the

licensee immediately removed the metal cabinet from the area and initiated CR 98-0442. Licensee corrective actions included remedial training briefing for HP personnel on control requirements for combustible loading.

The team noted that this practice did not meet the intent of NRC fire protection guidance and the licensee's procedure, which require notification of plant fire protection personnel in the Protection Services Department for an evaluation of its impact to the maximum allowed total combustible fire loading established for the fire zone or area as described in the UFSAR and the FHA. The failure to follow fire protection program procedures for control of combustible materials is identified as an unresolved item: **Failure to Follow Combustible Control Procedures to Manage the Use and Temporary Storage of Transient Combustibles in Safety-Related Areas (URI 50-335, 389/98-201-01).**

Measures to identify and control transient fire hazards within the plant are delineated in AP 0010434 and included in the licensee's fire inspection program. A designated fire inspector from the Protection Services Department conducts bi-weekly plant fire inspections to identify and correct potential fire hazards. The team reviewed the results of the fire inspections conducted between August 1, 1997, and February 23, 1998. These reports indicated that these fire inspections had routinely identified examples of combustible hazards control problems in the plant. Although CRs were not prepared for the specific identified problems, the plant fire protection staff had initiated corrective actions through the various responsible plant department supervisors. The team determined that implementation of the fire inspection program by the Protection Services Department was good; however, the various plant departments had not consistently implemented their responsibilities for combustible fire hazards control. The team also noted that previous quality assurance (QA) fire protection audit findings addressed in CRs 97-0464 and 97-0465 discussed examples of the licensee's failure to control combustible fire hazards.

c. <u>Conclusions</u>

The team concluded that the licensee's AP for the control of combustible materials adequately implemented the NRC-approved fire protection program. Implementation of the fire inspection program by the Protection Services Department was good; however, the various plant departments had not consistently implemented their responsibilities for combustible fire hazards control. The team concluded that the licensee's implementation of the combustible control procedures and plant operational practices were not consistent with the approved fire protection program in that plant personnel failed to follow combustible control procedures to manage the use and temporary storage of transient combustibles in safety-related areas. This is identified as an unresolved item.

F1.2 <u>Storage of Flammable and Combustible Liquids and Gases</u>

a. <u>Inspection Scope</u>

The team reviewed AP 0010434, "Plant Fire Protection Guidelines," Revision 35, dated January 14, 1998, to determine if it adequately prescribed the administrative controls of the approved fire protection program. The team inspected most of the significant safe-shutdown areas of the plant, observing licensee controls for the storage and use of flammable and combustible liquids and gases. The team inspected the hydrogen gas

piping system to the volume control tanks (VCTs) to determine if the arrangement complied with the NRC-approved fire protection program.

b. Observations and Findings

The team verified that administrative controls for the storage and use of flammable and combustible liquids and gases were prescribed in AP 0010434, Section 8.2. The procedural requirements were in accordance with the basic guidance of National Fire Protection Association (NFPA) Standard 30, "Flammable and Combustible Liquids Code."

The team observed that controls were being maintained for combustible liquids in areas containing potential lubrication oil and diesel fuel, such as the diesel generator rooms. Lubricants and oils were properly stored in UL/FM-approved safety containers. The team verified that all combustible liquids were stored only in those safety-related areas designated by Procedure AP 0010434 and in UL/FM-approved storage cabinets.

The team reviewed the hydrogen gas piping system to the VCTs. The gaseous hydrogen for both Units 1 and 2 was supplied from tube trailers and bottles located in the plant yard. The hydrogen gas distribution piping to the VCTs is routed through several elevations (19.5 ft. and -5.0 ft.) of the turbine and reactor auxiliary buildings. The team, using the Bulk Gas System Flow Drawings 8770-G-091, performed a walkdown inspection of the hydrogen gas piping system to the St. Lucie Unit 1 (Unit 1) VCT. This piping was not seismically supported but was provided with excess flow check valves installed in the open turbine building piping to mitigate or limit flow of hydrogen if a line break or a leak occurred. The team determined that the hydrogen storage and supply piping to the VCTs was arranged in accordance with the guidance of NFPA Standard 50A, "Standard for Gaseous Hydrogen Systems," and the NRC-approved fire protection program.

c. Conclusions

The team concluded that the licensee was properly implementing its administrative controls governing the storage and use of flammable and combustible liquids and gases. In addition, the team concluded that the hydrogen storage and supply distribution piping to the VCTs met the technical commitments established by the NRC-approved fire protection program.

F1.3 Housekeeping

a . Inspection Scope

The team reviewed AP 1800022, "Fire Protection Plan," Revision 20, dated January 28, 1998, to determine if it adequately prescribed the housekeeping administrative controls of the NRC-approved fire protection program. The team inspected most areas of the plant, observing licensee controls for combustible waste collection and plant cleanliness conditions. The team toured the plant to observe housekeeping practices and cleanliness conditions to determine whether safety or fire hazards or both existed.

b. Observations and Findings

The team verified that administrative controls for good housekeeping were prescribed in AP 1800022, Section 8.7.3.E. The team noted that the licensee utilized 55-gallon steel drums throughout the plant with self-closing metal covers as containers for trash and contaminated items. The team observed that the trash containers were emptied on a regular basis and there was no excessive accumulation of combustible waste in safety-related plant areas. The team also noted that significant licensee efforts were underway to remove various waste materials that had been stored in a number of metal shipping trailers in the exterior yard area.

c. Conclusions

The team found plant housekeeping and trash control was satisfactory. Significant licensee efforts were underway to remove various waste materials that had been stored in a number of metal shipping trailers in the exterior yard area.

F1.4 Ignition Source/Fire Risk Reduction

a. Inspection Scope

The team reviewed AP 0010434, "Plant Fire Protection Guidelines," Revision 35, and Plant St. Lucie (PSL) PSL-206, "Nuclear Plant Smoking Policy," Revision 7, to determine if they adequately prescribed the administrative controls of the NRC-approved fire protection program. During the inspection, the team toured the plant to observe implementation of the licensee's ignition source controls and to review hot work activities that were in progress.

b. Observations and Findings

The team verified that administrative controls for ignition source control were prescribed in AP 0010434, Section 8.7.2 and PSL-206. Licensee Procedure AP 0010434 requires that a hot work permit be obtained before performing any work involving welding, cutting, grinding, open flame, and other spark- or heat-producing activity in the general power block areas to minimize the possibility of starting a fire. The permit must be posted at the job site during the time the work is being performed. The permit requires that work areas be free of transient combustible materials and that additional fire protection be provided for in situ combustible materials. The procedure also requires that a continuous fire watch be posted and that the fire watch remain on station for 30 minutes after the completion of the hot work activity. Policy Procedure PSL-206 prohibits smoking in all plant areas, except in those marked outdoor areas designated specifically as smoking areas .

Two in-process hot work operations, involving welding and grinding, were observed. These operations were being performed in association with modifications being made to the start-up transformers located adjacent to the turbine building. A hot work permit had been issued and posted for each operation, and the appropriate fire prevention controls were established and implemented. The team observed that the plant smoking policy was being enforced.

c. Conclusions

The team concluded that the licensee's administrative controls for ignition source control were being implemented'in accordance with the NRC-approved fire protection program for the facility.

F1.5 Fire Reports and Investigations

a. Inspection Scope

The team reviewed the plant fire incident reports and the CRs resulting from these incidents for 1997-98, to assess maintenance-related or material condition problems with plant systems and equipment that may have initiated these fire events. The team assessed whether plant fire protection requirements were being met in accordance with AP 0006130, Revision 12, Appendix 2, "Guidance for the Issuance of Condition Reports," when fire-related events occurred.

b. Observations and Findings

The fire incident condition reports indicated that in 1997 there were three incidents of smoke or fire within a safety-related plant area, which required fire brigade response. Two of the fires, which occurred on August 27 and September 19, 1997, were related to 120- and 480-Vac non-vital electrical transformer failures within the St. Lucie Unit 2 safety-related reactor auxiliary building hallway and cable spreading room areas. The September 19 fire is discussed in NRC Integrated Inspection Report 50-335, 389/97-11. The team reviewed the licensee's CR root cause evaluations of the equipment failures and subsequent fires, which indicated that the transformer failures were the result of transformer insulation failures. The team determined that the root cause evaluations were thorough and the designated corrective actions were appropriate. A small welding fire had occurred during a Unit 1 outage within the containment on October 29, 1997, but was extinguished by the welder's fire watch before the fire brigade arrived. No fires had been reported in 1998. In all cases, the fire was identified and extinguished in a timely manner so as to limit the fire to the original source and prevent the fire from spreading to other equipment or cables.

c. Conclusions

During 1997 there were two incidents of fire caused by non-vital electrical transformer failures within Unit 2 safe-shutdown significant areas. The team concluded that these fire conditions were identified and extinguished in a timely manner. The team also concluded that the root cause elevations of the transformer failures and subsequent fires were thorough and that the designated corrective actions for these fire events were appropriate.

F2 Status of Fire Protection Facilities and Equipment

F2.1 Plant Tour and Inspection of Fire Protection Equipment

F2.1.1 Fire Brigade Equipment

a. Inspection Scope

The team reviewed PSL General Maintenance Procedures (GMPs) ½-M-0018F, Appendix A, "Fire Preventative Maintenance (PM)-Inventory," PM 259, Revision 25 and PM 5413, Revision 19. The team inspected the fire house in the yard and four fire brigade lockers. The inspection was conducted to verify that the fire brigade equipment specified in the NRC-approved fire protection program and the PM were accessible and available in the fire house and fire brigade lockers.

b. Observation and Findings

Using the PM inventory lists, the team inspected the fire house in the yard and four fire brigade lockers. The team observed that the equipment listed in the PM and in the NRC-approved fire protection program was accessible and available for use. The equipment in the fire brigade lockers was fire brigade helmets/hoods, high-top turnout boots, turnout coats, gloves, flashlights, and SCBA for each member of the fire brigade. The fire-house also contained fire brigade turnout gear, including bunker pants. Also 50 gallons of aqueous film forming foam (AFFF), a portable gas generator, two 5000-cfm portable smoke ejectors, a 2½-inch hose nozzle, spare SCBA air cylinders, several lengths of fire hose, and a fire response cart were stored in the fire house.

The team observed that the licensee outfitted the fire brigade with coats and high-top turnout boots, but that no turnout pants for personal thermal protection were provided in the fire brigade lockers. The thermal protective turnout pants were stored in the yard fire house. The licensee stated that the fire brigade's normal practice is to don the coats and high-top turnout boots. The team observed that the fire fighting equipment provided to the brigade in the lockers, and normally used to cope with on-site fire emergencies, did not offer the level of personnel safety that is afforded by current technology and required by current Occupational Safety and Health Administration (OSHA) requirements. On the basis of these observations during the fire brigade drill exercise (see Section F3.3), it was noted that the turnout coat and high-top boots did not provide the level of protection possibly needed for fighting fires inside a structure. For example, the turnout coat and high-top boots did not fully overlap, leaving some of the fire brigade member's body unprotected. This condition may not meet the full intent of current OSHA requirements related to protective clothing for the brigade members during interior structural firefighting, and is identified as an inspector followup item.

The licensee stated that the personal protective clothing provided was acceptable and met OSHA Standard 1910.156, Section E, "Protective Clothing." All other protective clothing, except boots, used by the fire brigade met NFPA requirements.

The team also observed that there was no battery-powered backup lighting in the yard fire house or in the areas of the four fire brigade dressout lockers. The lack of backup lighting was of concern in that a power failure from any cause could possibly delay the dressout and response of the fire brigade during a fire emergency. At the team's request, the licensee evaluated the lighting systems in the fire brigade dressout areas. The licensee stated that its evaluation had determined that backup lighting powered by either the emergency diesels or dc power was provided in the areas of the dressout lockers, but not inside the fire house. This was identified as a condition requiring attention by the licensee.

The licensee stated that fixed battery pack lighting was being added inside the fire house. The team determined that the licensee's evaluation and corrective actions to establish backup lighting in support of fire brigade operations was acceptable.

c. Conclusions

The team concluded that the backup lighting provided to the brigade in the dressout areas did not provide an adequate level of lighting and that under certain situations could delay the response and logistics of fire brigade equipment. The licensee evaluated this situation during the inspection and took corrective actions to establish backup lighting in these areas. The team concluded that these corrective actions were acceptable.

The team concluded that the personal protective fire fighting equipment provided to the brigade and used to cope with onsite fire emergencies did not provide the level of personal safety needed to handle onsite fire emergencies. This is identified as Inspector follow-up item; **Review of Licensee Support of Fire Brigade Operations (IFI 50-335, 389/98-201-01).**

F2.1.2 Outside Fire Protection

a. Inspection Scope

The team conducted walkdown inspections and reviews of the design and installation of the fire pumps, and water supply to determine compliance with UFSAR Section 9.5A, Section 2.2.E.2, "Fire Protection Water Supply System," and the approved fire protection program described in Sections 4.3.1 and 3.1.4 of the PSL Safety Evaluation Reports dated August 17, 1979, and November 24, 1980, respectively.

b. Observations and Findings

The team reviewed Engineering Piping and Flow Diagrams 8770-G-084 series, and conducted walkdown inspections of the fire pumps and portions of the water supply piping to determine the arrangement and material condition of the equipment.

The team verified that the licensee had two 300,000-gallon aboveground water supply tanks adjacent to the fire pumps. The tanks were filled from a connection to the local municipal water system. The tanks had provisions for connecting a temporary backup fire pump as compensatory action if one of the permanent fire pumps was required to be out of service for more than 30 days. NRC review of this compensatory action arrangement is discussed in Integrated Inspection Report Nos. 96-12 and 97-06.

The team observed that the licensee had two electric-motor-driven fire water pumps. The fire pumps were not located in a pumphouse, but were located outside in the yard area.

The pumps were not separated by rated fire barriers and this plant-specific arrangement was evaluated during licensing and determined to be acceptable. Each pump had a rated capacity of 2500 gpm at 125 psi. The team verified that the water suction and discharge valves were properly aligned and secured. The team noted that the maintenance and material condition of the fire protection water supply tanks, pumps, valves, and equipment were satisfactory.

c. Conclusion

The team concluded that the maintenance and material conditions of the plant fire pumps, fire protection water distribution system, and water supply was satisfactory and the system meets the technical design and performance commitments described in the NRC-approved fire protection program.

F2.1.3 Fire Extinguisher Equipment

a. Inspection Scope

The team inspected the distribution of first aid manual fire fighting equipment (i.e., fire extinguishers) in accessible areas of the plant. The inspection was conducted to determine if the equipment was properly maintained, accessible, and as described in the NRC-approved fire protection program.

b. Observations and Findings

The team observed that station fire extinguishers were well maintained. Fire extinguishers had received the appropriate monthly inspection. All fire response, fire fighting equipment was clearly identified and was easily accessible.

c. Conclusions

The team concluded that in the areas inspected, the fire extinguishers were adequately distributed, well maintained, and ready for use.

F2.2 Fire Protection Surveillance, Limiting Conditions for Operation (LCOs), and Compensatory Measures

a. Inspection Scope

The team reviewed AP 1800022, "Fire Protection Plan," Revision 20, dated January 28, 1998, and its Appendices A and B, to determine if they satisfied the surveillance and operability objectives established by the NRC-approved fire protection program described in UFSAR Section 9.5A, Section 2.4. The team reviewed 12 selected fire protection system surveillance test procedures and completed General Preventative Maintenance inspections to verify that the required test frequencies and appropriate acceptance criteria had been included in the licensee's surveillance procedures.

b. Observations and Findings

AP 1800022, "Fire Protection Plan," Section 8.1, states that the fire protection plan is the mechanism through which the licensee integrates the fire protection program elements.

AP 1800022, Section 8.1.7, states that safe-shutdown capability is an element of the fire protection program. AP 1800022, Section 8.9, and Appendices A, "Fire Protection Features Operability Requirements and Compensatory Measures," and B, "Fire Protection Schedule of Periodic Tests," provide the administrative requirements governing surveillance testing, operability, and compensatory measures for fixed fire protection features. The team's review of AP 1800022, indicated that the fire protection program has been updated to include the periodic testing, operability requirements, and compensatory measures for the passive fire barrier, and suppression and detection features included in UFSAR Section 9.5A, Section 2.4. However, the team noted that the program has not been revised to incorporate any administrative requirements governing surveillance testing, operability, and compensatory measures for the Appendix R post-fire safe-shutdown equipment and features providing that capability.

In response, the licensee stated that it recognized that there was limited consideration for safe-shutdown equipment and safe-shutdown capability in the PSL Fire Protection Plan. As such, the licensee committed to revising the Fire Protection Plan. Items in the revision include consideration of safe-shutdown equipment out-of-service time, compensatory actions for safe-shutdown equipment, and availability of safe-shutdown equipment. This had been identified as an unresolved item (see Section F5.1 for details).

The team reviewed General Maintenance Procedure (GMPs) 1-M-0018F, PM Nos. 260, 261, and 262, "Fire Hose Stations Inspections, " Revision 25, and noted that the licensee surveillance practice and acceptance criteria for the verification of installed fire hose length and fire nozzle type deviated from those specified in the UFSAR.

Unit 1 UFSAR, Section 9.5A, Sections 2.4.E.3 and 3.2, "Standpipes and Hose Stations," stated, in part, that up to 100 feet of 1½-inch fire hose with electrically safe fog nozzles are located throughout the plant, so that all areas are within reach of a fog nozzle when attached to more than 100 feet of hose.

Procedures GMP 1-M-0018F, PM Nos. 260, 261, and 262, do not provide procedural verification of the fire hose nozzle type. Also, the procedure's acceptance criteria for fire hose station length, Step 2.3.1, verifies only "a minimum of 50′ of fire hose installed on rack or reel." The team concluded that the scope of the PM procedures for fire hose stations do not confirm that the installed configurations of the fire hose length and fire nozzle type are maintained to provide the hose station suppression coverage committed to in the UFSAR. On the basis of the team's concerns, the licensee performed a walkdown inspection and evaluation of the fire hose stations in Units 1 and 2. The results of the walkdown inspection and evaluation were documented in CRs 98-0180 and 98-0563. The licensee stated that the dispositions of the CRs will address changes to the PM procedures to ensure that specified hose lengths and correct nozzle types are maintained. Therefore, this item is identified as an unresolved item: **Failure of the Fire Hose Station Surveillance Program to Confirm Hose Station Coverage in Accordance with Requirements of the UFSAR (URI 50-335, 389/98-201-02).**

The team verified that, other than the issues noted, the completed fire protection periodic tests and inspections reviewed were appropriately completed and met the fire protection surveillance requirements of the Fire Protection Plan and NRC-approved fire protection program.

c. Conclusions

The team concluded that the licensee had satisfactorily implemented the fire protection surveillance and inspection requirements for selected fire protection systems. However, the team identified two examples of fire protection surveillance program deficiencies that involved (1) the failure to include any administrative requirements governing surveillance testing, operability, and compensatory measures for the Appendix R post-fire safe-shutdown equipment and features in the fire protection program, and (2) the failure of the fire hose station surveillance program to confirm coverage in accordance with requirements of the UFSAR. These items have been identified as unresolved items.

F3 Fire Protection Staff Performance

F3.1 Fire Emergency Plans (Fire Fighting Strategies)

a. Inspection Scope

The team reviewed the licensee's firefighting strategies described in AP ½-1800023, "Fire Fighting Strategies," Revision 11, for nine selected plant areas to evaluate the adequacy and implementation of the approved fire protection program described in UFSAR Section 9.5A, Section 2.5 and 7.0.

b. Observations and Findings

AP ½-18000023 detailed the guidelines and methodology for fighting plant fires. The licensee had developed a strategy for each fire area and arranged the strategies by fire area and then by fire zones within the fire area. The team reviewed the fire fighting strategies for Unit 1 fire zones 36, 47, 44A, 56, 57, 58, 60, and 77. The strategies included information concerning the zone location, fire brigade access and egress, hazards, communications, suppression and detection systems, ventilation, and equipment that might be affected by a postulated fire. The team noted that some strategies also contained instructions for the fire brigade to perform manual actions, namely operating or securing normal plant air handling systems and opening doors for removal of smoke generated by a fire. All of the strategies addressed manual smoke removal using the two portable smoke ejectors to eject smoke and supply fresh air. However, the team noted that the firefighting strategies had not been updated to reflect the specific requirements of 10 CFR Part 50, Appendix R, Section III.K.12, as specified by the NRC-approved fire protection program described in UFSAR Section 9.5A, Sections 2.5 and 7.0. Specifically the firefighting strategies do not address (1) manual actions to ensure ventilation requirements specified in recent revisions to the licensee's safe-shutdown analysis (SSA) and procedures; (2) radiological controls for firefighting water drainage or water control for critical water-sensitive equipment, and (3) detailed manual smoke removal instructions capable of maintaining the habitability for those operators performing concurrent post-fire safe-shutdown manual actions in adjacent associated areas of the plant. This was considered a condition in the fire protection

program relating to the failure to update the firefighting strategies to reflect the specific requirements of 10 CFR Part 50, Appendix R, Section III.K.12, and is identified as an unresolved item: **Failure to Update the Fire Fighting Strategies to Reflect the Requirements of the Approved Fire Protection Program and 10 CFR Part 50, Appendix R (URI 50-335, 389/98-201-03).**

c. Conclusions

The team concluded that the licensee had developed firefighting strategies for each fire area, but had failed to ensure that these strategies were revised to reflect three specific requirements of the approved fire protection program and 10 CFR Part 50, Appendix R, Section III.K.12. This item is identified as an unresolved item.

F3.2 Fire Brigade Practice Sessions

a. Inspection Scope

The team reviewed the licensee's fire brigade training practice sessions described in AP 0005729, "Fire Protection Training, Qualification and Re-qualification," Revision 14, to verify that practice sessions were conducted in accordance with the NRC approved fire protection program described in UFSAR Section 9.5A, Sections 2.5, III.I.2, and 7.0.

b. Observations and Findings

AP 0005729, Section 8.4.2, detailed the requirements for annual practice sessions for each fire brigade shift. The team reviewed the computerized training records of the emergency team and verified that each shift fire brigade engaged in practice sessions annually at the on-site fire brigade training facility.

c. Conclusions

The team concluded that the licensee had implemented the training frequency for fire brigade practice sessions as specified by the NRC-approved fire protection program.

F3.3 Fire Brigade Drill Exercise

a. Inspection Scope

The team observed an unannounced fire drill to review the fire brigade's response and effectiveness and its compliance with procedures and the requirements of the NRC-approved fire protection program as described in UFSAR Section 9.5A, Sections 2.5, III.I.3 and 7.0.

b. Observations and Findings

The team witnessed a fire drill conducted on March 31, 1998. The drill involved a simulated cable tray fire in the Unit 1 reactor auxiliary building within the cable loft area (Fire Zone 44A). Responding to the simulated fire were a fire brigade leader, four fire brigade members from operations, and other security, health physics, and operation personnel to provide additional assistance to the brigade, as required. The team

observed the fire brigade dressout at the fire house in the yard and Unit 1 fire brigade locker; establishment of the fire ground command post; initial entry into the fire affected room; assessment of the fire, its location, and the environmental conditions; the search of the area for victims; communications with the control room personnel; fire suppression activities; and smoke removal operations. The team made the following observations concerning the performance of the fire brigade:

- The fire brigade leader properly established a command post outside the fire affected area and promptly initiated communications with the control room. The fire brigade members responded to the command post for instructions from the brigade leader in a timely manner.

- The fire hose from Hose Station HS-15-34 was not properly racked out by security personnel. The hose was not laid out straight down the hallway, but was curled up in several places. The team noted that, when the brigade laid the hose up the vertical ladder to access the cable loft area, the hose was still curled over itself in several places. If pressurized, fire hose water might not have been immediately available without additional effort to straighten the fire hose.

- Before entering, the fire brigade checked the door to the cable loft for heat.

- The fire brigade's initial attack on the fully developed cable tray fire was made with portable extinguisher.

- The brigade's fire attack with a single hose stream was not backed up with another hose line. The fire brigade team did not review the potential effects of fire fighting water flooding on either the radiological controls for the areas below the cable loft or adjacent critical water-sensitive equipment. **(See Section F3.1)**

- The fire brigade removed the attack hose line before ventilation was started without consideration for fire re-flash.

- Recovery and salvage efforts to control fire suppression water damage were not implemented by the fire brigade. Also a fire watch was not posted in the fire affected cable loft area after the fire was extinguished to check for possible re-flash.

- The fire brigade attempted to remove smoke through a door from the cable loft by ejecting it into an adjacent area using two 5000-cfm portable smoke ejectors. The fire brigade team did not review the potential effects of the ejected smoke on adjacent equipment or on maintaining the habitability for those operators who may have been performing concurrent post-fire safe-shutdown manual actions in adjacent associated areas of the plant. **(See Section F3.1)**

- The fire brigade equipment, specifically the use of turnout boots, were not current technology and did not provide an appropriate level of personal safety to those individuals performing plant fire fighting operations. **(See Section F2.1.1)**

In UFSAR Section 7.0, the licensee stated that the fire brigade consists of five personnel on each shift trained in accordance with those applicable requirements of 10 CFR Part 50. The licensee further stated in Section 9.5A, "Appendix R Guidelines," Section 2.5, paragraph III.I.3.e.2, that the site fire brigade drills shall include an assessment of the fire brigade member's use of fire fighting equipment, including the SCBA.

The team observed that, throughout the drill, including entry and activities within the fire affected zone, the fire brigade members simulated donning their SCBA face-masks and utilizing their air supply bottles. The licensee's practice of simulation of donning SCBA face-masks and utilizing air supply bottles was of concern in that it does not enforce the importance of using an SCBA during firefighting operations. For example, it does not expose the fire brigade personnel to the stresses and limitations related to breathing air from the SCBA, the restricted vision through a face-mask, and difficulties in communicating with other fire brigade team members under simulated fire conditions. This is identified as unresolved item: **Failure to Perform Fire Brigade Drills in Accordance with the Requirements of the Approved Fire Protection Program and 10 CFR Part 50, Appendix R (URI 50-335, 389/98-201-04).**

c. Conclusions

On the basis of observations made during a fire drill, the team concluded that the licensee's fire brigade exhibited some operational deficiencies as noted above. The team observed that the fire brigade did not fully use the SCBA during the drill. The partial use of the SCBA did not expose the fire brigade personnel to the stresses and limitations created by its full use. The team concluded that the importance of the full use of the SCBA was not recognized and is identified as an unresolved item.

F4 Fire Protection Staff Training and Qualifications

F4.1 Site Personnel Fire Prevention/Control Qualifications

a. Inspection Scope

The team reviewed the training and experience of the Protection Services Group members, to determine if their qualifications were properly maintained as described in the NRC-approved fire protection program and UFSAR, Sections 2.4 and 7.0.

b. Observations and Findings

The team reviewed the training and personnel qualification records of the three members of the Protection Services Group responsible for fire protection coordination at PSL. The team determined that the Protection Services staff had almost 40 years of combined experience and training in fire protection including State of Florida certifications to conduct firefighting instruction.

c. Conclusions

The team concluded that the Protection Services Group members' training and experience met the criteria established by the approved fire protection program and that their qualifications had been maintained up-to-date.

F4.2 Site Personnel Fire Prevention/Control Training

a. Inspection Scope

The team reviewed AP 0010434, "Plant Fire Protection Guidelines," Revision 35, dated January 14, 1998, and AP 0005729, "Fire Protection Training, Qualification, and Requalification," Revision 14, dated June 5, 1997, to determine if they satisfied the fire watch training and qualification objectives established by the NRC-approved fire protection program.

b. Observations and Findings

The use of a fire watch is a recognized compensatory measure at the plant. Established fire watches were either continuous or a one-hour roving patrol. Fire watch personnel were expected by the licensee to inform the control room of a fire and to attempt to extinguish small fires. The licensee had an established training program for individuals who were assigned as fire watch personnel. The team reviewed the training documents and records for fire watch personnel and verified that the personnel were trained in accordance with the established training requirements. The team observed several individuals who were assigned and performed fire watch duties. The fire watch personnel were knowledgeable of their duties, responsibilities, and locations of communication equipment for rapidly reporting a fire.

c. Conclusions

The team concluded that the fire watch training and qualification program met the requirements of the NRC-approved fire protection program.

F4.3 Fire Brigade Training and Qualification

a. Inspection Scope

The team reviewed the licensee's fire brigade organization and training described in AP 0005729, "Fire Protection Training, Qualification and Re-qualification," Revision 14, to verify that training was accomplished in accordance with the approved fire protection program described in UFSAR Section 9.5A, Sections 2.5, III.I.3 and 7.0.

b. Observations and Findings

The organization and training requirements for the plant fire brigade were established by AP No. 0005729. The fire brigade for each of five shifts was composed of an Operations fire brigade leader and at least four additional brigade members from the on-shift operating crew assigned from the Emergency Team Roster. The Emergency Team Roster, dated March 10, 1998, listed a total of 59 members on the station's fire brigade. Each fire brigade member was required (1) to be qualified on the use of respirators, (2) to receive initial and re-qualification firefighting-related training, (3) to participate in annual field practice sessions, (4) to attend at least two drills annually, and (5) to satisfactorily pass a fire brigade medical evaluation.

The team reviewed summary records of the fire brigade training and qualifications for the fire brigade members on the Emergency Team Roster and verified that the training, drill, respiratory and physical examination requirements for each active member were up to date and met the established site training requirements. The team also verified that sufficient shift personnel were available to staff each shift with at least five qualified fire brigade members.

c. Conclusions

The team concluded that the fire brigade organization and training met the requirements of the plant's procedure and the approved fire protection program.

F4.4 Fire Brigade Drills and Records

a. Inspection Scope

The team reviewed the licensee's fire brigade drill program described in AP ½-1800022, "Fire Protection Plan," Revision 20, dated January 28, 1998, and AP 0005729, "Fire Protection Training, Qualification and Re-qualification," Revision 14, to verify that drills were conducted in accordance with the NRC-approved fire protection program described in UFSAR Section 9.5A, Sections 2.5, III.I.3 and 7.0.

b. Observations and Findings

The fire brigade drills and drill scheduling requirements for the plant fire brigade were established by AP 1800022, Section 8.7 and AP No. 0005729. The team reviewed the fire drill critiques for 1997, and March 20-30, 1998, and verified that fire drills had been conducted in safe-shutdown plant areas and that the periodic drill requirements were met for each shift.

c. Conclusions

The team concluded that fire brigade drills were conducted in accordance with the approved fire protection program, except, for the licensee's failure to exercise the use of SCBAs during drills. This is discussed in Section F3.3 of this report.

F5 Fire Protection Organization and Administration

F5.1 Fire Protection Plan - Responsibilities

a. Inspection Scope

The team reviewed the licensee's Fire Protection Plan. This review was focused on assessing how the plan addressed the availability/operability of the post-fire safe-shutdown methodologies developed by the SSA and the reportability of fire protection program deficiencies.

b. Observations and Findings

The team reviewed AP 1800022, Revision 20, "Fire Protection Plan," dated

January 28, 1998, fire protection and post-fire safe-shutdown, licensee event reports (LERs) and immediate notifications since 1995, the Unit 1 UFSAR Chapter 9.5A, Unit 1 Technical Specifications (TS), CR 97-2288 and CR 97-2288 Supplement 1, and FPL Quality Instruction ENG-QI-3, Revision 2, dated January 19, 1998, "Nuclear Engineering Operability Determinations."

10 CFR 50.48(a) states in part:

> Each operating nuclear power plant must have a fire protection plan that satisfies Criterion 3 of Appendix A to this part. This fire protection plan must describe the overall fire protection program for the facility, identify the various positions within the licensee's organization that are responsible for the program, state the authorities that are delegated to each of these positions to implement those responsibilities, and outline the plans for fire protection, fire detection and suppression capability, and limitation of fire damage. The plan must also describe specific features necessary to implement the program described above, such as administrative controls and personnel requirements for.... the means to limit fire damage to structures, systems, or components important to safety so that the capability to safely-shutdown the plant is ensured.

PSL AP 1800022, Revision 20 "Fire Protection Plan," dated January 28, 1998, acknowledges the existence of redundant post-fire safe-shutdown trains and alternative post-fire safe-shutdown capability at PSL only in certain sections. These Sections are

Section 5.2.14 "Fire Brigade Leader," states that the fire brigade leader has the knowledge of plant systems or has received sufficient training on plant safety-related systems to understand the effects of fire and fire suppression on safe-shutdown capability and advise the control room. This is the only personnel position in the plant hierarchy for which the term (post-fire) "safe-shutdown" is used to describe duties and responsibilities.

Section 8.1, "Discussion," mentions safe-shutdown capability as an element of the fire protection program.

Section 8.3, "Safe-Shutdown Capability," discusses the capability to achieve cold shutdown in connection with the existence of the PSL Units 1 and 2 safe-shutdown analysis studies.

Section 8.7.3.D (on plant changes) discusses goals of reviews conducted under PSL Nuclear Engineering Procedures to determine the potential impact of modifications on safe-shutdown capability, including the primary goal of assuring compliance with Appendix R to 10 CFR Part 50.

Section 8.8.3.D, "Alternate Shutdown Capability," mentions that post-fire safe-shutdown from outside the control room could occur if the control room is "inhabitable" due to fire and/or smoke or due to fire in the cable spreading room, and that the off-normal operating procedures on control room inaccessibility pertain.

Section 8.9, "Fixed Fire Protection Features-Controls and Compensatory Measures," mentions the potential impact of fire on fixed, active, and passive fire protection features in areas in which safe-shutdown capability could be affected.

In the following Sections of AP 1800022, post-fire safe-shutdown is not addressed:

Section 3.4, "Definitions"

Section 3.4.14, "Fire Protection Program." This definition focuses on industrial fire protection topics comprising the first two facets of nuclear power plant fire defense in depth. [This omission of post-fire safe-shutdown has great impact in Section 5, "Responsibilities," because the term "fire protection" (without augmentation with the term "safe-shutdown") is used widely to describe the duties and responsibilities of all cognizant plant employees from fire brigade member to corporate nuclear division president.]

Section 3.4.22, "Safety-Related Systems and Components," (which focuses solely on equipment necessary for mitigation of design-basis accidents, rather than equipment necessary to achieve safe-shutdown after fire events)

Section 3.4.26, "Required Systems," (which are discussed in the context of their support for safety-related systems, which, by the definition of Section 3.4.22, are design-basis accident mitigation rather than post-fire safe-shutdown systems, equipment, or components).

Section 8.6, "Audits"

Section 8.10.8 (Quality Assurance), "Inspections"

Section 5 (Fire Protection), "Responsibilities," for the positions of FPL Nuclear Division President, St. Lucie Plant Vice President, Plant General Manager, Protection Services Supervisor, Maintenance Manager, Nuclear Plant Supervisor, Fire Protection Coordinator, Fire Inspector, Operations Supervisor, and Nuclear Plant Fire Brigade member.

Reportability of Post-Fire Safe-Shutdown Capability Outside Its Design Basis

10 CFR 50.48 (b) states that "all nuclear power plants licensed to operate prior to January 1, 1979, shall satisfy the applicable requirements of Appendix R to this part, including specifically the requirements of Sections III.G, III.J, and III.O." It also states that Appendix R to this Part establishes fire protection features required to satisfy Criterion 3 of Appendix A to this Part (General Design Criteria for Nuclear Power Plants) with respect to certain generic issues for nuclear power plants licensed to operate prior to January 1, 1979. 10 CFR 50.72(b)(ii) states that for "any event or condition during operation that results in the condition of the nuclear power plant, including its principal safety barriers, being seriously degraded; or results in the nuclear power plant being .... in a condition that is outside the design basis of the plant the licensee shall notify the NRC within one hour of the occurrence of the event or condition." 10 CFR 50.2 states that "design bases" means that information which identifies the specific functions to be performed by a structure, system or component of a facility ...." Similar wording can be found in 10 CFR 50.73 with respect to 30-day LERs.

On the basis of the preceding regulatory requirements, deficiencies at PSL would clearly be reportable when specific post-fire safe-shutdown "functions" are rendered inoperable or are not properly protected from fire (e.g., redundant trains could be damaged by a postulated fire). This would extend beyond active and passive fire barrier functionalities to the fire damage of systems and components which, in the event of a fire, would be necessary for achieving and maintaining safe-shutdown as specified by Sections III.G and III.L of Appendix R.

Another direct indication that the NRC clearly expects that post-fire safe-shutdown capability is to be considered part of a nuclear power plant's design basis.is the information contained in Section 2.1 of Attachment 1 to Generic Letter (GL) 91-18, Revision 1, "Information to Licensees Regarding NRC Inspection Manual Section on Resolution of Degraded and Nonconforming Conditions." In part, this Section states, "The current licensing basis (CLB) includes .... the plant-specific design basis information defined in 10 CFR 50.2 as documented in the most recent UFSAR as required by 10 CFR 50.71 and the licensee's commitments remaining in effect that were made in docketed licensing correspondence .... as well as licensee commitments...." Section 9.5.1 of the Unit 1 UFSAR states that the "fire protection program provides assurance that a fire will not prevent performance of necessary plant shutdown functions" and further states that conformance to 10 CFR Part 50 Appendix R is described in UFSAR Section 9.5A.

In Section 2.0, "Specific Corrective Actions," of CR 97-2288 Supplement 1, dated February 23, 1998, "Final Engineering Disposition," the development of an interim safe-shutdown guideline document for each unit based on the original SSAs was discussed. These documents were issued on February 6, 1998, as Unit 1, 2 ONOPs "Response to Fires" These documents informed the plant operators of the potential that (due to the fact that manual actions identified in the original mid-1980s SSA are not included in post-fire safe-shutdown procedures, as discussed in detail in Sections F6.2 and F6.3), certain redundant trains of post-fire safe-shutdown equipment may actually become inoperable during a fire, as a result of fire damage to electrical cables. Although these interim ONOPs are an admission that the Unit 1 post-fire safe-shutdown capability can not meet Section III.G.1. of Appendix R due to the lack of fire protection features (barriers), the Unit 1 safe-shutdown capability was not reported as being outside its design basis or inoperable from 1995 through March, 1998. The PSL Fire Protection Plan or its referenced procedures does not establish specific criteria or guidelines for determining when either fire risk-sensitive fire protection features or post-fire safe-shutdown features are inoperable or outside their design basis and when the reporting of such conditions to the NRC under 10 CFR 10.72 or 50.73 is required. This is an area where the fire protection plan does not establish reportability criteria for fire risk-sensitive plant fire protection features or post-fire safe-shutdown features and is an area where program enhancements could be made.

Operability/Availability of Post-Fire Safe-Shutdown Capability

As stated in NRC Information Notice (IN) 97-48, Appendix A to BTP APCSB 9.5-1 specifies that licensees should establish administrative controls for normal and abnormal conditions or such other anticipated operations as modifications .... The controls should be reviewed by appropriate levels of management, and appropriate

special actions and procedures, such as fire watches or temporary fire barriers, should be implemented to ensure adequate fire protection and reactor safety.

Unit 1 UFSAR Chapter 9.5A states (with respect to Section III.G.1.a. of Appendix R to 10 CFR Part 50): "The Unit 1 Fire Protection Program is designed to ensure that at least one train of systems necessary to achieve and maintain cold shutdown is always available."

FPL Quality Instruction "Nuclear Engineering Operability Determinations (ENG-QI 2.3, Revision 2, dated January 19, 1998) makes no reference to post-fire safe-shutdown nor fire events. The document focuses exclusively on the prevention and mitigation of design-basis accidents.

Section 8.7.3.J of AP 1800022, Revision 20, dated January 28, 1998, now states that the guidance provided in NRC IN 97-48 should be considered to ensure compensatory measures adequately address degraded or inoperable fire protection features "which are not currently addressed in this procedure," but provides no amplification nor plant-specific direction or guidance.

PSL CR 97-2288, dated November 21, 1997, "Initial Engineering Disposition," states that in AP 1800022, Revision 20, dated January 28, 1998, no specific operability requirements are specified for essential safe-shutdown analysis equipment or cables. Only fire rated assembly (fire barrier), detection system, and suppression system operability requirements are addressed in the document and its Appendix A titled, "Fire Protection Features Operability Requirements and Compensatory Measures." It should be noted that the CR 97-2288 Initial Engineering Disposition stated that not only were the Unit 1 and Unit 2 Essential (post-fire safe-shutdown) Equipment Lists (EELs) and SSAs going to be reviewed and revised, but that "the SSA review program will provide guidance to promptly evaluate and correct any potential operability concerns that may be identified .... the program will also identify the need for enhanced fire protection compensatory actions...." At the time of the inspection, this change had not been issued.

Unit 1 TS 6.8.1.f requires written procedures for fire protection program implementation. This would include administrative controls and procedures established to reduce fire risk to plant safety when one train of shutdown equipment is out of service or inoperable. Contrary to this TS requirement, no such administrative controls or written procedures were found that govern the operability of Unit.1 post-fire safe-shutdown capability. This is identified as unresolved item: **Failure of the Fire Protection Plan to Address Appendix R Post Fire Safe-Shutdown Capability (URI 50-335, 389/98-201-05).**

c. Conclusion

The team concluded that the PSL Fire Protection Plan or its referenced procedures does not establish specific criteria or guidelines for determining when either fire risk-sensitive plant fire protection features or post-fire safe-shutdown features are inoperable or outside their design basis. As such, the PSL Fire Protection Plan does not adequately address when the reporting of such conditions to the NRC under 50.72 or 50.73 is required.

In addition, the team concluded that the PSL Fire Protection Plan does not establish adequate controls that govern the operability or availability of post-fire safe-shutdown equipment such that power operations can be conducted with the assurance that a train of systems needed for safe-shutdown will be free of fire damage or, if conditions of inoperability exist, appropriate measures have been established to compensate for the post-fire safe-shutdown system deficiency. Unit 1 TS 6.8.1.f requires written procedures for fire protection program implementation. This would include administrative controls and procedures established to reduce fire risk to plant safety when one train of shutdown equipment is out of service or inoperable. Contrary to this TS requirement, no such administrative controls or written procedures were found that govern the operability of Unit 1 post-fire safe-shutdown capability. This is identified as unresolved item.

F6 Quality Assurance In Fire Protection Activities

F6.1 Site Fire Protection QA Implementation

a. Inspection Scope

The team audited the licensee's fire protection QA program. Specifically, the team assessed the procedures governing the scope of the periodic audits that the licensee performs in the area of fire protection and post-fire safe-shutdown design and implementation.

b. Observations and Findings

The team reviewed AP 1800022, a March 28, 1995, PSL QA Department listing of audits, and a March 10, 1998, PSL QA Department, "Audit Scoping Document."

The March 28, 1995, PSL QA Department listing of fire protection audits (scopes and periodicities) stated that safe-shutdown capabilities were to be audited annually.

AP 1800022, Revision 20, "Fire Protection Plan," dated January 28, 1998, states in Section 8.6 2.C. that biennial audits of the fire protection program "should be performed .... as outlined in GL 82-21, "Technical Specifications for Fire Protection Audits," dated October 6, 1982. GL 82-21 specifies biennial fire protection program audits without distinguishing between the post-fire safe-shutdown (nuclear safety-related fire protection) and non-post-fire safe-shutdown areas of fire protection.

Contrary to the biennial guidance of GL 82-21, the recently revised PSL QA "Audit Scoping Document" (issued March 10, 1998) states that Audit Point 160, "Safe-shutdown Capabilities and Cable Separation," should be included in a triennial audit.

c. Conclusion

The team concluded that the current triennial frequency of post-fire safe-shutdown capabilities and cable separation is not in agreement with the biennial guidance of GL 82-21. The biennial quality assurance audits of the fire protection program are not

consistent with GL 82-21 guidance. This is an area where additional licensee attention is needed.

F6.2 Implementation of the Site Fire Protection Corrective Action Program

a. Inspection Scope

The team audited the licensee's corrective action program. Specifically, the team assessed the conditions and indicators which identified programmatic weaknesses associated with the licensee's ability to demonstrate compliance with 10 CFR 50.48.

b. Observations and Findings

The team reviewed AP 1800022, "Fire Protection Plan," Revision 20, CR 97-2288 and its associated initial engineering disposition, Plant Manager Action Item (PMAI) 96-03-728, PMAI 97-12-151, and PMAI 97-12-152, Quality Assurance Audit QSL-OPS-95-02, off-normal operating procedures (ONOPs) 1-ONOP-100.01, and 2-ONOP-100.01 "Response to Fire" (Revision 0), CR 97-2288 Supplement 1 and its associated final engineering disposition, and St. Lucie Quality Department Quality Instruction (SLQD QI) 18.4, Revision 0.

With respect to corrective action programs, Appendix A to BTP APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," states: "Measures should be established to ensure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material and non-conformances are promptly identified, reported and corrected."

PSL AP 1800022, Revision 20, "Fire Protection Plan," states in Section 8.62.C that biennial audits of the fire protection program "should be performed .... as outlined in GL 82-21." Section 8.0, "Corrective Action," of Enclosure 2, "Quality Assurance," of Generic Letter 82-21 states: "Measures shall be established to ensure that conditions adverse to fire protection such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material and non-conformances are promptly identified, reported and corrected. These measures ensure that:

a. Procedures are established for evaluating conditions adverse to fire protection .... to determine the necessary corrective action.

b. In the case of significant or repetitive conditions adverse to fire protection .... the cause of the conditions is determined and analyzed, and prompt corrective actions are taken to preclude recurrence. The cause of the condition and the corrective action taken are promptly reported to cognizant levels of management for review and assessment."

Section B, "Scope," of Enclosure 3, "Minimum Elements That Should Be Incorporated in Annual and Triennial Fire Protection Audits," of GL 82-21 states: "The audit should verify that .... identified deficiencies have been promptly and adequately corrected."

Section 10.0 of Enclosure 2 of GL 82-21 amplifies the guidance in Appendix A to BTP APCSB 9.5-1 by stating: "Followup action is taken by responsible management to correct the deficiencies revealed by the audit."

Not until November 1997 (almost three years after QA audit QSL-OPS-95-02 noted that the original mid-1980s PSL SSA had identified numerous post-fire safe-shutdown manual actions not reflected in PSL post-fire safe-shutdown procedures (described in detail in Section F6.3 of this report) did the PSL Engineering Department recognize that the information in the original SSA was not documented to the level of detail required. As a result, CR 97-2288, dated November 18, 1997, was prepared and PMAI 96-03-728, "Manual Actions Not in Procedures," was embodied in PMAI 97-12-151 and PMAI 97-12-152. Also, a full-time staff of 30 people was dedicated to a comprehensive review and evaluation process encompassing a majority of the Appendix R requirements at PSL.

CR 97-2288 contained the "Initial Engineering Disposition" of the issue. Completion dates for the two PMAIs were set for mid-1998. The SSA revalidation effort was based on CR 97-2288 pointed out that, in 1986, when the EEL and SSAs for each unit were developed, the "operating philosophy" assumed that the operator actions specified in the SSA for fires in areas other than the control room or cable spreading room could be accommodated within the guidelines of the existing normal operating procedures (NOPs) and ONOPs (i.e., it was assumed that there would be no fire damage to the redundant train of safe-shutdown equipment in non-CR and non-CSR plant areas). The discrepancy between the "operating philosophy" assumption and the failed cable dispositions in the SSA was not acted upon in 1986 (apparently because it was not recognized by the plant staff).

On February 6, 1998, more than three years after QSL-OPS-95-02 was issued, and as an outgrowth of CR 97-2288, the licensee issued 1-ONOP-100.01 and 2-ONOP-100.01, "Response to Fire" (Revision 0). These ONOPs were based on the original SSA and not on the revalidated SSA under development at the time of the inspection. The two ONOPs informed operators of possibly required manual actions (e.g., "NOTE: Aligning the Shutdown Cooling System (SDC) following a fire event may involve LOCAL MANUAL operation of electrically operated SDC and Component Cooling Water (CCW) valves."). Plant personnel who were interviewed stated that the ONOPs were to be revised upon completion of the SSA revalidation effort.

CR 97-2288 Supplement 1, dated February 23, 1998, is PSL's "Final" Engineering Disposition of the SSA manual actions issue. This document declares "oversight" and "lower SSA document standards in the mid-1980s" to be the cause of the cable failure disposition/manual actions issue.

By 1997, the plant staff had acted to correct the administrative cause of the slow response to the manual actions issue. Section 5.4 of PSL Quality Department Quality Instruction (SLQD QI) 18.4, Revision 0, dated February 1, 1995, had discussed the use of "ITR (Independent Technical Review Group) Recommendations" for documenting conditions adverse to quality, and had discussed issuance of St. Lucie

Action Reports (STARs) to initiate plant response to ITR Recommendations (later termed "Technical Recommendations"). The April 30, 1997, version of SLQD QI 18.4 (Revision 4, dated April 30, 1997) eliminated all references to ITR Recommendations. It issued "QA Findings" as the formal process for documenting conditions adverse to quality, and stated that the "Condition Reports" mechanism of PSL AP 0006130 was the "site-wide corrective action process." The same plant-wide change from a recommendation/finding options structure to QA audit findings coupled with CRs (as requests for corrective action) is reflected by comparison of the content of SLQD QI 16.1, Revision 1, dated February 23,1995, ("Corrective Action Follow-up for Quality Assurance Audits"), versus the content of SLQD QI 16.1, Revision 6, dated June 20, 1997.

Licensee personnel stated during the inspection that the 1997 change to QA findings and CR mechanisms was made to ensure that action responsibilities, due dates, and high-level tracking would exist for all problems and nonconformances, contrary to the experience with the manual actions issues of QSL-OPS-95-02.

The inspection team could not find any department, division, section, group, or individual at PSL with continuing and comprehensive responsibility and accountability for post-fire safe-shutdown. As stated in STAR 0-950149, (the Interim Engineering Disposition of QA Audit QSL-OPS-95-02): "The individual plant SSA documents were issued by the cognizant architectural-engineering company, EBASCO..."

Had there been adequate ownership of the post-fire safe-shutdown program at PSL, some designated FPL organization, or some FPL employee assigned responsibility for post-fire safe-shutdown, would have recognized in the mid-1980s the significance of EBASCO's cable failure/manual actions data and ensured that (1) the information was sufficiently detailed, and (2) plant procedures were quickly and appropriately updated. Also, had there been adequate ownership of the post-fire safe-shutdown program at PSL, corrective action for the problem would have commenced in 1995 based on the information in Audit QSL-OPS-95-02.

c. <u>Conclusion</u>

The team concluded that the root cause of the SSA manual actions "oversight" was a lack of ownership of post-fire safe-shutdown by the licensee site and corporate staff during the mid-1980s.

F6.3 <u>Site Fire Protection QA Audits</u>

a. <u>Inspection Scope</u>

The team reviewed selected licensee audits of the PSL fire protection program, including the findings and actions taken to resolve the findings.

b. <u>Observations and Findings</u>

The team reviewed Chapter 9.5A of the PSL UFSAR, QA Audit QSL-OPS-95-02 and its attached interim engineering disposition STAR 0-950149; PSL AP 1800023, "Fire Fighting

Strategies;" PMAI 96-03-728, "PSL Assessment Report," Revision 1; Nuclear Assurance Quality Report 98-0141; and QA Audit QSL-FP-97-16.

PSL Unit 1 was licensed before January 1, 1979. NRC guidance for an acceptable QA program for PSL Unit 1 is found in Appendix A to BTP APCSB 9.5-1, dated February 2, 1977, and Footnotes 3 and 4 of 10 CFR 50.48 (four referenced documents, including GL 77-002, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Control and Quality Assurance"). With respect to audits, Appendix A to BTP APCSB 9.5-1 states: "Audits should be conducted and documented to verify compliance with the fire protection program including design and procurement documents; instructions; procedures and drawings; and inspection and test activities."

Section 9.5A, Section 7.5 of the PSL Unit 1 UFSAR states: "The Quality Assurance Program ensures that the Fire Protection Program and Equipment is properly maintained. This includes QA audits of the program implementation, conduct of periodic test inspections, and remedial actions for systems and barriers out of service. This program emphasizes those elements of fire protection that are associated with safe-shutdown and their significance when evaluating the program and equipment deficiencies."

The inspection team reviewed St. Lucie Quality Assurance Audit QSL-OPS-95-02 (January 1995). The audit stated:

<u>The following Technical Recommendation is reported</u>.

> The PSL SSA provide disposition statements regarding failed cables resulting from a postulated fire. These statements are very brief and may indicate that plant manual actions be taken which may not be specifically prescribed by current plant procedures. It is recommended that Nuclear Engineering assess the adequacy of detail provided by SSA disposition statements and provide the results of this review to the plant for potential procedure enhancements. A PSL STAR is generated to address this issue. (STAR 950419)

Audit QSL-OPS-95-02 also addressed the listings of cables in the fire zone-by-fire zone firefighting strategies contained in AP ½-1800023 (for use by control room operators and fire brigade members). The listings of cables were found to be similar to the cable listings in the SSA, but were determined not useful for plant operations (e.g., performance of manual actions required during a fire situation due to fire damaged (failed) cables). That is, the cable listings in the firefighting strategies did not constitute operating procedures for fires not requiring control room evacuation (which the SSA's "disposition statements" for potentially fire damaged cables had indicated were needed).

Attachment 2 to the 1995 QA audit QSL-OPS-95-02, was an "Interim Engineering Disposition STAR # 0-950149," dated May 18, 1995, restated the SSA cable failure issue as follows: "Because of the lack of details of the SSA circuit dispositions, personnel may not fully understand the disposition as a manual action. The information regarding

manual actions is important to be clear for adequate translation into plant procedures for actions to be taken for fire contingencies and safe-shutdown events."

The interim engineering disposition stated that the PSL Engineering Department had identified, based on the SSA failed cable dispositions, 110 manual actions needed for Unit 1, and 146 manual actions for Unit 2, for hot shutdown, cold shutdown, and spurious actuation concerns. The timeliness of the actions was noted as an important issue and, therefore, closely related to the availability of plant personnel during a fire or safe-shutdown event. May 31, 1996, was set by STAR 0-950149 for completion of engineering evaluations of the manual actions. In the root cause Section of this interim engineering disposition, it was noted that Operations Department personnel were never given the opportunity to review the cable failure dispositions and translate the implicit manual actions into plant procedures, and that the SSA cable failure dispositions likely needed enhancement to gain the level of detail necessary to accomplish their translation into procedures.

Nowhere in Interim Engineering Disposition STAR 0-950149 (attached to QA Audit QSL-OPS-95-02) was concern expressed that the PSL post-fire safe-shutdown capability may be inadequate or incomplete as a result of the cable failure disposition issue. PMAI 96-03-728, "Manual Actions Not in Procedures," was prepared to track work on the SSA failed cable disposition issue of STAR 0-950149.

On April 26, 1996, in response to a series of significant problems and events at PSL, the Site Vice President directed the Plant General Manager to conduct a broad self-assessment of PSL operations "to identify the fundamental (most limiting) weaknesses which have caused a decline in PSL performance." PSL Assessment Report, Revision 1, was issued on October 18, 1996. Of the eight fundamental weaknesses identified, the following four are directly applicable to the known post-fire safe-shutdown program weaknesses at PSL:

- Self-assessment: Lack of emphasis on identifying and correcting problems at the worker and supervisor levels .... Self-assessments were mostly conducted to address significant events, but self-assessments did not become a Part of the normal plant routine to identify and correct problems at PSL.

- Corrective Actions: Less-than-effective implementation of corrective action processes and lack of corrective action follow through.

- Accountability: Lack of consistent assignment and/or enforcement of individual accountabilities .... PSL management did not clearly state expectations and hold individuals accountable for meeting those expectations .... and, as a result, weaknesses developed in the areas of attention to detail, procedural adherence, configuration control, and other areas of responsibility.

- Programs/Processes/Procedures: Lack of emphasis on, and accountability for, important programs, processes, or procedures used at PSL. Knowledge-based procedures were in use for many years, relying on experienced, trained personnel to properly perform tasks despite limited procedural detail. Personnel performance and job completion were valued more than having correct procedures .... Program performance has suffered from to a lack of program accountability.

On February 18, 1998, the QA Department issued Nuclear Assurance Quality Report 98-0141, a self-assessment of 1995 and 1996 audit activities in the fire protection functional area. The basic condition noted in the report was that QA audit "conditions adverse to quality," which were issued in the Form of recommendations, tend to become recurring issues without acceptable closure. An example given was the SSA manual action Technical Recommendation of QSL-OPS-95-02. The following examples of recurrence were given in Quality Report 98-0141:

- Audit QSL-FP-96-23 categorized the SSA manual action TR corrective action as an example of "the failure of the corrective action process to complete identified corrective actions in a timely manner."
- Audit QSL-CA-96-20 stated that the SSA response was "an example of overdue corrective actions."
- Audit QSL-FP-97-016 stated that "untimely corrective actions" cause "weaknesses in safe-shutdown analysis implementing procedures."

Nuclear Assurance Quality Report 98-0141 stated that because the SSA manual actions condition had been characterized as a Technical Recommendation, generic implications and measures to prevent recurrence were not addressed, and the QA Department was not offered concurrence in the content and timeliness of the response. The Technical Recommendation option, as well as STAR and PMAI tracking systems, have been eliminated, and CRs have been instituted as the sole means of tracking corrective actions at PSL. Corrective actions for Quality Report 98-0141 are being tracked under CR-0282.

Quality Assurance Audit QSL-FP-97-16, "Fire Protection Functional Area Audit," concluded that there had been inattention in the Fire Protection area (greatly improved since November 1997), and that corrective actions for deficiencies identified in 1995 concerning procedures necessary to implement the Appendix R Safe-shutdown Analysis were untimely and not commensurate with the safety significance of the weaknesses. The audit also concluded that characterization of the weaknesses as a Technical Recommendation resulted in a lack of emphasis on the corrective actions, and that closure of the two related PMAIs in mid-1998 would represent a time period in excess of 3 years and 3 plant refueling outages, Unit 1 steam generator replacement, and extensive Thermo-Lag rework in both units between initial discovery and correction of the identified problem.

With the exception of mis-characterizing the SSA cable failure/manual actions issue as a Technical Recommendation instead of the stronger option of "finding," the QA Department performed its function of finding post-fire safe-shutdown capability problems at PSL. Contrary to the credible performance of the QA Department, the Engineering Department has been slow to correct problems identified in the fire protection/post-fire safe-shutdown functional area. This is considered an unresolved item: **Failure to Conduct Timely Corrective Action**

for Identified Post-Fire Safe-Shutdown Procedural Deficiencies (URI 50-335, 389/98-201-06).

c. Conclusion

The team concluded that the Quality Assurance Department at PSL has been conducting detailed, critical and insightful QA audits in the fire protection and post-fire safe-shutdown area. On the basis of Nuclear Quality Assurance Report 98-0141, the licensee made a change to its procedures to ensure proper characterization of problems (as findings rather than as technical recommendations) and automatic entrance of those problems into a system structured to result in timely corrective action. The team considered the fire protection and post-fire safe-shutdown audit performance of the St. Lucie Quality Assurance Department since 1995 to be of notable strength (that, unfortunately, has been diminished by slow corrective action on the part of the St. Lucie Engineering Department). The failure of the Engineering Department to take prompt corrective actions to resolve post-fire safe-shutdown issues is identified as an unresolved item.

F6.4 50.59 Process, Design Reviews and Modification Packages

a. Inspection Scope

The team audited the 50.59 and design review process and how they are applied to plant modifications and their potential to impact on fire protection/post-fire safe-shutdown.

b. Observations and Findings

The team reviewed AP 1800022, Revision 20, Engineering Quality Instruction 1.1, and "Engineering Quality Instruction 1.2;" AP 0010124, Revision 44, "Engineering Quality Instruction QI-3-PSL-1;" Procedure ADM 17.11, Lesson Plan 2002991, Revision 02, and Engineering Quality Instruction 2.0.

AP 1800022, Revision 20, dated January 28, 1998, discusses fire protection and post-fire safe-shutdown modifications only in Section 8.7.3.D, and refers to Nuclear Engineering Procedures (Quality Instructions) for modification process controls.

Three forms of modifications exist at PSL:

- Engineering Packages (Engineering Quality Instruction 1.1)
- Minor Engineering Packages (Engineering Quality Instruction 1.2)
- Temporary System Alterations (AP 0010124)

Form 3F, "Fire Protection Review Checklist," has been required for engineering packages by QI 1.1. In a 1998 procedural change, Form 3F was added as an option for minor engineering packages conducted under QI 1.2, but no similar change had been made for AP 0010124 for temporary system alterations. Form 3F directs the reviewer to consider safe-shutdown EELs, the SSA, and post-fire safe-shutdown electrical circuits, alternative safe-shutdown components, associated circuits of concern, and post-fire safe-shutdown manual actions. There was no reiteration of, nor direct correlation with, the four criteria in AP 1800022 (page 27) for consideration by the lead engineer, which (if satisfied), result in "further evaluation."

Form 3F does not direct the lead discipline engineer to conduct a licensing/design-basis review (SERs, license amendments, exemptions), although this is routinely done as part of the 50.59 review process. PSL Engineering Department procedure QI-3-PSL-1 Appendix C, "Department (Plant Change/Modification) Review Guidelines" specified a Licensing Department review (as well as a fire protection review by the Protection Services Department) of all modifications. No review by the Operations or Training Departments was specified, and a post-fire safe-shutdown review was not explicitly directed.

Procedure ADM 17.11, Section 4.11, stated that modification reviewers will "possess the requisite experiences to competently analyze the proposed change/activity." A "Qualified Reviewer's Checklist" is mentioned in ADM 17.11 in Sections 3.12, 4.11, and 6.2. This list, titled "Qualified 10 CFR 50.59 Reviewers," did not group Engineering Department staff members by engineering topic, nor did it list specific technical expertise of the engineers (e.g., "post-fire safe-shutdown," "Appendix R," or "fire protection"). The Engineering Department Training Coordinator stated that no Appendix R/post-fire safe-shutdown training records exist in individual training folders except for a one-time February 1998 "Fire Protection Requirements" session (Lesson Plan 2002991, Revision 02 given to 156 engineering support personnel). The training coordinator also stated that Station Modification Engineer (SME) training addresses only general processes and procedures, not areas of technical expertise, such as fire protection or post-fire safe-shutdown.

Section 4.3 of QI 2.1 mentions the existence of a "Design Basis Group" within the Engineering Department comprised of personnel responsible for independent review of 50.59 screening. These individuals receive more advanced 50.59 training, but no post-fire safe-shutdown-specific training could be identified for these reviewers.

Four engineers holding Society of Fire Protection Engineers certificates were on staff at the time of the inspection, one at FPL corporate headquarters and three at the PSL site. These personnel routinely review and sign off on all fire protection-related modification packages.

Engineering Quality Instruction 2.0, "Engineering Evaluations," specifies a "Fire Protection Engineer Review (FPER)" designation for GL 86-10 and other fire protection or post-fire safe-shutdown-related evaluations as an indicator of technical specialty.

AP 0010124, "Temporary System Alterations," Revision 44 specified few checks for negative impact on post-fire safe-shutdown capability (e.g., potential invalidation of the alternative post-fire safe-shutdown methodology was not discussed, nor were possible fire hazards from the installation of electrical jumpers). At one point, the reviewer was directed to check for "separation of redundant trains."

Engineering QI 1.0, Revision 6 stated that the "lead discipline is responsible for review and approval of proposed changes." At PSL it is difficult to determine the lead discipline for post-fire safe-shutdown. Post-fire safe-shutdown modification review specialists (engineers who had received documented training in that subject area and were designated to conduct such reviews) were not formally identified. Criteria for "requisite experiences" (as required by St. Lucie Procedure ADM 17.11) for post-fire safe-shutdown modification reviewer qualification did not exist. Only in 1998 was Form 3F, "Fire Protection Checklist," offered for reviewer consideration as an optional process for minor modifications.

c. Conclusion

The team concluded that the modification review process at PSL could be enhanced to ensure post-fire safe-shutdown capability is properly addressed.

F7 Miscellaneous Fire Protection Issues

F7.1 Post-Fire Safe-Shutdown Capability

F7.1.1 Systems Required to Achieve and Maintain Post-Fire Safe-Shutdown Capability

a. Inspection Scope

The team reviewed the licensee's post-fire safe-shutdown methods to determine if the systems defined for use to achieve and maintain safe-shutdown conditions satisfied the reactor performance goals established by Appendix R to 10 CFR Part 50.

b. Observations and Findings

The systems used to achieve post-fire safe-shutdown must be capable of achieving the following performance goals:

- Reactivity control capable of achieving and maintaining cold-shutdown reactivity conditions ($K_{eff} < 0.99$ and reactor coolant system (RCS) temperature ≤ 200 °F).
- Reactor coolant makeup capable of maintaining water level within the level indication of the pressurizer at all times during shutdown operation.
- Process monitoring capable of providing direct readings to perform and control the preceding functions.
- Supporting functions capable of providing process cooling, lubrication, etc., necessary to permit operation of the equipment used to achieve safe-shutdown.

The equipment and systems used to achieve and maintain hot-standby conditions must be free of fire damage during accomplishment of the preceding performance goals. Additionally, the equipment and systems used to achieve and maintain cold-shutdown conditions must be either free of fire damage or the damage must be limited to allow repair of the systems necessary to achieve and maintain cold-shutdown conditions from either the control room or emergency control station(s) within 72 hours.

[illegible]

During post-fire safe-shutdown, the reactor coolant system process variables must be maintained within those predicted for a loss of normal ac power, and fission product boundary integrity must be maintained; i.e., there shall be no damage to the fuel cladding, and the integrity of the containment and primary coolant system pressure boundary must be maintained.

Safe shutdown, as defined by FPL for PSL, includes the following plant conditions:

- Hot Standby or Hot Shutdown: The reactor coolant system temperature is greater than or equal to 325 °F and K_{eff} is less than 0.99,

- Cold Shutdown: The reactor coolant system temperature is equal to or less than 200 °F and K_{eff} is less than 0.99, and

- Cooldown: The transient condition between hot and cold shutdown.

The next paragraphs evaluate in detail the licensee's approach to meet the post-fire safe-shutdown performance goals described above, as referenced in the licensee's SSA.

Reactivity Control Function

The reactivity control function is required to maintain the reactor core in subcritical conditions (K_{eff} < 0.99) from reactor trip through cold shutdown. This requires any positive reactivity increases due to xenon decay, to be compensated for RCS cooldown, or any boron dilution in the RCS. The reactor is tripped from the control room by utilizing the manual reactor trip button in the main control room or from outside the control room by manually opening one of the two C.E.A. drive M-G set electrical breakers (BKR 1-40207 or BKR 1-40507). Reactivity may be monitored through the excore neutron flux instrumentation (RI/RE-26-80A1, A2, A3 or RI/RE-26-80B1, B2, B3) in the control room or from the neutron flux instrumentation located on the hot shutdown control panel (HSCP) (RI-26-80A4, A5 or RI-26-80B4, B5). Reactivity is controlled by using the charging system to inject borated water into the RCS via the chemical and volume control system (CVCS) makeup flowpath. There are two sources of borated water; the VCT, in conjunction with the boric acid makeup tanks (BAMTs) [short term], and the refueling water tank (RWT) [long term]. Injection of borated water into the RCS compensates for reactivity increases due to xenon decay and RCS temperature decreases.

Reactor Coolant System Inventory and Pressure Control

A cooldown employing natural circulation is different from a normal reactor trip cooldown. With normal letdown isolated, required makeup has to be minimized to prevent the pressurizer from going solid, so the RCS cooldown also has to reduce the RCS water volume. Therefore, the only need for makeup is RCS boration and reactor coolant pump (RCP) seal cooling, if the RCPs are not stopped. RCS inventory is accomplished by the following:

- RCS inventory makeup is controlled by using one positive displacement charging pump with either the VCT/BAMTs or the RWT as a source of borated makeup. Charging is manually controlled via the makeup flow path.

- Pressurizer level indication is provided by LI/LT-1110X or LI/LT-1110Y in the control room or by LI-1110Y-1 on the HSCP.

- RCS inventory loss is controlled by isolation of normal letdown, reactor vessel head vents, and pressurizer PORV isolation.

- The RCS shutdown cooling (SDC) boundary is isolated by closure of SDC isolation valves V3481 and V3651, or V3480 and V3652.

- The reactor coolant pumps are tripped within 15 minutes of loosing seal injection, to ensure that RCP seal integrity is maintained.

During the hot standby period, with the RCS isolated, the only makeup needed is for RCS boration and during plant natural circulation cooldown, for RCS contraction. Three pressurizer safety-relief valves (V1200, V1201, and V1202) are provided for overpressure protection of the RCS in hot shutdown. During a controlled cooldown, the pressurizer PORV and the pressurizer are designed to ensure that the RCS pressure-temperature limits are not exceeded. To prevent inadvertent RCS depressurization, the pressurizer auxiliary spray and the normal letdown flow paths are isolated. The preferred method of pressure control is pressurizer level control using normal makeup, ambient losses, and inventory shrinkage. The pressurizer PORV is only operated if an increased depressurization rate is required. During cooldown, RCS pressure and temperature are monitored to verify that the plant does not exceed its cooldown curve limit of 100 °F per hour when the RCS temperature exceeds 140 °F.

<u>Reactor Heat Removal Function and Secondary Side Pressure and Level Control</u>

The RCS consists of two similar heat transfer loops connected in parallel to the reactor vessel. Each loop contains two reactor coolant pumps and a steam generator, along with associated piping and instrumentation. The natural circulation capability of the RCS provides a means of decay and sensible heat removal when the reactor coolant pumps are unavailable in the event of a loss of offsite power. During natural circulation, the licensee must maintain adequate primary to secondary heat transfer, RCS subcooling, and makeup inventory. The auxiliary feedwater (AFW) system is required to support RCS decay heat removal and to control steam generator inventory. The AFW system uses the condensate storage tank (CST) for a source of secondary water. The AFW system contains one turbine-driven and two motor-driven pumps. The turbine driven pump may be used to feed both steam generators, but each motor driven pump feeds only one steam generator. The main steam (MS) system is protected against overpressurization by a bank of eight code safety valves located on each steam line upstream of the main steam isolation valves (MSIVs). Additionally, upstream of the code safety valves, each steam line is provided relief protection by an atmospheric dump valve (ADV), which can be manually actuated before reaching the lowest set point pressure of the code safety valves. The code safety valves and ADVs are accessible from outside the containment.

In the event that a fire requires safe-shutdown, AFW flow is sufficient to restore and maintain steam generator's water levels above the lower limit of the steam generator's narrow range level indication. The steam generator's ADVs will be used to remove decay heat during hot shutdown and during the cooldown to cold-shutdown conditions. If the Unit 1 CST supply becomes depleted, the Unit 2 CST can be manually aligned to provide an alternate source of water to the AFW system. If instrument air is available, the ADVs may be controlled remotely from the control room or the HSCP. If Instrument Air is not available, the ADVs are controlled locally from the steam trestle area, located between the containment and turbine buildings.

Process Monitoring System

While maintaining the plant in hot-shutdown conditions and during the transition to cold shutdown, the operators require process monitoring system support. The following process instruments are provided for safe-shutdown:

- Pressurizer Level
- Steam Generator Level
- Steam Generator Pressure
- Reactor Coolant System Temperature
- Pressurizer Pressure
- Excore Neutron Flux
- Condensate Storage Tank Level
- Refueling Water Tank Level

These instruments provide the process monitoring information required to achieve and maintain the reactor coolant makeup, pressure control, and decay heat removal functions. Additionally, the process monitoring instrumentation supports monitoring natural circulation conditions, core reactivity, RCS subcooling margin, and compliance with the Unit 1 technical specifications pressure/temperature and cooldown limits.

Support Systems

The systems and equipment used to achieve the safe-shutdown functions require miscellaneous supporting functions, such as ac/dc power, lubrication, heating, ventilation, and air conditioning (HVAC), and process cooling. The support systems required to maintain acceptable performance of the safe-shutdown components are

- Emergency power distribution system
- Intake Cooling Water (ICW) system
- Component Cooling Water (CCW) system
- HVAC systems
- Communications system

Hot Shutdown Control Panel (HSCP) Room HVAC

While reviewing the licensee's HVAC air flow diagram (8770-G-862), the team noted that the HSCP room has its own supply and exhaust fans (HVS-9 and HVE-35), and that the licensee had not listed these fans as Appendix R essential equipment. For fires in alternative shutdown areas, the normal HVAC may be lost due to a LOOP, which would also result in a loss of HVAC to Electrical Equipment Room 1B, which is the only access to the HSCP room. The licensee stated that based on calculation PSL-1FJM-91-001, the temperature in Electrical Equipment Room 1B should not exceed 102 °F, (worst case), and by opening the door to the HSCP room, due to light heat loads present in that room, the ambient temperatures should be comparable. Review of the calculation assumptions

showed that restoration of HVAC in 3 hours was assumed and the heat generated from a fire in the cable spreading room, which is adjacent to Electrical Equipment Room 1B, was not considered. The team also questioned the licensee's ability to control smoke from a cable spreading room fire in the HSCP room without HVAC, since it may have to be manned for up to 72 hours. These issues were discussed in a subsequent meeting between the team and licensee, in which the licensee agreed to include these fans on the EEL and to manually load them on the EDGs under LOOP conditions. The lack of HVAC support for the HSCP is identified as unresolved item: **Failure of the Fire Protection Program and the Post-Fire Safe-Shutdown Analysis to Demonstrate Compliance with Appendix R to 10 CFR Part 50 (URI 50-335, 389/98-201-07).** Additional examples of this unresolved item are discussed in Section F7.1.2.

Cold Shutdown

When the RCS temperature and pressure have been reduced to less than 325 °F and less than 275 psig, the SDC system is placed in service. During cold-shutdown operation, reactor coolant flows from the RCS to the low-pressure safety injection (LPSI) pumps through the tube side of the SDC heat exchangers, where heat is transferred to the CCW system. The inlet (suction) lines to the SDC system are connected to the hot legs of both RCS loops. The SDC return (discharge) lines are connected to each of the RCS cold legs. The desired RCS cooldown rate is maintained by throttling the flow through the SDC heat exchanger. No repairs are required to establish and maintain cold-shutdown conditions.

c. Conclusions

Section III.L of Appendix R to 10 CFR Part 50, states that support functions shall be capable of providing the process cooling necessary to permit the operation of equipment used for safe-shutdown functions, and that alternative shutdown capability shall accommodate post-fire conditions where offsite power is and is not available for 72 hours. Not including HVAC for the HSCP room represents a lack of incorporation of Appendix R fire effects in safe-shutdown-required analyses. This is identified as an unresolved item.

F7.1.2 Separation of Post-Fire Safe-Shutdown Functions

a. Inspection Scope

For fire areas other than those requiring an alternate or dedicated shutdown capability (Unit 1 Control Room and Cable Spreading Room), Section III.G.1 of Appendix R to 10 CFR Part 50 requires, in part, that fire protection features be provided that are capable of limiting fire damage so that (1) one train of systems necessary to achieve and maintain hot-shutdown conditions from either the control room or emergency control stations remains free of fire damage, and (2) systems necessary to achieve and maintain cold-shutdown conditions from either the control room or emergency control stations can be repaired within 72 hours.

b. Observations and Findings

Validity of Safe-Shutdown Analysis

As stated by the licensee in Attachment 4, page 2, of CR 97-2288, dated December 12, 1997, *"as part of the internal self-assessment plan in preparation for the upcoming 1998 Fire Protection Functional Inspection (FPFI), the Unit 1 SSA was identified for detail review."* One of the deficiencies noted by the licensee during its self-assessment was a lack of specific operating procedures for manual operator actions required to achieve and maintain post-fire safe-shutdown capability. This deficiency was previously identified by the licensee in a QA audit performed in 1995 (QSL-OPS-95-02), and one of the recommendations resulting from that audit was to perform an assessment of the original SSA (Drawing 8770-B-048).

One of the immediate actions taken by the licensee as Part of its 1998 self-assessment was to assess the validity of the SSA. This was done by performing a "test case" review of SSA dispositions of essential cables within a selected fire zone. As a result of this "test case" review, the licensee found the SSA to contain a number of fundamental flaws in the identification of essential cables and equipment *"which necessitates a thorough review of both Unit 1 and Unit 2 Essential Equipment Lists and Safe-Shutdown Analyses."*

Deficiencies identified by the licensee during its validation of the SSA were found to be documented in an internally generated "Anomaly Report," made which describes 128 deficiencies in the current SSA. From a review of this document, the inspection team made the following findings related to the post-fire safe-shutdown capability of Units 1 and 2:

- 28 findings related to inadequate circuit analysis
- 28 findings related to missed equipment or cables
- 10 findings related to errors in Essential Equipment and Essential Cable Lists
- 3 findings related to incorrect cable routing information
- 10 findings related to incorrect shutdown function designations of equipment or cables

Cable Routing Review

On a sample basis, the adequacy of separation provided for power, control, and instrumentation cabling associated with redundant trains of shutdown equipment was evaluated. The evaluation addressed cabling of components associated with decay heat removal, reactor coolant makeup, fire suppression, and shutdown cooling functions, and included a sample of components whose inadvertent operation due to fire may adversely affect the post-fire safe-shutdown capability. The specific components selected for review are listed in the following table:

Redundant Train Cable Separation Evaluation	
SSD FUNCTION	COMPONENTS SELECTED FOR REVIEW
Reactor Coolant Makeup	Charging Pump 1A, Charging Pump 1B, and Charging Pump 1C LT-1110X and LT-1110Y SE-02-1 and SE-02-2 V2514, V2508, V2509, V2504, V2501
Decay Heat Removal	AFW Pump 1A, AFW Pump 1B, AFW Pump 1C MV-08-14, MV-08-13, MV-08-3 MV-09-9, MV-09-10
Fire Suppression	Motor Driven Pumps 1A and 1B
Shutdown Cooling	V3481, V3480, V3651, V3652, V3659, V3660, V3452, V3453

The adequacy of separation provided for cables of equipment associated with essential safe-shutdown functions was based on a review of the following information:

- Cable routing information retrieved from the FPL computerized Cable and Raceway Data Management System (CARS),
- Post-fire safe-shutdown compliance strategies and separation analyses documented in the FPL Unit 1 Safe-shutdown Analysis, and
- Color-coded conduit and cable tray routing drawings prepared by the licensee during the inspection.

As a result of this review, plant areas were identified in which cables of redundant trains of components appeared to interact. For the purpose of this review, an interaction was identified whenever cables of redundant shutdown paths and/or divisions were shown on the CARS data and cable tray routing drawings as being in the same fire zone. Following their identification, a sample of interactions was then selected to assess the comprehensiveness of the FPL post-fire safe-shutdown analysis and to determine the adequacy of their disposition. The following conditions were the only unacceptable conditions noted during this review:

Decay heat removal necessary to achieve and maintain hot-shutdown conditions is accomplished by the AFW. At PSL, AFW Pump 1C is a steam-driven pump that draws

suction from the CST and discharges this coolant to Steam Generator 1A or 1B. For post-fire safe-shutdown, Pump 1C is considered redundant to the two motor-driven pumps (AFW Pumps 1A and 1B). However, the SSA only credits the operation of this pump in the event of fire in the steam trestle area (Fire Area SS). Motive steam required for Pump 1C operation may be supplied from either Main Steam Line 1A or 1B through normally closed, motor-operated valves (MOVs) that are connected upstream of the ADV (HCV-08-2A and HCV-08-2B) and MSIVs (HCV-008-1A and HCV-08-1B). Normally closed MOV MV-08-13 is connected to Steam Line 1A, and is redundant to normally closed MOV MV-08-14 which is connected to Steam Line 1B. On the opposite end of both of these valves is a common leg, which connects to a third normally closed valve, MOV MV-08-3. In this manner, steam from Steam Generator 1A may be supplied to Pump 1C through series-connected valves MV-08-13 and MV-08-3. Similarly, steam from Steam Generator 1B may be supplied through MV-08-14 and MV-08-3. These valves were selected for review because fire-induced inadvertent operation (opening) of either combination of two valves MV-08-13 and MV-08-3 or MV-08-14 and MV-08-3 could adversely affect the post-fire safe-shutdown capability by causing uncontrolled blowdown of steam and subsequent dryout of the steam generator(s).

The review of cable routing information found all three valves to have control cables located in the following Unit 1 Fire Zones:

- Fire Zone 57-Cable Spreading Room
- Fire Zone 70-Main Control Room
- Fire Zone 55W-El. 19.5' Main Hallway West and Cable Loft Area
- Fire Zone 27-Aerated Waste Storage Tank Area

In its response to the team-identified interactions shown above, the licensee confirmed that control cables for all three valves are located in each of the fire zones listed above. In its disposition of this condition, the licensee states that, since the 1C AFW pump is not relied upon for fire in these zones, a loss of control of these valves is acceptable. On the basis of the conclusions stated in its response and from subsequent discussions with licensee representatives, it was determined that FPL had not considered the potential for more than one spurious operation to occur as a result of fire in any single fire zone, regardless of the number, specific location, or fire damage experienced by other circuits or cables that are also located within the zone.

As discussed below in Section F7.1.5, the inspection team informed the licensee that it does not agree with its position regarding the number of spurious operations that should be assumed to occur as a result of common-cause fire damage to multiple cables. For the specific case noted by the inspection team, since control cables for all three valves are susceptible to fire damage, fire-initiated spurious operation (opening) of valves (MV-08-13 and MV-08-3 or MV-08-14 and MV-08-3) could occur and should have been considered. Therefore, to achieve compliance with Section III.G of Appendix R, either isolation of this diversion flowpath should be ensured for all fire zones or an analysis of this condition should be performed, which demonstrates that spurious operation (open) of the affected valves would not adversely affect the post-fire safe-shutdown capability.

Conformance to Approved Exemptions

Fire Protection of Cables Associated With Charging Pump 1A

As documented in CR 98-0188, dated February 3, 1998, during its preparations for the FPFI, FPL identified a discrepancy between the fire protection features provided for conduits carrying cables for Charging Pump 1A in Fire Area N, the UFSAR and the NRC-approved exemption for this fire area. The Fire Hazards Analysis for Fire Area N of Unit 1 is contained the UFSAR, Volume 9.5A, Section 4.N. This Section of the UFSAR includes a discussion of applicable exemptions. Specifically, Exemption N1 states: "Conduits carrying cables for charging pump (CP) 1A in Fire Zone 38 will be provided with minimum 1-hour rated protection." Contrary to this design requirement, the 1-hour rated fire protection barriers were not installed. The lack of required raceway fire barrier protection for CP 1A is identified as another example of unresolved item URI 50-335, 389/98-201-07.

Separation of Redundant Trains of Cables in Containment

The Fire Hazards Analysis for Containment (Fire Area K) of Unit 1 is documented in the UFSAR, Volume 9.5A, Section 4.K. This Section of the UFSAR states that NRC had approved an exemption from Section III.G.2.d of Appendix R where the containment cables and associated non-safety-related circuits of redundant trains are not separated by 20 feet with no intervening combustibles (Exemption K1). Additionally, UFSAR Paragraph 4.K.2 (d) states that radiant energy shields are provided between safety-related A and B cables in the cable penetration area. However, the UFSAR is not-specific about required separation distances.

To determine the specific cable separation requirements and the method in which they were met, the licensee reviewed all correspondence concerning Exemption K1. As a result of this review, FPL determined that redundant cable trays were to be separated by more than 7 feet horizontally and 25 feet vertically. Contrary to these requirements, cable trays located between column line 7 and 8 at elevation 23 feet, are located within 3 feet of each other with no radiant energy shield. Additionally, between column line 6 and 7 at elevation 45 feet, redundant cable trays pass directly over penetrations of the opposite train with less than 25 feet of vertical separation and no radiant energy barrier. As a result of these findings, the licensee initiated CR 98-0552, dated March 28, 1998. This is identified as another example of unresolved item URI 50-335, 389/98-201-07.

Potential for Fire to Damage Credited Method of Shutdown-Fire Area J

At the time of the inspection, FPL was in the process of conducting a revalidation of the Post-Fire Safe-shutdown Analysis for Unit 1 (Document No. 8770-B-048, Revision 3, dated February 13, 1986). This effort is being conducted under CR-97-2288. As a result of this review, FPL discovered that the previously assumed protected method of shutdown for Fire Area J was incorrect. Specifically, the Post-Fire Safe-shutdown Analysis and off-normal operating procedure 1-ONOP-100.01, "Response to.Fire," were found to credit the use of Train A equipment to achieve and maintain safe-shutdown conditions in the event of fire in this area. However, as a result of its review, the licensee discovered that Fire Area J contained unprotected cables associated with Train A of shutdown cooling equipment, including the 1A LPSI pump. Fire damage to these cables could result in a failure of the 1A LPSI pump to run when required or could cause the pump to start and run when not desired. The licensee is handling this finding under CR 98-0407, dated March 4, 1998, which states that further evaluation of cables in Fire Area J determined that Train B equipment would be available in the event of fire in this area. The licensee intends to redesignate this area from a Train A protected area to a Train B protected area. This is identified as another example of unresolved item URI 50-335,389/98-201-07.

Effect of Fire on Fire on Non-Credited Train of Equipment and Cables

The current safe-shutdown analysis of record (SSA; Drawing No.8770-B-048) credits a specific train of equipment (Train A or Train B) to perform post-fire safe-shutdown functions in the event of fire in each fire area. Once identified, this equipment was classified as "essential equipment" and put on the EEL. A review of these documents, however, indicated that components and cables associated with the non-credited/non-protected train may have been inappropriately suppressed from further evaluation. As a result, it was not clear to the team if the evaluation performed under the original SSA fully considered the effect of fire damage to the non-credited train of systems for potentially adverse effects on the capability of the credited systems to perform required shutdown functions.

In its response to this observation, the licensee gave the inspection team (1) a "draft" version of its SSA revalidation for Fire Area C, which was performed as a corrective action under CR 97-2288, and (2) a document describing the revised methodology to be used during the revalidation effort (Reference: "St. Lucie Plant-Unit 1 1997 Appendix R Safe-shutdown Re-analysis," Revision 1, dated February 9, 1998). A review of these documents found them to acknowledge that the original SSA (8770-B-048) may have inappropriately suppressed cables associated with the non-protected/non-credited train of equipment. As a corrective action, the licensee states that its current revalidation does not suppress any cables or equipment. To implement this change, the revised methodology document was found to significantly modify previous definitions of the terms "essential equipment" and "essential cables." Specifically:

Essential Equipment:

Original SSA:	Any component that is relied upon to bring the plant to cold shutdown
Revised Methodology:	Mechanical equipment, such as pumps, valves, coolers, piping, and tanks used for safe-shutdown that are either electrically indicated, controlled, and/or powered Electrical equipment, such as cables, buses, breakers, fuses, relays, controllers, contractors, and bistables that support the indication, control, and power requirements for safe-shutdown Equipment electrically indicated, controlled, and/or powered that does not support safe-shutdown but that has the potential to adversely affect it.(emphasis added)

	Equipment used for fire detection and suppression that is electrically indicated, controlled, or powered
<u>Essential Cables</u>	
Original SSA:	Any cable that is required for the proper operation of an essential component
Revised Methodology:	Cables that support safe-shutdown equipment or whose fire-induced failure could adversely affect safe-shutdown equipment or functions (i.e., associated circuits)

Additionally, where the original SSA stated that only components listed on the EEL are considered essential, the revised methodology provides significant clarification by stating that the EEL contains only the <u>primary</u> mechanical and electrical equipment related to safe-shutdown and <u>should not be confused with the larger population of safe-shutdown components that are considered essential equipment</u>.

These changes are indicative of an important observation made by the licensee during its revalidation of the original SSA. Specifically, as a result of its reanalysis, the licensee recognized that the scope of the methodology used during the original SSA may have been too narrowly focused on ensuring that one set of components would be available to accomplish required safe-shutdown functions. The implementation of this approach may not have fully considered the larger population of components whose damage due to fire may adversely affect the ability of the credited systems to perform their intended shutdown functions. This is identified as another example of unresolved item URI 50-335, 389/98-201-07.

c. <u>Conclusions</u>

For the sample of circuits selected for review during the inspection, the level of protection provided for redundant trains of post-fire shutdown systems was not found to satisfy the technical requirements of Sections III.G and III.L of Appendix R to 10 CFR Part 50. Specifically, a fire in Fire Zones 57 (Cable Spread Room), 70 (Control Room), 55W, or 27 may initiate spurious valve operations that could adversely affect the post-fire safe-shutdown capability. Additionally, as a result of its current SSA revalidation effort, the licensee has identified instances in which equipment relied on to achieve and maintain safe-shutdown conditions may not have been capable of performing its intended post-fire safe-shutdown function due to (1) inadequate fire protection (Charging Pump 1A, and lack of radiant energy shields in containment), (2) inadequate separation distances (cables in containment), or (3) SSA deficiencies (Fire Area J and effects of fire on non-credited equipment). Therefore, the team concludes that compliance with Section III.G of Appendix R to 10 CFR Part 50 could not be adequately demonstrated.

F7.1.3 <u>Walkdown of Post-Fire Safe-Shutdown Capability</u>

a. <u>Inspection Scope</u>

During the onsite inspection, the team performed a walkdown of the systems and components used to support its post-fire safe-shutdown capability. During this walkdown, the team visually assessed the physical condition of these systems and components.

b. Observations and Findings

During a plant walkdown, the physical condition of the post-fire safe-shutdown equipment showed that it was well maintained inside the plant. However, some manual valves located outdoors that were exposed to the weather appeared to have not been operated or maintained. Examples are the four manual valves used to isolate the steam generator blowdown system (V23113, V23138, V23112, and V23137). The licensee stated that the blowdown isolation valves and other non-safety-related equipment requiring manual operations for safe-shutdown would be added to the plant's preventive maintenance list if it was not already on it.

Locking devices were in place on equipment requiring locks and there was consistency between the plant piping and instrumentation diagrams (P&IDs) and the in-plant operational configuration of safe-shutdown equipment. Examples of the inspection included verification that motor-operated valves V2509, V2508, V2504, and V2501 in the charging system had hand wheels on them, and that V12175 and V12177 in the AFW system, as well as SB21190 and SB21237 in the ICW system, were locked closed.

c. Conclusions

On the basis of its walkdown and the post-fire safe-shutdown components examined, the team concluded that the physical condition of the components gave the appearance that they were being properly maintained and that they would be capable of performing their post-fire safe-shutdown function.

F7.1.4 Alternative Post-Fire Safe-Shutdown Methodology

a. Inspection Scope

On the basis of a review of the SSA, a sample of required safe-shutdown equipment was selected for detailed evaluation. The objective of this evaluation was to assure that the equipment design, layout, and post-fire safe-shutdown analytical approach satisfied the Appendix R reactor performance criteria for safe-shutdown from outside the main control room.

b. Observations and Findings

Charging Pump Makeup Capability

For safe-shutdown from outside the control room, the charging system is used to provide high-pressure makeup to the RCS. The Unit 1 UFSAR states that one charging pump is only capable of keeping up with a 0.3-inch break in the RCS at normal operating pressure and temperature. Since boration is provided to the RCS via the CVCS using gravity feed from the boric acid makeup tanks, and since MV-02-2, the CVCS discharge isolation valve, throttles closed to a mechanical stop when the RCPs are tripped, the licensee was asked to submit the engineering analysis demonstrating the adequacy of charging pump makeup flow to the RCS and that back pressure (flow resistance) from the VCT will not preclude injection of boric acid, given this configuration for post-fire safe-shutdown. The team reviewed documentation (DBD-CVCS-1 and Calculation PSL-2EJM-80-085, Revision 0) provided by the licensee, which included net positive suction head (NPSH) curves for the charging pumps and design-basis documentation on the CVCS, which included loss coefficients for the system. A check calculation was performed to show that frictional flow losses in the CVCS were reasonable. The check calculation verified makeup capability equivalent to a 0.32-inch RCS break at normal operating pressure and temperature.

Auxiliary Feedwater System Flow Rates

In reviewing the AFW flow diagram (8770-G-080, Sheet 4), the team noticed that the recirculation lines back to the CST from each AFW pump remain open. This could be a significant flow diversion from the steam generators. Since one steam generator and one motor-driven AFW pump are required for post-fire safe-shutdown, the licensee was asked to provide documentation demonstrating the adequacy of this configuration. Review of the NPSH curves (8770-6083R0 and 8770-6079R0) for the AFW pumps, and the results of a check calculation performed, showed that the required flow to the steam generator can be achieved in this configuration.

Timeline Analysis

The licensee was asked to provide the timeline analysis that supports the implementation of post-fire safe-shutdown procedures. The team was specifically concerned about the time constraints placed on performing required operator manual actions, given the manning level of four operators available to implement post-fire safe-shutdown from outside the main control room. Initially, the licensee submitted a table showing four time-critical action requirements based on other design-basis events (loss of feedwater-calculation EMF-97-060, Revision 0 and station blackout-calculation PSL-1FJF-92-042, Revision 0). After the team reviewed the documentation, it held discussions with the licensee dealing with the applicability of the boundary conditions and the adequacy of the four time-critical action requirements to envelope an Appendix R fire scenario. During the second week of the onsite inspection, the licensee produced a RETRAN sensitivity analysis for Appendix R scenarios (PSL-1FJF-98-024, Revision 0). Subsequent team review of this document and discussions with the licensee showed that this analysis was comprehensive and that it enveloped transients that could result from an Appendix R scenario.

c. Conclusions

The team concluded that the analytical approaches used by the licensee to demonstrate charging pump makeup capability, auxiliary feedwater system flow rates, and the basis for the post-fire safe-shutdown timeline analysis satisfied the Appendix R reactor performance criteria.

F7.1.5 Associated Circuits

a. Inspection Scope

Section III.G of Appendix R to 10 CFR Part 50 specifies, in part, that associated non-safety-related circuits and cables that could prevent operation or cause mal-operation of structures, systems, and components important to safe-shutdown, should be provided with a level of fire protection necessary to ensure that such circuits will remain free of fire damage. Options for providing this level of fire protection are specified in Section III.G.2 of Appendix R.

In GL 81-12, dated February 20, 1981, and in its subsequent clarification, dated March 22, 1982, the NRC provided the principal staff guidance regarding potential configurations of associated circuits of concern to post-fire safe-shutdown capability. In addition, the staff, through the issuance of additional generic letters and information notices, has presented other opportunities for licensees to recognize the potential impact fire-induced failures in associated circuits may have on the implementation of post-fire safe-shutdown capability. Specifically, additional guidance related to this issue has been disseminated in IN 84-09, IN 85-09, IN 92-18, and GL 86-10. As described in these documents, associated circuit configurations of concern to post-fire safe-shutdown include the following:

- Circuits that share a **common power supply** (e.g., switchgear, motor control center, fuse panel) with circuits of equipment required to achieve and maintain safe-shutdown; or,

- Circuits that share a **common enclosure** (e.g., raceway, conduit, junction box) with cables of equipment required to achieve and maintain safe-shutdown; or,

- Circuits of equipment whose **spurious operation or mal-operation** may adversely affect the successful performance of safe-shutdown functions.

During the inspection, the potential effect of fire on each associated circuit configuration described above was evaluated on a sample basis. This assessment included an evaluation of a selected sample of power, control, and instrument circuits for potential fire-initiated problems. The specific sample of circuits selected for review was based on an evaluation of components and equipment designated by the licensee as necessary for the achievement of safe-shutdown performance goals.

b. Observations and Findings

Review of Circuits Associated by a Common Power Supply

This concern arises when nonessential equipment shares a common power supply (for example switchgear, MCC, distribution panel, or junction box) with equipment required to perform a safe-shutdown function. In the absence of adequate fire protective features (per Section III.G.2 of Appendix R) or electrical coordination (selective tripping), fire-induced faults on branch/load circuits of a required power supply may propagate to cause a trip (open) of a protective device (i.e., circuit breaker, relay, fuse, etc.) located upstream of the supply, preceding actuation of the individual branch/load protective device(s). This condition is could be unacceptable since it may result in a loss of electrical power to all loads powered from the affected supply.

Electric power sources for equipment needed to achieve and maintain post-fire safe-shutdown of Unit 1 is delineated in the EEL (Drawing No. 8770-B-049, Revision 1, dated December 24, 1992). As part of its ongoing re-validation effort, FPL has reevaluated the adequacy of selective coordination provided for electrical equipment included on the EEL. The objective of this evaluation was to demonstrate that

fire-induced faults on nonessential circuits of a required power supply would not affect the post-fire safe-shutdown capability of the plant. The results of this study were documented in Calculation No. PSL-1-FJE-98-001, "Review of Selected Coordination for the Electrical Circuits on St. Lucie Unit 1 Essential Equipment List," Revision 0, dated March 8, 1998. This evaluation identified coordination (selectivity) deficiencies. However, further review by FPL determined that none would have an adverse effect on the post-fire safe-shutdown capability of Unit 1. On the basis of a review of the referenced calculation and other information submitted by the licensee, the team concurred with this conclusion. Additionally, to address the identified coordination deficiencies, FPL has initiated CR 98-428, dated March 6, 1998.

On a sample basis, the adequacy of protection provided for power supplies of equipment relied on to achieve post-fire safe-shutdown conditions was reviewed. This evaluation included a review of protective device time/current curves and associated calculations developed by FPL. The specific sample of circuits selected for review and the corresponding results of the evaluation are summarized below.

Adequacy of Protective Device Coordination (Selectivity)

VOLTAGE LEVEL	POWER SUPPLY	SELECTIVITY
4.16kV	1A2	ACCEPTABLE
	1A3	ACCEPTABLE
	1AB	ACCEPTABLE
480 VAC	MCC1B5	ACCEPTABLE
	Switchgear 1A2	ACCEPTABLE
	MCC1A6	ACCEPTABLE
125 VDC	BUS 1AB	ACCEPTABLE
	BUS 1A	ACCEPTABLE
	RTGB 105	ACCEPTABLE
120 VAC	PP103	ACCEPTABLE
	PP101	ACCEPTABLE
	PP102A	ACCEPTABLE
	BUS MD	ACCEPTABLE

As indicated in the preceding table, the sample of power supplies selected for review was found to be provided with a sufficient level of selective coordination between feed and load protective devices to address post-fire safe-shutdown concerns.

On the basis of the results of this review, the coordination/selective tripping capability of power supplies relied on to achieve and maintain safe-shutdown was found to be acceptable.

Administrative Control of Fuse Replacement

In 1988, the Electrical Maintenance Department at PSL reviewed 983 fuses. Of this total, 56 fuses were found to be the wrong size. As a result of an Electrical Distribution Systems Functional Inspection (EDSFI) performed by NRC during the first quarter of 1991 (Reference: NRC letter to FPL dated May 17, 1991, "Electrical Distribution Systems Functional Inspection at St. Lucie, Finding 91-03-05), the NRC noted that improvements were required in the control of fuse sizes and types. During its evaluation of circuit breaker and fuse coordination in preparation for the FPFI, the licensee discovered that there was no controlled procedure governing the replacement of fuses. At the time of the inspection, the licensee noted that this finding was documented in CR 98-0226, dated February 9, 1998. As part of its corrective actions under this CR, the licensee will develop a controlled fuse replacement procedure that is similar to a procedure currently in use at the licensee's Turkey Point Nuclear Plant.

High-Impedance Faults

To meet the separation requirements of Appendix R to Section III.G.2, multiple high-impedance faults (MHIFs) should be considered in the evaluation of electrical power supplies required for post-fire safe-shutdown (Reference GL 86-10, Question 5.3.8). The team found that FPL had incorporated a general note into its post-fire safe-shutdown procedures (1-ONOP-100.01 and 1-ONOP-100.02). Because these procedures alert operators to the potential loss of required power sources and provide guidance for the restoration of affected supplies, they would appear to satisfy the guidance of GL 86-10. However, the team found that the procedures do not provide specific guidance regarding the power supplies that may be affected as a result of fire in a given fire area. Due to the generic nature of the guidance contained in the ONOPs, and the licensee's lack of an analysis of this issue on a fire area or power supply specific basis, the team concluded that in the absence of a more comprehensive evaluation, the potential exists for losing multiple power sources as a result of a single fire. Under this scenario (loss of multiple power sources), there may not be sufficient time or staff available to perform the restoration activities described in the ONOPs.

During the inspection, the licensee acknowledged the team's conclusion and stated that it had initiated a comprehensive analysis of the effects of fire-induced high-impedance faults on the safe-shutdown capability. This evaluation was found to be contained in undated draft, Calculations PSL-1FSE-98-003, "Multiple High Impedance Faults Analysis for Unit 1 AC Circuits-Appendix R," and PSL-1FSE-98-004, "Multiple High Impedance Faults Analysis for Unit 1 DC Circuits- Appendix R." The licensee further stated that upon completion, the results of these analyses will identify specific power sources susceptible to failure in each fire area. For each fire area, the analysis will verify that fire-induced high-impedance faults will not cause tripping of required power sources or, if power sources are affected, appropriate actions will then be integrated into the shutdown procedures. In this manner, the scope of potentially affected power sources will be greatly reduced to a clearly defined set of power sources that are clearly identified in the operating procedures.

Because of the potential impact that post-failure restoration activities may have on operator staffing requirements, the licensee was asked to identify power sources of "time critical" loads (i.e., loads required to remain operable during the first hour of the fire event), which may be subject to loss as a result of fire in alternate shutdown fire areas (control room and cable spreading room). In its response, the licensee stated that, based on its preliminary calculations, the following "time critical" power sources may be affected:

(1) 125-Vdc power to 4-kV Switchgear 1B3 and 480-Vac Switchgear 1B2, and

(2) 480-Vac power to 480-V Switchgear 1B2 and MCC 1B5.

For Case 1 above (potential loss of 125-Vdc control power), the licensee states that this scenario could only occur if MHIFs were to occur before procedurally directed, operator actions were made to isolate switchgear control cables from the control room and cable spreading room. However, to mitigate the potential for such an occurrence, the licensee states that it will enhance the control room inaccessibility procedure to provide specific direction for restoring dc power should a loss occur and that any impact on the current time-line analysis of operator actions will be considered. Considering the low probability of the occurrence of multiple faults preceding isolation and the licensee's commitment to enhance the existing procedures as necessary to provide specific operator guidance necessary for restoration, the inspection team found the licensee's proposed method of resolution acceptable.

In its evaluation of Case 2 (potential loss of 480-V Switchgear 1B2 and Motor Control Center 1B5), the licensee states that restoring power to either Switchgear 1B2 or MCC 1B5 would require opening three nonessential loads on each bus and re-closing the respective bus feeder breakers. However, to provide assurance that time-critical loads connected to these power sources would remain unaffected, the licensee stated that it will revise its current control room inaccessibility procedure to provide specific direction for operators to shed nonessential loads from Switchgear 1B2 and MCC 1B5. Since shedding nonessential loads as a preventive action (i.e., before bus failure) will assure operability of the required power source only, and since all required operator actions may be accomplished in a timely manner (the affected power sources are located in the same area as the alternate shutdown panel), the inspection team found this method of resolution acceptable.

<u>Review of the Spurious Signals Associated Circuit Concern</u>

Fire damage to circuits and cables may adversely affect the post-fire safe-shutdown capability by causing equipment to spuriously operate in an undesired and/or uncontrolled manner. This evaluation is principally comprised of two items:

(1) The mal-operation of required equipment due to fire-induced damage to associated cabling or instrument sensing lines. Examples include false control and instrument indications that may be initiated as a result of fire-induced grounds, shorts, or open circuits in connected cables.

(2) The spurious operation of components (shutdown-related or non-shutdown-related) that could adversely affect the plant's post-fire safe-shutdown capability.

The fire protection requirements specified in 10 CFR Part 50.48 require that the fire protection program have a means to limit fire damage to structures, systems, and components important to safety so that the plant's safe-shutdown capability is assured. Additionally, Section III.G of Appendix R to 10 CFR Part 50 requires, in part, that associated non-safety-related circuits and cables that could prevent operation or cause mal-operation of systems and components important to a safe-shutdown, be provided with a level of fire protection necessary to ensure that such circuits will remain free of fire damage. Acceptable options for providing this level of fire protection are delineated in Section III.G.2 of the regulation.

In GL 81-12 and GL-86-10, the NRC staff established that either physical protection from fire (per Section III.G.2 of Appendix R) or detailed electrical circuit analyses may be used to demonstrate that fire will not cause equipment to spuriously actuate in a manner that could adversely affect the post-fire safe-shutdown capability of the plant. Although either approach is acceptable, the use of analytical techniques places greater importance on the assumptions, criteria, and review methodology that Form the basis of the analysis.

Also in GL 86-10, the NRC staff presented its Appendix R guidance related to identifying non-safety-related circuits that could prevent the operation or cause mal-operation, and defined the circuit failures to be considered. Specifically, the NRC staff response to Question 5.3.1 gave the following guidance:

> "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 de-energized by <u>one or more</u> of the above failure modes (emphasis added). Therefore, valves could fail open or closed; pumps could fail running or not running; electrical distribution breakers could fail open or closed ...."

This guidance (1) establishes that when performing a circuit failure analysis, one or more circuit failure modes (e.g., multiple hot shorts or a hot short combined with a ground or open circuit) must be considered when identifying circuits that can prevent the operation or cause the mal-operation of redundant trains of systems necessary to achieve and maintain hot shutdown conditions; (2) indicates that when the circuit analysis identifies circuits that can cause spurious actuations that may affect the post-fire safe-shutdown capability, they should be considered as circuits required for safe-shutdown and be protected in accordance with the separation criteria of Section III.G.2 of Appendix R; and (3) by the context of the question and its answer, presumes that a fire can cause multiple fire-induced spurious equipment actuations.

Contrary to the regulatory requirements and staff positions described above, the inspection team found that the licensee's analysis of potential fire-induced spurious equipment operations had assumed only one spurious operation to occur as a result of fire in any area, regardless of the number, type, function, or specific location of potentially affected cables and circuits.

One relatively simple example discussed with the licensee was its evaluation of flow diversion pathways having two normally closed, MOVs connected in series. For this case, if control cables of both valves were subject to damage as a result of a single fire, it should be assumed that both valves would spuriously change position (i.e., open) unless shown by separation, protection, or analysis that such spurious operations are not possible as a result of the fire. During its discussions with the inspection team, however, the licensee stated that when cases such as this were encountered, it had assumed that only one of the valves would spuriously change position and no further evaluation was, therefore, necessary, unless the valves comprised a high-to-low pressure interface.

An example of how the licensee's application of its assumptions and analysis methodology may affect the post-fire safe-shutdown capability of PSL was identified by the team during a review of the protection provided for cables of equipment associated with essential safe-shutdown functions (see Section F7.1.2 above). As a result of this review, the inspection team determined that the inadvertent operation (opening) of either combination of two valves (MV-08-13 and MV-08-3 or MV-08-14 and MV-08-3) is possible as a result of fire in several areas. This scenario could adversely affect the post-fire safe-shutdown capability by causing uncontrolled blowdown of steam and subsequent dryout of the steam generator(s). In its reanalysis of Fire Area B, Zone 57 (cable spreading room), dated March 31, 1998, the licensee provides its basis for fire damage to cabling associated with valves MV-08-3, MV-08-13, and MV-08-14. With regard to the spurious operation of these valves, the reanalysis indicates that spurious operation of MV-08-3, MV-08-13, and MV-08-14 is possible as a result of fire in this area,"but since this is not a high to low pressure interface, only a single spurious operation is assumed." This position was found to be in agreement with the licensee's circuit analysis methodology implemented during its current revalidation effort (Reference: "St. Lucie Plant-Unit 1 1997 Appendix R Safe-shutdown Re-analysis," Revision 1, dated February 9, 1998, page 7) which states, in part:

> Unprotected essential cables (within the fire area) are assumed to result in mal-operation of related essential equipment unless....equipment within the same system precludes the effect of the mal-operation, such as:
>
> I. two normally closed valves in series that provide redundant isolation (only one valve is assumed to be affected by fire), or
>
> ii. two normally open valves in parallel that provide redundant flow paths (only one valve is assumed to be affected by fire), or;
>
> iii. a valve and a pump in series (either the valve or the pump is assumed to be affected by fire)" (emphasis added).

In response to this inspection issue, the licensee prepared a "white paper titled "Spurious Equipment Actuations for Appendix R Analysis" (see Attachment 1) to (a) document the

FPL position, assumptions, and methodology for evaluating fire-induced spurious operations and (b) present the basis for the FPL analysis of fire-induced spurious operations contained in (1) the original SSA (i.e., the SSA of record; Calculation No. 8770-B-048, Revision 1, dated February 13, 1986) and (2) the current SSA validation effort performed under CR 97-2288. As noted in this document, on the basis of comments received from the team during the FPFI, the licensee.reconsidered its position regarding spurious operations and included a proposed approach for resolving the inspection team's findings. However, as stated in this document, the licensee intends to re-evaluate its analysis of fire-induced spurious equipment operations, but proposed enhancements will only be implemented if no hardware modifications are required. At the exit meeting, the team informed the licensee that, in its view, this approach was not acceptable and did not meet Sections III.G.1 and III.G.2 of Appendix R to 10 CFR Part 50.

High/Low Pressure Interfaces

High/Low Pressure interfaces exist where the high-pressure RCS interfaces with systems designed to withstand lower operating pressures. In the event that cabling associated with electrically controlled devices (such as motor-operated valves) used to isolate the primary coolant boundary are damaged by fire, there is a potential for an uncontrolled loss of reactor coolant into the low-pressure system, thereby resulting in a fire-induced loss-of-coolant accident (LOCA) through the high/low pressure interface. Due to the potentially serious consequences of this event, the NRC has established more rigorous evaluation criteria for electrically operated devices, which comprise a high/low pressure interface boundary. Specifically, cables and circuits of these devices must consider the potential for fire to cause multiple, simultaneous, hot shorts of the proper polarity without grounding.

The protection provided for primary system high/low pressure interfaces at Unit 1 is described in Volume 9.5A, Section 6, of the UFSAR which states, in part, "Several low pressure systems are connected to the high pressure primary coolant system. In some cases, low pressure system isolation is provided solely by redundant electrically operated valves. The design of these systems must ensure that a fire-induced LOCA cannot result due to a single fire opening all the valves in series at a high/low pressure interface." The UFSAR further identifies the systems in the table that follows as potential high/low pressure interfaces of concern at PSL.

High/Low Pressure Interface System	UFSAR Disposition / Method of Control
1. Letdown Isolation	The letdown line is provided with two pneumatic valves in series, each of which is capable of isolating the reactor coolant system (RCS). The valves fail closed on loss of power or air. Cable routing analysis demonstrates that a single fire can not prevent letdown line isolation.
2. Sampling System	Each line has redundant (Train A and B) pneumatic valves, which fail closed on loss of air or power. In addition each line has a restriction orifice designed to limit flow to less that the makeup capability of one charging pump; thus, these passive devices eliminate the possibility of a LOCA through these lines
3. Reactor Coolant Gas Vent System	Provided with redundant solenoid -operated valves, which fail closed on loss of power. Both vent lines have restriction orifices designed to limit flow to less than the makeup capability of one charging pump; thus, these passive devices eliminate the possibility of a LOCA through these lines
4. Shutdown Cooling Isolation	The RCS is isolated from the low-pressure safety injection system by means of redundant motor-operated valves. Each line has two valves in series. To preclude the possibility of a fire-induced LOCA, the power to these valves is locked out during power operation.

High/Low Pressure Interface System	UFSAR Disposition / Method of Control
5. Power Operated Relief Valves	The pressurizer is provided with redundant power-operated relief valves (PORVs). These are solenoid-operated valves, which are designed to fail closed on loss of power. Each PORV has a motor-operated block valve located upstream for isolation. The PORVs are dc-powered, and the block valves are ac-powered. In all cases, except containment, cable spreading room, and control room, the cables for one of these valves are protected. To ensure relief capacity is available during alternative shutdown, the controls for the PORV and its block valve are protected (insoluble) from the control room and cable spreading room.

Potential for Fire-induced LOCA Through PORV Flowpath

As indicated in the preceding table, the Unit 1 UFSAR states that in all cases except containment, the cable spreading room, and the control room, the cables for either the PORV or its associated block valve are protected. Providing protection for at least one valve in the flowpath precludes the potential for a fire-induced LOCA through this interface. With respect to this design requirements the FPL SSA (Drawing 8770-B-048, Revision 3), credits the protection of the PORVs (V1402 and V1404) in areas other than the containment, the cable spreading room, and the control room. Contrary to this design requirement; however, as part of its ongoing revalidation of the Unit 1 SSA, the licensee discovered that a portion of cabling associated with the PORVs may be susceptible to damage as a result of fire in the Train A electrical penetration room (Fire Area A, Zone 77) or the Train B electrical penetration room (Fire Area C, Zone 78). For other fire areas in which protection of the PORVs is credited, the PORV power cables are routed in dedicated conduit, thereby precluding the possibility of fire-induced "hot-shorts" due to contact with other external energized cables. Within the electrical penetration rooms at a location near the containment penetrations; however, PORV power cables were found to be routed in wireways containing other energized cables. With this configuration, other energized cables are near the PORV power cables, thereby creating a potential for fire-induced energization of the PORV cables and subsequent PORV operation (opening). Isolation via the PORV block valves (V1403 and V1405) would not be possible since these valves (1) are normally open MOVs which fail as-is (open) on loss of power and (2) are not protected in these areas.

To address this finding, document operability considerations, and track corrective actions, the licensee has initiated CR 98-0189, dated February 24, 1998. Since this condition placed Unit 1 outside its design basis with respect to protection provided for high/low pressure interfaces, it was deemed reportable by FPL. At the exit meeting, the licensee informed the inspection team that on April 2, 1998, it had issued an LER.

Potential for Fire-induced Opening of Reactor Head Vent and Pressurizer Vent

As indicated in the preceding table the Unit 1 UFSAR defines the reactor coolant system gas vent system (RCSGV) as a high/low pressure interface. The RCSGV includes the reactor head vent and the pressurizer vent. The Unit 1 SSA (Drawing 8770-B-048, Revision 3) evaluated the spurious opening of RCSGV valves by stating that a fire-induced spurious opening was acceptable based on the ability of restriction orifices in each line to limit the flow to less than the makeup capability of one charging pump. Further evaluation by the licensee, however, determined that the SSA did not appear to fully consider the potential for fire to cause both vents (reactor and pressurizer) to open at the same time. The licensee stated that a preliminary analysis indicates that this condition (flow with both vents open) would be marginally less than the flow from one charging pump. However, the licensee further stated that this condition "is not conducive

to control of pressurizer pressure or the reactor coolant system and may cause difficulty in proceeding to cold shutdown."

The licensee has documented this finding in CR 98-0403, dated March 4, 1998. This evaluation indicates that both vents (reactor head vent and pressurizer vent) are susceptible to inadvertent spurious operation as a result of fire in Fire Areas A, B, C, and F because (1) the cables for these valves are routed in cable trays with other energized cables; (2) the indication circuit is in the same multi-conductor cable as the power cable for these valves, and (3) sufficient cables are present in Fire Areas A, B, C, and F to cause both the reactor head vent and pressurizer vent to open at the same time. At the time of this CR a 30 minute roving fire watch was already in place throughout the reactor auxiliary building (RAB) as a result of CR 97-2288. Therefore, the licensee determined that there is no immediate operability concern for this finding.

Letdown System High/Low Pressure Interface Boundary Not Isolated for Fires Requiring Alternative Shutdown Capability (Control Room or Cable Spreading Room)

As part of its safe-shutdown analysis (8770-B-048) revalidation performed under CR 97-2288, the licensee performed a review of the control room inaccessibility procedure in effect at that time (ONOP 1-0030135). As a result of this review FPL discovered that the procedure would not isolate letdown as required by the SSA. In addition, the licensee discovered that the method used to isolate letdown in the SSA would not function.

As indicated in the preceding table, isolation of letdown is considered part of the high/low pressure interface boundary with the RCS. As stated in Section 6 of the UFSAR, isolation may be accomplished by ensuring one of two air-operated isolation valves (V2515 and V2516) remains closed. For a fire in the cable spreading room or control room, valve V2515 was credited to provide this function following isolation at the HSCP. From a review of cable routing information, however, the licensee determined that the capability of V2515 to perform this function was not assured. Specifically, this review found V2515 circuits (Cable 10157A) to be routed through the cable spreading room and not isolated by the isolation switch. Fire damage to this cable could cause Valve V2515 to remain open even if the control switch was in the closed position. Additionally, Procedure ONOP 1-0030135 did not provide any instructions to use the HSCP control for redundant series Valve V2516. Further analysis determined that V2516 is capable of performing the isolation function.

The licensee documented this finding in CR 98-1054, dated January 28, 1998. Corrective actions include revision of the control room inaccessibility procedure to require the control switch for V2516 to be placed in the closed position on the HSCP. This will ensure that letdown is isolated.

Instrument Sensing Lines

At the time of the inspection, the licensee was not able to demonstrate that the thermal effects of fire on instrument sensing lines would not result in false instrument indications or cause the connected instrument(s) to initiate inadvertent automatic operations that could adversely affect the post-fire safe-shutdown capability. At the exit meeting, the licensee stated that an analysis of this issue would be included as part of CR 97-2288.

Protection From Potential Loss of Shutdown Capability Due to Fire-Induced Circuit Faults (Reference: NRC Information Notice 92-18)

As described in NRC IN 92-18, fire-induced faults (hot shorts) in the control circuits of certain MOVs needed to shut down the reactor and maintain it in a safe condition may occur at locations where protection that is normally provided by limit and torque switches is bypassed. If this were to occur, the valve would spuriously operate in a manner that could result in an inoperable MOV due to failed motor windings and/or mechanical valve damage.

The licensee's evaluation of issues described in IN 92-18 is described in an internal memorandum from H. N. Paduano (Nuclear Engineering) to C.F. Ferriday, dated September 25, 1992. This evaluation concludes that no additional or corrective action is required for PSL since thermal overload protection would not be affected and MOVs would be protected. The team's review of this evaluation, however, found that it was limited to a control room fire only. Other plant fire areas, such as the cable spreading room, had not been evaluated. It should be noted that this finding was also previously identified by the NRC in Inspection Report No. 50-335/97-06.

As discussed above, in preparation for its revalidation of the Unit 1 Appendix R SSA, the licensee has developed a new methodology and evaluation criteria for performing circuit analyses (Reference: St. Lucie Plant-Unit 1 1997 Appendix R Safe-shutdown Re-analysis, Revision 1, dated February 9, 1998). This revised methodology requires fire-induced faults of the type described in IN 92-18 (i.e., those that could lead to a loss of mechanical protection) to be evaluated for <u>all</u> fire areas.

Review of Associated Circuits by Common Enclosure

A review of the cable routing information provided by the licensee found nonessential cables to be routed within a common enclosure (e.g., raceway, cable tray, conduit, junction box) with cables of equipment required to achieve post-fire safe-shutdown conditions. To determine if fire-induced faults on these nonessential cables could initiate secondary fires because of inadequate electrical protection, a sample of cable enclosures, known to contain cables of equipment required for safe-shutdown, was selected for review. The inspection sample included nonessential cables routed in the following cable trays: (1) Tray No. M31 at Plan Point 2053 and (2) Tray No. C30 at Plan Point 2113. For nonessential cables routed within each cable tray, the licensee was asked to submit information describing the size, type, and construction of nonessential cables and the electrical protection provided (i.e., fuse/breaker size/type). For each of the enclosures selected, the electrical protection provided for nonessential circuits routed within the enclosure was found to be acceptable.

c. Conclusion

For the sample of circuits reviewed, the team concluded that the FPL evaluation of circuit breaker, relay, and fuse coordination for low-impedance, bolted faults satisfied Section III.G of Appendix R to 10 CFR Part 50. However, the licensee had not developed a controlled procedure to govern the replacement of fuses. Additionally, the licensee's reliance on generic procedural guidance, which directed operators to restore operability of power sources that may be lost due to fire-induced high impedance faults, was not found

to satisfy Section III.G of Appendix R or the guidance contained in GL 86-10. As part of its ongoing SSA revalidation effort, FPL is performing more detailed evaluations of the effect of fire-induced high-impedance faults on the operability of power sources relied on to accomplish post-fire safe-shutdown functions. The result of these analyses will serve to define the scope of potential operator actions by identifying specific power sources susceptible to loss as a result of fire in any fire area or zone. Additionally, in response to the team's findings regarding "time critical" alternative shutdown loads, the licensee has developed operator actions to prevent the loss of power sources whose operation is immediately required to support the accomplishment of alternative shutdown from outside the main control room. Therefore, the inadequacy of circuit coordination (lack of procedure to control fuse replacement) and high-impedance faults (completion of detailed calculations and revision of procedural guidance) is identified as another example of unresolved item URI 50-335, 389/98-201-07.

The team concluded that the licensee's analysis and method of protection for fire-induced spurious equipment operations do not satisfy Section III.G or III.L of Appendix R to 10 CFR Part 50. Specific deficiencies include (1) an analysis methodology, which assumed only one spurious operation to occur as a result of fire in any area without any further consideration of the number, type, or specific location of potentially affected cables and circuits; (2) potential for fire to cause a breach of pressurizer PORV and reactor coolant system gas vent system (RCSGV) high/low pressure interface boundaries; (3) lack of an analysis of the effect of fire on instrument sensing lines; and (4) inadequate evaluation of the potential for fire to cause damage to MOVs relied on to accomplish post-fire safe-shutdown functions as described in IN 92-18. These deficiencies are identified as additional examples of unresolved item URI 50-335, 389/98-201-07.

From the sample of circuits reviewed, the team concluded that the level of electrical protection provided for nonessential cables that share a common enclosure with cables of equipment relied on for post-fire safe-shutdown was acceptable.

7.2 Operational Procedures and Operator Readiness

F7.2.1 Post-Fire Safe-Shutdown Procedure and Alternative Safe-Shutdown-Capability Procedures

a. Inspection Scope

The team performed a review of 1-ONOP-100.02, Revision 1, the licensee's operating procedure for alternate safe-shutdown, and 1-ONOP-100.01, Revision 3, the licensee's operating procedure for post-fire safe-shutdown from the main control room. The team's review focused on ensuring that all required functions for post-fire safe-shutdown and the corresponding equipment necessary to perform those functions were included in the procedures. The review also examined the consistency between the post-fire safe-shutdown procedures and other procedure-driven activities associated with post-fire safe-shutdown (i.e., firefighting activities and security).

b. Observations and Findings

When the SSA was developed in 1986, the licensee's operating philosophy assumed that operator actions specified for fires in areas other than those requiring control room evacuation could be accommodated within the existing normal and off-normal operating procedures. The basis for this philosophy was that since Unit 1 was designed with essentially two redundant and separate trains of equipment, failure of one train due to an Appendix R fire could be accommodated with the redundant train. It was assumed that the existing operating procedures provided enough detail to enable the operators to shut down with the redundant and unaffected train. As part of an internal assessment in preparation for the FPFI, the licensee performed a detailed review of the SSA for Unit 1. From that assessment, CR 97-2288 was generated and identified the lack of specific operating procedures for manual actions required to cope with an Appendix R fire as a deficiency. This step resulted in the writing of 1-ONOP-100.01 and the revision of 1-ONOP-100.02. Review of the latest revision of the licensee's post-fire safe-shutdown procedures by the team revealed that many operator actions were not incorporated, in particular those dealing with restoration of HVAC. A concurrent review of the firefighting strategies showed that fixed HVAC in each fire area was identified for potential smoke control purposes. Because of this ambiguity between the fire fighting strategies and the post-fire safe-shutdown procedures concerning HVAC, the team believed there was a significant possibility that smoke could be vented or could migrate into an area in which operator actions associated with post-fire safe-shutdown have to be performed (see Section F3.1 for details). Other items identified for the procedures included no instructions to trip the main feedwater pumps or to close the feedwater regulating valves, or to close the main steam bypass valves. There was also no table in the procedures identifying which instrumentation was protected for each shutdown method.

Specific to the review of 1-ONOP.100.02, the team also found no instruction to isolate the reactor vessel head vents, which could result in RCS inventory loss. The team believed that this fact was significant since it was determined earlier in the inspection that the charging pumps can only keep up with a 0.3-inch opening in the RCS boundary, and the two head vents are equivalent to a 1.5-inch opening. Additionally, if the key card system were to become inoperative, a key to open doors in the plant is required. On a plant walkdown inspection the team observed that only one master key was available to operations in the main control room. Since four operators are sent into the plant simultaneously to implement alternate safe-shutdown, the licensee agreed with the team that three additional keys were needed. By the end of the onsite inspection, three additional keys were made available to operations by the security manager, who administratively controls the master keys.

c. Conclusions

On the basis of its review of the post-fire safe-shutdown procedures 1-ONOP-100.01 and 1-ONOP-100.02, the team concluded that these procedures exhibited omissions in that they did not properly address isolation of the main feedwater system and its regulating valves, the main steam bypass valves, and the reactor head vent valves. This is identified as an area where additional licensee attention is needed.

F7.2.2 Alternative Post-Fire Safe-Shutdown Procedure Walkdown Inspection

a. Inspection Scope

The team performed a walkdown inspection of 1-ONOP-100.02, Revision 1, with the licensee's operations staff. Areas inspected included the ability to perform required safe-shutdown actions in a timely manner and the technical adequacy of the actions sequence to meet predicted plant responses to them.

b. Observations and Findings

During the walkdown inspection, the team noted various ergonomic (human factors-related) observations. Isolation switches requiring manual operation are located more than 6 feet above the floor, making them difficult to access with no step stool present. Although all equipment was properly labeled, the team believed that labeling of appendix R-related equipment could be improved. It was also noted that when hand-held radios, which serve as backup for the sound-powered phone system, were keyed in close proximity to the HSCP, instrumentation on the HSCP would momentarily fluctuate. In addition, there was no chair or table in the HSCP room to facilitate HSCP operations.

The licensee issued CR 98-0580, which investigated the impact of momentary instrumentation fluctuations induced by portable radios. Review of the specific corrective actions in the CR stated that it is within the knowledge of operations personnel that some equipment is susceptible to interference caused by radio operation and that operations personnel would recognize the condition and take mitigating actions. The licensee also agreed to review and correct when appropriate, the other ergonomic observations found during the procedure walkdown inspection by the team.

While performing the walkdown inspection, the team noted that there was no emergency lighting present in the stairwell to the blowdown heat exchanger isolation valves, or at the location of the valves, or in outside areas of the turbine building. The team also noted that there was no sound-powered phone located in the vicinity of the blowdown heat exchanger isolation valves. Emergency lighting and communications is discussed further in section F7.5 of this report.

c. Conclusions

As a result of the walkdown inspection, the team concluded that the alternative shutdown capability could be operationally implemented within the time line analysis reviewed in Section F7.1.4 of this report.

F7.2.3 Post-Fire Safe-Shutdown Operator Training

a. Inspection Scope

The team examined a sampling of the licensee's training program to evaluate the adequacy of integrating the safe-shutdown required actions into the overall operator training program.

b. Observations and Findings

The licensee maintains Job Performance Measures (JPMs) for licensed operator training and requalification. The following documents for Unit 1 were reviewed, relevant to procedures 1-ONOP-100.01, Revision 1, and 1-0030135, Revision 30:

- JPM-0821033, Revision 9, Locally Close the Main Steam Isolation Valves
- JPM-0821070, Revision 5, Perform the Actions of RCO "B" Under Conditions of Control Room Inaccessibility
- JPM-0821099, Revision 7, Perform the actions of RCO "A" To Place the Plant in Safe Condition From the HSCP
- JPM-0821053, Revision 3, Locally Operate Unit 1 Atmospheric Dump Valve

The operator training and qualification tasks were found to be quite comprehensive and reflected the current approved revision of the safe-shutdown procedures. The tasks covered major steps in the procedures in sufficient detail to ensure the adequacy of the needed level of understanding of the operators.

c. Conclusions

The team concluded, for the areas sampled, that the JPMs adequately covered the operations and manual actions required by post-fire safe-shutdown procedure 1-ONOP-100.01 and that they were of sufficient detail to provide the operators with the level of understanding needed to perform the required tasks.

F7.2.4 Post-Fire Safe-Shutdown Implementation Staffing

a. Inspection Scope

The team reviewed the adequacy of shift manning to determine whether there was sufficient staffing to accomplish post-fire safe-shutdown operations and adequately man the plant fire brigade.

b. Observations and Findings

Operations Policy OPS-201, Revision 4, states that the minimum shift crew for operation of the plant (both units) is composed of 14 individuals (1 nuclear plant supervisor, 1 qualified fire brigade leader, 2 assistant nuclear plant supervisors [1 per unit], 4 reactor operators [2 per unit], 2 senior nuclear plant operators [1 per unit], 2 nuclear plant operators [1 per unit], and 2 associate nuclear plant operators [1 per unit]. Excluding fire brigade members, this leaves four operators to implement the units's post-fire safe-shutdown methodology. The licensee stated that currently this level of staffing was adequate to implement safe-shutdown. However, if the current safe-shutdown analysis revalidation results in additional operator manual actions, the current shift manning level would have to be reevaluated.

c. Conclusions

Using the current procedures as a basis, the team did not identify any unresolved items in the area staffing.

F7.3 Fire Protection of Safe-Shutdown Capability

F7.3.1 Fire Barriers Enclosures - Thermo-Lag Walls

a. Inspection Scope

The team reviewed the status and actions that FPL is taking to resolve the technical issues related to the fire-resistive performance of its Thermo-Lag fire barriers (i.e., rated fire walls). The team also reviewed installed fire barriers (existing and upgraded), the plant licensing basis, installation instructions, supporting fire tests, and evaluations.

b. Observations and Findings

In 1984, the licensee installed numerous Thermo-Lag fire barriers under PC/M No. 260-183. The description of the change follows: "Add three hour-rated fire barriers construction of reinforced concrete or structural steel with fire-proofing in various areas of the RAB at Elevations 19.50' & 43.00'." The PC/M states the "Need for Change: Required for compliance with Appendix R to 10 CFR Part 50." The PC/M further defines "the separation between safety-related A and B redundant systems for fire protection." The licensee's commitment for a 3-hour rated fire barrier in these areas is documented in the UFSAR (e.g., p. 9.5A-121 for Unit 2).

In 1991, the NRC found that Thermo-Lag fire barrier material did not perform to the manufacturer's specifications. NRC Bulletin 92-01, "Failure of Thermo-Lag 330 Fire Barrier Systems to Maintain Cabling in Wide Cable Trays and Small Conduits Free From Fire Damage," required licensees with Thermo-Lag barriers to consider these fire barriers to be degraded and to take appropriate compensatory measures for areas in which they are installed. The licensee established roving fire watches as compensatory measures in these areas.

PSL has unique Thermo-Lag installations as "stairwell enclosures" at Column Lines RA3 and RA7, on Elevation 19.50 feet and "Cable Loft Areas" on Elevation 19.50 feet. The use of Thermo-Lag is unique in the fact that the material was not used to protect individual or grouped raceways (e.g., conduits, cable trays) but rather to build complete wall sections. The original installation (PC/M 260-183) required the use of two ½-inch-thick panels fastened to structural steel framing. Recognizing that this was a unique, untested application of Thermo-Lag, FPL teamed with Carolina Power & Light Company (CP&L) and performed full-scale fire testing. Two fire tests were performed on similar wall designs. The walls were constructed by installing a ½-inch-thick Thermo-Lag 330-1 panel on each side of the steel framing. The panels were installed with the stress skin facing out and the "V-ribs" hammered flat. The panels were fastened to the frame with 1/4-inch bolts, washers, and nuts. The assembly was post-buttered with Thermo-Lag 330-1 trowel-grade material. The first test was performed on September 14, 1994 (Omega Point Project No. 14980-97261). The test was run for a 1-hour rating period using American Society for Testing and Materials (ASTM) E-119 as

the testing method and acceptance criteria. The assembly met the temperature rise limits as measured on the cold side of the wall. A solid-bore hose stream test was conducted upon completion of the fire test. At 60 seconds into the hose stream test, water leakage was discovered at the interface of panel to panel joints. The hose stream test was stopped. Note that ASTM E-119 requires the hose stream test to last a minimum of 1 minute (60 seconds) per a 100-square foot test assembly (i.e., 60 seconds for this test assembly to be considered a one-hour rated assembly). After the assembly sat for approximately 1½ hours, the testing laboratory conducted an after-the-fact additional 90 second hose stream test. The assembly remained unchanged with the additional leakage around thermocouple 25. Due to these discrepancies the required hose stream test for a 1-hour rated assembly is considered to be indeterminate. Also note that ASTM E-119 requires a minimum 2-1/2 minutes (150-second hose stream test for a 100-sq. ft. assembly) to qualify a 3-hour fire barrier assembly.

A second full-scale test was performed on May 23, 1995 (Omega Point Project No. 14980-98207). The test article contained an upgrade to the penetration seal sleeves. The upgrade consist of 1/8-inch trowel-grade skim coat with stainless steel stress skin and another 1/16-inch skim coat. This test was scheduled to run for a 3-hour rating period with no hose stream test at the end. The licensee had planned on using the hose stream test results from the test of September 4, 1994, as allowed, with restrictions by ASTM E-119. (See previous discussion on concerns involving the acceptability of the hose stream testing.) At 1 hour and 48 minutes (1:48) into the test, the average allowable temperature rise of 250 °F was exceeded. At 2 hours and 3 minutes (2:03), the maximum allowable single thermocouple temperature rise exceeded the 325 °F maximum limit. The Thermo-Lag wall failed to qualify as a 3-hour rated fire barrier.

On the basis of this testing, the licensee prepared a detailed evaluation in an attempt to justify the failed 3-hour wall test. FPL evaluation PSL-FPER-96-002, "St. Lucie Unit 2 Fire Protection Evaluation for TSI Walls, Floors, and Ceilings," was issued in May 1997. The stated purpose of the evaluation was to (1) determine the fire rating of the installed walls, (2) determine the adequacy of the specific fire rating, and (3) recommend modifications to the barrier. The evaluation uses a technically obsolete method[1] of averaging the fire loading over the square footage in the area. The licensee further approximates that for each 80,000 BTU/sq. ft. of fire loading, 1-hour of fire resistance is needed. This criterion contradicts the evaluation. For example, cable loft "A" has 330,800 BTU/sq.ft., which would equate to requiring a minimum 4.14-hour rated fire wall.

The Unit 2 evaluation and physical upgrades were complete at the time of this inspection. Unit 1 work was in process.

c. Conclusion

The team concluded that the Thermo-Lag fire testing demonstrated the upgraded fire wall would at best provide a fire rating of 1 hour and 48 minutes for thermal performance in lieu of the 3-hour Appendix R requirements. This rating, however, may be questionable,

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1 For a detailed discussion of the technical adequacy of averaging the fire load (BTU) over the area's square footage, see NFPA Fire Protection Handbook, 18th edition, Section 7, Chapter 5, "Confinement of Fire in Buildings," pp.7-78.

considering the failed hose stream testing performed on the 1-hour test assembly. Further, the team concluded that the licensee had failed to demonstrate the acceptance of the wall in its evaluation, and could not demonstrate acceptability to the team. In the case of the Unit 1 cable lofts, the evaluation is further weakened by the lack of any automatic fire suppression. This issue is considered significant since the Thermo-Lag fire wall is not designed or rated to bound the in situ fire loading and the lack of diverse fire protection (i.e., no automatic sprinklers installed in the area). This is identified as an unresolved item: **Fire Barriers Not Qualified To Meet Plant Licensing Basis Requirements (URI 50-335, 389/98-201-08).**

F7.3.2 Raceway Fire Barrier Thermo-Lag Raceways

a. Inspection Scope

The team reviewed the status and actions the licensee is taking to resolve the technical issues related to the fire-resistive performance of its Thermo-Lag Electrical Raceway Fire Barrier Systems (ERFBS) (i.e., fire-rated raceway protection). The team also reviewed installed fire barriers (existing and upgraded), the plant licensing basis, installation instructions, supporting fire tests, and evaluations.

b. Observations and Findings

Unit 1 had approximately 2000 linear feet of rated 1- and 3-hour conduit protected. Appendix R reevaluation reduced the total conduit required to approximately 1250 linear feet by circuit reanalysis and rerouting of five conduits. Only one conduit (about 8 feet) will require 3-hour protection. The scope of work addresses upgrading approximately 22 conduits.

Unit 2 had approximately 2300 linear feet of rated 1- and 3-hour conduit protected. Appendix R reevaluation reduced the total conduit required to approximately 1300 linear feet by circuit reanalysis and rerouting of six conduits. Only one conduit (about 6 feet) will require 3-hour protection. The scope of work addresses upgrading approximately 23 conduits.

The team reviewed Thermo-Lag installation specification MN-3.21, Revision 8 during the inspection. Section 7.5.1.1 provides the requirements for protecting intervening items. The specification requires a minimum of 9 inches as measured from the outside of the essential barrier. There are no requirements or limitations on the size of the intervening item (i.e., a Section of 5/8-inch unistrut is treated in the same way as a Section of 4 by 4 tube steel.) Testing has demonstrated that, as expected, larger-cross sectional areas will conduct more heat into the protected assembly than smaller cross sections. The MN-3.21 references the Nuclear Energy Institute (NEI) test 1-6 for this qualification. Review of the NEI Thermo-Lag Application Guide Revision 1, Section 5.0, p. 27, provides this same 9-inch requirement and no restriction on the size of the intervening item. Review of NEI test 1-6 indicates that the supports tested were P2546 unistrut (for the vertical Sections) and P1001 unistrut (for the horizontal sections). Page 156 of the Omega Point Test Report (Project No. 13890-95676 for NEI Test 1-6) describes the support protection as "9 inches from the cable raceway into the fire zone." The test report does not provide any instrumentation (thermocouples) or specific information regarding the temperature profiles on the supports. The Tennessee Valley Authority (TVA) tested larger structural

members in TVA Test 6.1.4 (Omega Point Test Report 11210-94943-b). The TVA tests were made available through NEI. The licensee uses other TVA tests in Thermo-Lag installation specification MN-3.21, Revision 8. The test demonstrated that 18 inches was the minimum acceptable protection for large structural steel supports. Structural support steel as large as W6 I-beams and 4-inch tube steel are protected under the 9-inch rule at PSL, thus providing inadequate thermal short protection for rated 1-hour ERFBS.

c. Conclusion

The team concluded that the Thermo-Lag 330-1 ERFBS are being adequately upgraded by the licensee's program, with the exception of the thermal short protection.

F7.3.3 Equipment Fire Barriers - Radiant Energy Shields

a. Inspection Scope

The team reviewed the actions the licensee is taking to resolve the technical issues related to the combustibility of Thermo-Lag Radiant Energy Shields (RESs) installed inside Units 1 and 2 containments. The team also reviewed the design packages for the RES, the plant licensing basis, installation instructions, and supporting evaluations.

b. Observations and Findings

As a part of the resolution to the Thermo-Lag issue, the licensee had to address the combustibility of Thermo-Lag 330-1 installed inside containment as RES. Unit 1 has approximately 400 sq.ft. of wall inside containment. Unit 2 has approximately 439 sq.ft. of wall and 41 linear feet of conduit. The corrective action consist of overlaying 24-gauge stainless steel sheet metal over the installed Thermo-Lag 330-1 and fastening it with bands and pop rivets. The Thermo-Lag 330-1 walls are removed and replaced with 16-gauge sheet metal.

Both units were under power during the inspections, and inspectors could not enter containment to inspect the RES.

c. Conclusion

The team concluded that the corrective actions addressed the combustibility issues of Thermo-Lag 330-1 installed inside containment.

F7.3.4 Equipment Fire Barriers - Sheet Metal Ceramic Fiber

a. Inspection Scope

As a part of the Thermo-Lag reduction effort, the licensee installed a design change in the Unit 1 "B" Inverter Room (Fire Zone 57B).

b. Observations and Findings

The Thermo-Lag 330-1 walls and ceiling have been removed from the Unit 1 "B" Inverter Room (Fire Zone 57B). PC/M No. 97038 installed sheet metal and ceramic fibre barrier in its place. The installation consists of stainless steel sheet metal attached to the steel frame with 5 to 8 inches of thermal ceramics 8 lb./ ft^3 Kaowool blanket. The design was advanced, authorized, and installed at risk since the 3-hour ASTM E-119 fire endurance test had not yet been performed. Details of the proposed test plan may be found in Test Plan Report PSL-FPER-98-008, "Fire Endurance Tests of a Wall/Ceiling Assembly Protected with a Ceramic Fiber and Sheet Metal Fire Barrier System." Compensatory measures remain in place.

c. Conclusion

At the time of inspection, the licensee had completed the installation of the walls and ceiling. The licensee had performed Fire Protection Evaluation PSL-FPER-97-001 and has high confidence that the assembly will pass the 3-hour fire test. The design was authorized in advance and is installed at risk. The fire test is currently scheduled for the third quarter of 1998. The team could not draw any conclusions regarding the acceptability of this proposed fire-rated assembly since it has not been qualified by appropriate fire endurance tests.

F7.4 Design-Base Verification of Fire Protection Systems and Features

F7.4.1 Fire Detection and Alarm Systems

a. Inspection Scope

In licensing Amendment No. 33, dated August 17, 1979, Section 4.2, "Fire Detection and Signaling System," identifies that the system is in conformance with NFPA 72A. UFSAR Table 9.5A-2 further indicates that the Code of Record for NFPA 72A is 1972. NFPA 72A (72), Section 3430, "Detecting Equipment", Subsection 3431, "Location," requires the following: "Fire-detecting equipment shall be located upon the ceiling or on the side walls near the ceiling. It shall be installed throughout the protected premises, including all rooms, halls, storage areas, basements, attics, lofts, and other subdivisions and accessible spaces; and inside all closets, elevator shafts, enclosed stairways, dumb waiter shafts, chutes, and other minor subdivisions and enclosures." Section 3433, "Spacing," further requires the following: "Detector spacing shall not exceed the linear maximums indicated by tests of Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, and Factory Mutual Research Corporation for the particular device used. Closer spacing may be required because of structural characteristics of the protected area, possible drafts, or other conditions affecting detector operation." Licensing Amendment No. 14, dated June 1995, Section 3.5, "Fire Detection System," further states "Detector coverage areas overlap, so that if a detector fails, one close by [will] be available to detect a fire. Devices are located and mounted such that accidental operation will not result from vibration or jarring."

b. Observations and Findings

Before the start of this FPFI, the licensee performed "reviews in preparation for the fire protection functional inspection" of fire protection systems and features. In the course of the licensee's review of the fire alarm and detection systems, numerous CRs were identified. The following is a list of the problems identified by the licensee:

- CR 98-0259: Smoke Detector Embedded in Thermo-Lag.
- CR 98-0260: Detectors not located at ceiling and are shielded from floor coverage by cable trays. Heat detectors installed where smoke detectors are required; piping obstructions in front of detectors, Class B circuit supervision installed where Class A is required. Further, the FSAR states "Detector Coverage Overlaps," whereas the actual installation exceeds the maximum spacing.
- CR 98-0303: NFPA code compliance review performed that identified discrepancies. (The CR lists 8 basic detection system requirements, e.g., detector spacing, then lists multiple examples.)
- CR 98-0304: Problems in the Turbine Building, such as painted detectors, location of detectors, and obstructions to detectors.
- CR 98-305: Use of wrong edition of the code for later design in contradiction with FSAR requirement.
- CR 98-306: Use of solid combustible panels in the Unit 2 main control room (MCR) ceiling despite SER requirement for open metal grid ceiling (i.e., to allow the smoke detectors installed above to operate.) The CR also identifies missing detectors that were never installed despite 1982 commitment to NRC.

On March 10, 1998, the team performed a field inspection of the system. Detection testing was being performed in the MCR while the team was there. The team noted that the fire alarm annunciator could not be heard and requested to see the results of the MCR Human Factors Evaluation. The team also requested information on the combustibility of the floor covering, wall paneling, and ceiling panels. The team also noted that solid panels were installed in the ceiling, but smoke detectors were located above the ceiling. The team further requested to see the licensee's evaluation of IN 95-33 which discussed problems with hearing the fire alarm control panel (FACP) in the MCR. The licensee initiated CR 98-0486 concerning the ceiling panels. [Note that this issue was previously identified in CR 98-306 and dispositioned as "No further action required by this CR."] After reviewing the audible levels of the FACP in the MCR, the licensee determined the alarm level appeared to be too low and was inconsistent with the guidelines established in NUREG-0700, "Guidelines for Control Room Design Reviews." CR 98-0453 was issued on March 11, 1998, to address this deficiency. IN 95-33 identified a fire event that occurred at Waterford Nuclear Power Plant (NPP). The IN states, "Although the appropriate fire alarms had activated in the control room, the control room crew was not aware of the alarm because of (1) other auditory alarms caused by the event and (2) the lack of a visual fire alarm signal on the front panel of the control room .... Nevertheless, fire alarms that are inaudible under actual operational conditions and lack redundant visual signals can inhibit prompt identification of, and response to, plant fires." The licensee's review of this information (IN 95-33, FPL issue: FOP 95-051, item #5) indicated that the condition did not exist at PSL and "No Action is Required."

On April 1, 1998, the inspection team performed an additional field inspection of the system. The team noted that the auxiliary building general air supply fans take their intake air from outside the building through bag-type filters. There are no duct smoke detectors located in the main supply trunk. Located approximately 10 to 20 feet from the air intake are flammable liquid storage cabinets. This area was also used as a laydown area with tow motors traveling therein. A fire in this area (any source: flammable liquid transfer spill fire, tow motor, transient combustibles, etc.) would produce smoke that will be drawn into the intake and distributed throughout the auxiliary building. Eventually, spot-type smoke detectors in rooms would pick up this condition. By the time the source of the smoke was discovered and the ventilation system isolated, smoke would have been distributed throughout the building. The licensee reviewed the concerns expressed by the team and drew the following conclusion: "The probability of a fire occurring in this area is remote. The consequences of a fire in this area is small (some smoke in the auxiliary building). Detection by personnel and the alarm system would be rapid, and suppression should be rapid in this accessible location." The conclusions made by the licensee were not based on an analysis nor did the licensee specifically implement administrative controls which prohibited the use or storage of combustible material near the air intakes. Therefore, the team did not agree with the licensee's conclusions.

c. Conclusion

The team concluded that the FPL identification of system errors and deficiencies was appropriate. The team concluded that the licensee had numerous missed opportunities in correcting problems (e.g., MCR ceiling tiles, annunciator level) associated with the detection system. The team also concluded that the licensee failed to demonstrate that the system design deficiencies did not have an impact on the system's defense-in-depth ability to rapidly detect a fire. This is identified as an unresolved item: **Fire Mitigation System Does Not Meet Plant Licensing Basis Requirements/Commitments or Minimum Industry Codes and Standards for System Design and Testing (URI 50-335, 389/98-201-09).**

F7.4.2 Water Supplies

a. Inspection Scope

The team reviewed the fire protection water supply system during the inspection. The system consists of two independent 300,000-gallon water tanks and two electric motor-driven 2,500-gpm at 125 psig fire pumps. The pumps have independent power connections and are backed by the emergency diesel generators.

b. Observations and Findings

On March 31, 1998, the team reviewed the pump installation and supply headers. During the inspection of the fire protection system, the team noted excessive pressures on the preaction sprinkler systems: Valve 15860 (fan room preaction system) was reading 225 psig, Valve 15854 (cable loft preaction system) was reading 210 psig, and Valve B15874 (feedwater pumps) was reading 220 psig. The maximum working pressure allowed by NFPA 13 is 175 psig. On the basis of the team's observations, the licensee issued CR 98-0578.

During reviews in preparation for the FPFI, the licensee reviewed its fire protection water supply systems. The licensee issued CR 98-0431 for a non-code compliant issue with the fire pump installations.

c. Conclusion

The team concluded that the overall fire protection water supply delivery system appeared to be fully functional, with the exception of the code deviations identified concerning the fire pumps and the preaction system over pressurization identified by the team.

F7.4.3 Fixed/Automatic Fire Suppression

a. Inspection Scope

The team inspected the testing procedures for a preaction sprinkler system protecting a safety-related area to determine if the vendor's testing requirements were included in the site-specific program.

In licensing Amendment No. 33, dated August 17, 1979, Section 4.3.1.5, "Automatic Water Suppression Systems," indicates that "all the automatic water suppression systems conform to NFPA 13 or 15." The team reviewed the recently identified CRs on the water-based fire suppression systems.

b. Observations and Findings

The team reviewed "Surveillance of Fire Protection Sprinkler System for RAB and Diesel Generator Building," Procedure No. 2-1800057, Revision 5. Review of the procedure indicates that the trip tests are performed with the system isolation valve closed (i.e., the outside screw and yoke [OS&Y] valve directly upstream of the Grinnell A4 Multimatic deluge valve), and the clapper valve access cover removed. The valve, without water pressure, is visually checked to determine that the clapper is free to operate. This does not agree with the vendor's requirements for testing. In the Grinnell vendor manual for A4 Multimatic valve testing, Technical Data (TD) sheet TD 117G recommends "that the following wet (i.e., supply pressurized) trip test procedure be performed at least annually by a qualified Inspection Service." The vendor manual then continues to describe the detailed steps required for an acceptable test. Additionally, NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," 1995 edition, Section 9-4.3.2.2, states: "Each deluge or preaction valve shall be trip tested annually at full flow in warm weather and in accordance with the manufacturer's instructions."

During reviews in preparation for the FPFI, the licensee reviewed its water-based automatic suppression systems. The following CRs were identified:

- CR 98-0307: Non-code-compliant sprinkler systems installed in the diesel generator buildings.
- CR 98-0405: Non-code-compliant sprinkler systems installed in Units 1 and 2.
- CR 98-0429: Non-code-compliant water spray systems installed in Units 1 and 2.

c. Conclusion

The team concluded that the licensee's procedures for testing the preaction sprinkler system's deluge valve do not meet NFPA 25 or the vendor's requirements for testing and that the automatic water-based fire suppression systems do not meet minimum industry codes and standards, and in some cases, the plant's licensing basis. This is another example of unresolved item URI 50-335, 389/98-201-09.

F7.4.4 Total Flooding Gas Suppression System

a. Inspection Scope

The UFSAR comparison to Appendix A to BTP APCSB 9.5.1, Section E.4, identifies that a Halon 1301 automatic fire suppression system is installed to protect the Unit 1 cable spreading room (CSR) (Unit 2 CSR is protected with automatic sprinklers). Table 9.5A-2 identifies NFPA 12A, 1980 edition, as the Code of Record (COR).

b. Observations and Findings

The UFSAR states that the system is designed to provide a concentration of 5 to 7 percent for a minimum of 10 minutes. Review of the startup and test procedure TP-505 indicates that the system delivered and held more than 6 percent for 4 to 5 minutes and more than 5 percent for 11 to 12 minutes. This figure met the acceptance criteria of TP-505; however, it does not meet the criteria of NFPA 12A (1980). The COR provides the following requirements and guidance:

- Section 1-5.4, Duration of Protection -- It is important that an effective agent concentration not only be achieved but that it be maintained for a sufficient period of time to allow effective emergency action by trained personnel. This [requirement] is equally important in all classes of fires since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch or "deep-seated" fire) can lead to a recurrence of the initial event once the agent has dissipated.

- Section 2-2.1.4 -- Deep-seated fires may become established beneath the surface of fibrous or particulate material. This [condition] may result from flaming combustion at the surface or from the ignition within the mass of fuel. Smoldering combustion then progresses slowly through the mass. A fire of this kind is referred to in this standard as a "deep-seated" fire. The burning rate of these fires can be reduced by the presence of Halon 1301, and they may be extinguished if a high concentration can be maintained for an adequate soaking time. However, it is not normally practical to maintain a sufficient concentration of Halon 1301 for a sufficient time to extinguish deep-seated fires.

- Section 2-4.3 -- It is usually difficult or impractical to maintain an adequate concentration for a sufficient time to ensure the complete extinction of a deep-seated fire (see [Section] A-2-4).

- Section A-2-1 -- For deep-seated fires, the critical concentration required for extinguishment is less definite, and has in general been established by practical test work.

- Section A-2-4 -- Deep-seated fires usually require much higher concentrations than 10 percent and much longer soaking time than 10 min .... To date, no firm basis has been developed to predict the agent requirements for a deep-seated fire. In a practical sense, however, the use of a Halon 1301 system for control or extinguishment of a deep-seated fire is usually unattractive. Long soaking times are usually difficult to maintain without an extended agent discharge, and at high agent concentrations, these systems become rather expensive. The use of Halon 1301 systems will generally be limited to solid combustibles, which do not become deep-seated.

Before the start of the FPFI, the licensee performed "reviews in preparation for the fire protection functional inspection" of fire protection systems and features. In the course of reviewing the Unit 1 CSR Halon system, the licensee identified deficiencies in the system and issued CR 98-0131. The CR identifies the following problems:

(1) Preventive maintenance for dampers FDPR-25-117/118/119, which are required to close to allow automatic system actuation, may not satisfy all FSAR testing requirements.

(2) Preventive maintenance for doors RA-41,44,46,308, and 320, which are required to close to allow automatic system actuation, may not satisfy all FSAR testing requirements.

The CR did not address the NFPA 12A criteria discussed above (NFPA 12A Sections 1-5.4, 2-21.4, 2-4.3, A-2-1 and A-2-4) regarding the minimum concentrations and soak times necessary for extinguishment of deep-seated electrical cable fires. Section A-2-1 specifically recommends that appropriate testing be performed to properly address the hazard. In 1986, the NRC commissioned Sandia National Laboratories to perform research on the question of effectiveness of fire suppressants on electrical cable fires. The results of this work were published in NUREG/CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fires." Table 6 of the report states that for exposure fires, the minimum soak time required for a 6 percent concentration of Halon 1301 was 10 minutes for IEEE-383 qualified cables and 16 minutes for unqualified cables in the horizontal position. Table 10 of the report states that for fully developed fires, the minimum soak time required for a 6 percent concentration of Halon 1301 was 15 minutes for IEEE-383 Qualified cables and 10 minutes for Unqualified cables in the horizontal position.

c. <u>Conclusion</u>

The team concluded that, as a result of the licensee's recent self-assessment, problems were discovered with the Unit 1 CSR Halon 1301 system However, the question of the minimum required concentration (6 percent) and the minimum soak time (16 minutes) had not been addressed in the CR. The licensee currently considers the system to be in an "operable" status. On the basis of the preceding discussion, the licensee could not produce design-basis tests for the concentrations and soak times of the system or demonstrate operability to the inspectors. The team also considers this system to be limited in its ability to mitigate a fire since the system is not designed to extinguish the expected hazard (i.e., a "deep- seated" cable fire). This is identified as another example of unresolved item URI 50-335, 389/98-201-09.

F7.4.5 Hose Stations and Standpipes

a. Inspection Scope

UFSAR Section 3.2, Standpipes and Hose Stations, identifies NFPA 14 as the design basis for the system. Table 9.5A-2 identifies the 1973 edition of NFPA 14 as the COR. Review of the Unit 1 UFSAR indicates that the standpipe hose stations are provided at approximately 100-foot spacings in the plant and "are located so that any area containing essential equipment or components can be reached with an effective stream of water." Because of the minimal use of automatic suppression systems in Unit 1, the UFSAR further states: "All areas of the plant are accessible from two or more hose stations which are located throughout the plant both inside and outside of buildings."

b. Observations and Findings

Before the start of the FPFI, the licensee performed an internal self-assessment of fire protection systems and features. In the course of reviewing the standpipe and hose stations, the licensee identified deficiencies in the system and issued CR 98-0180. The CR identifies the following problems:

(1) The original system design did not identify the class of service of the system. NFPA 14, Section 12, defines three classes of service: Class I - For use by fire department and those trained in handling heavy fire streams (2 ½-inch hose), Class II - For use primarily by the building occupants until the arrival of the fire department (small hose), and Class III - For use by either fire departments and those trained in handling heavy hose streams or by the building occupants.

(2) The current number and location of standpipe hose stations do not provide adequate coverage for the plant (i.e., not all areas can be reached with a maximum 100 feet of hose and a 30-foot hose stream.) Deficiencies were discovered in the Unit 1 MCR, the Unit 1 and Unit 2 reactor containment buildings, the Unit 1 and Unit 2 fuel handling buildings, the Unit 1 and Unit 2 auxiliary buildings, the turbine building, and the steam trestle.

(3) Hose stations located on the turbine deck are obstructed by feedwater heaters.

(4) There are additional COR compliance issues such as the number and location of system isolation valves and installation of system pressure gages.

The CR did not address the UFSAR requirement that "two or more" hose stations are available for all areas of the plant.

c. Conclusion

As a result of the licensee's recent self-assessment, the team discovered problems with the standpipe and hose stations. All areas of the plant are required to be accessible from two or more hose stations, which are located throughout the plant both inside and outside buildings. This issue has not been addressed by the licensee and is considered a significant design limitation since the "primary protection" hose stations have been determined to possess certain design weaknesses. This brings into question the ability of the "backup" hose station (i.e., second hose station) to provide adequate coverage. Furthermore, the determination that the system is for Class II service may be incorrect since the standpipe and hose stations provide both "primary" and "backup" fire suppression for both the building occupants and the fire department. This is identified as another example of unresolved item URI 50-335, 389/98-201-09.

F7.4.6 Passive Fire Protection Features

a. Inspection Scope

License Amendment No. 33, dated August 17, 1979, Section 4.9, "Fire Barrier Penetrations," notes the penetration requirements for the plant. Section 4.3.9, "Electrical Cable Penetrations," specifies that the cable penetrations are rated for 3 hours when tested in accordance with ASTM Standard E119-73.

b. Observations and Findings

The licensee had previously identified an anomaly with the installation of the cable tray penetration seals and issued CR 97-1278 and LER 97-004-00. The anomaly involves the installation of ceramic fiber between the cables as was qualified in the original testing. As a part of the required testing for the new CF-SM Fire Barrier System (see Section F7.3.4), FPL will be testing "as installed" (i.e., without the ceramic fiber material installed between the cables) and "modified" versions of the cable tray penetration seal. The cable penetrations assemblies will be a part of a larger CF-SM fire barrier system and will be tested concurrently in the same test assembly. Details of the proposed test plan may be found in Test Plan Report PSL-FPER-98-008, "Fire Endurance Tests of a Wall/Ceiling Assembly Protected with a Ceramic Fiber & Sheet Metal Fire Barrier System." The preliminary test plan was reviewed and discussed with the licensee during the inspection. The main area of concern was Section 7.3, "Raceway & Fill," which describes the type of cables and percent fill in wireways and cable trays. Although the largest percentage of fill will be used, the largest cables (1000 MCM) were not included. The licensee agreed and will revise the test plan to be more representative of the actually installed plant configurations.

c. Conclusion

At the time of inspection, the licensee had not tested a proposed cable tray penetration seal assembly. The fire test is currently scheduled for the third quarter of 1998. The acceptability of this proposed fire resistive assembly as a 3-hour fire barrier penetration seal will be reviewed during a subsequent NRC inspection.

F7.4.7 Reactor Coolant Pump (RCP) Oil Collection Systems

a. Inspection Scope

The oil collection system for the RCPs, was reviewed for compliance with the requirements of 10 CFR Part 50, Appendix R, Section III.O.

b. Observations and Findings

On May 2 and May 29, 1997, respectively, the licensee made a 1-hour notification to the NRC per 10 CFR 50.72 and submitted LER 97-0007, noting that the oil collection systems installed for the lubrication systems to the RCP motors were outside of the facility's design basis. The licensee concluded that RCP oil collection system for both units may not meet NRC fire protection requirements per 10 CFR Part 50, Appendix R, Section III.0. This system did not meet the requirements of 10 CFR Part 50 Appendix R, Section III.O because two leakage points from the RCP motor lubrication system were not being collected by the oil collection system. The licensee also issued CRs 97-0703 and 97-0897 to document these conditions. These leakage points were at unpressurized instrument penetration locations in the lubrication systems (RCP top hat) above the normal operating level of the oil reservoirs and low-pressure RCP shaft seal in the lower motor lube oil reservoir area. FPL concluded that any leakage from these low-pressure areas would not be in large enough quantities to sustain a fire and the potential for a fire resulting from minor oil leakage from the low-pressure areas was not credible. The oil collection system was evaluated by the licensee and determined to be operable, based on the limited potential leakage and extremely small likelihood of a fire. The licensee developed and implemented plant modification packages PC/M 97-025 and 97-043, "RCP Oil Collection System Modification," to correct the discrepancy for Units 1 and 2.

The team reviewed the CRs, UFSAR Section 9.5A, the licensee's Fire Protection Plan requirements, RCP oil collection system modification packages, and other related documentation.

The RCP oil collection tank did not have a level alarm. The tank had a liquid-level gauge inside the containment behind the biological shield (to permit access at power) to provide local indication of oil in the tank. Loss of oil from the RCP motor lubrication systems would be detected by the RCP motor oil reservoir high/low-level alarm. If the oil level in the oil reservoir of any RCP motor reached 2 inches above or below the normal level (equivalent to about 6 gallons of oil), an alarm would be received in the control room. A low level in the RCP motor oil reservoir would prompt a containment entry to check the level of the RCP oil collection system tank. The tank is also checked during post-outage pre-startup per PSL Procedure ½-0030120, "Restart Checkoff List," to verify that the tank is empty and the level instrumentation is operable. The inspectors reviewed these procedures, interviewed Operations personnel, and concluded that sufficient procedural guidance was provided to verify that the RCP oil collection tank is normally maintained empty and that the plant operators can identify an oil leak from the lubrication system of one of the RCP motors and take appropriate action.

Since both units were operating at power during the inspection period, the team was unable to observe the RCP oil collection system's installation following completion of the modifications to determine conformance to the design requirements.

The team concluded that the original oil collection system should have caught and collected any major oil leak from the lubrication system, and the modifications made to the oil collection system should collect any potential leakage from the identified low-pressure locations.

The failure to provide an oil collection system capable of catching and collecting all potential points of oil leakage from the lubrication system for each RCP motor does not

meet the requirements of 10 CFR Part 50, Appendix R, Section III.O; however, this issue was identified by the licensee and appropriate action was initiated to correct this problem during the earliest available refueling outages, i.e., Spring 1997 for Unit 2 and Fall 1997 for Unit 1.

c. Conclusions

The licensee discovered that the oil collection system for reactor coolant pumps was not catching and collecting oil leaking from the RCP motor's lubrication system as required by 10 CFR Part 50, Appendix R, Section III.O. This failure is identified as another example of unresolved item URI 50-335, 389/98-201-07.

F7.5 Emergency Lighting and Communications

a. Inspection Scope

Section III.J of Appendix R to 10 CFR Part 50 requires emergency lighting units having at least an 8-hour battery supply to be provided in all areas needed for operation of shutdown equipment and in access and egress routes thereto. Additionally, to meet the guidance of Appendix A to BTP APCSB 9.5-1 for fixed emergency communications to be available, FPL has committed to ensure the availability of the voice-powered communications system. As part of the assessment of the plant's ability to achieve and maintain post-fire safe-shutdown conditions, the team asked the licensee to submit documentation demonstrating that communications and emergency lighting were available to support post-fire safe-shutdown operations.

b. Observations and Findings

During plant walkdowns, the team focused on the adequacy of both emergency lighting and communications, whereby manual actions are required to support safe-shutdown. Isolation of the steam generator closed blowdown system requires an operator to manually close four valves located on the roof of the RAB. The team found no emergency lighting or sound-powered communications at this location. There was also no emergency lighting provided for the stairwell leading to this area. Additionally, outdoor equipment locations (particularly in the turbine building areas) requiring manual operator actions, were not provided with emergency lighting or sound- powered phone capability. For alternative shutdown areas (fire in the main control room and cable spreading room), the sound-powered phone system must be isolated to remain functional. A manual operation of this isolation switch is required, but the switch is located in the cable spreading room. Therefore, if a fire was in the cable spreading room, the sound-powered phone system could be damaged by the fire and rendered inoperable.

c. Conclusions

As part of its ongoing SSA revalidation effort, the licensee had issued CRs identifying deficiencies in emergency lighting (CR 98-0135) and communications (CR 98-0179) described above. These conditions associated with emergency lighting and communications are identified as another example of unresolved item URI 50-335, 389/98-201-07.

F7.6 Individual Plant Examination of External Events Fire Risk Analysis

a. Inspection Scope

The Individual plant examination of external events (IPEEE) inspection focused on the assumptions noted in the IPEEE for Unit 1, and on cases in which inspection insights conflicted with the credit given for fire protection features.

b. Observations and Findings

Partial and/or complete Thermo-Lag walls rated at 1 hour 48 minutes serve as barriers for the following two significant pairs of fire areas: (1) common area consisting of cable loft A, battery room A, and switchgear room A, and the common area consisting of switchgear room B and battery room B; and (2) the cable spreading room and common area consisting of the switchgear room B and remote shutdown panel B. In each of these areas, the ignition frequency is significant (i.e., 7E-3 per reactor year to 2E-2 per reactor year).

On the basis of the ignition frequencies and the combustible loading in these areas, the Thermo-Lag walls are considered to be important because they provide primary fire barrier separation between redundant trains of post-fire safe shutdown equipment. Under the conditions of a severe fire, there is a possibility that the Thermo-Lag wall could fail, and the equipment in both rooms could be fire damaged. Even though a fire of such severity is unlikely, it is possible that it could occur in areas where ignition sources and cables are present. A significant amount of cables exists in the cable spreading room and in cable loft A, which is part of switchgear area A. Therefore, the team views this reduction in the fire rating for these walls as non-conservative and that this non-conservatism may contribute to a increase in risk due to fire.

Manual suppression is credited in control room fires. However, CR-98-0180 indicates that "hose lengths may not be adequate (and may have to be extended) for use during a Unit 1 control room fire."

Barrier reliability of 100 percent was credited for all barriers considered worthy in the IPEEE. This includes the Thermo-Lag barriers discussed above, all other Appendix R barriers, and some non-Appendix R barriers. Impairment records since December 1995 for selected barriers RA-308, RA-316, RA-47, and T-4 revealed that impairment requests lasting from days to weeks were issued for this set of doors. No indication of actual unavailability is made in the impairment records.

c. Conclusion

On the basis of a review of the IPEEE, actual plant experience, and existing plant conditions, the team concluded that the credit (100% fire barrier reliability) taken by the IPEEE was non-conservative. One-hundred percent fire barrier reliability is inaccurate assumption (e.g., fire barrier impairment records demonstrate inoperable conditions). In addition, the team concluded that the credit taken by the IPEEE for manual suppression was non-conservative, because of inadequate hose station coverage.

V. Management Meeting

X1 Exit Meeting Summary

The inspectors presented the inspection results to members of licensee management at the conclusion of the inspection on April 3, 1998. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel-Florida Power and Light

Name	Title
J. Arpa	Principal Engineer
C. Bible	Engineering Manager
W. Bladow	QA/QC Supervisor
R. Church	Engineering Department Training Coordinator
R. De La Espriella	QA Manager
J. DiVentura	Documentation Lead
B. Faubert	Lead Electrical Engineer
J. Hoffman	FPFI Lead Project Engineer
R. Jennings	Nuclear Engineer
J. Kabadi	Engineering Supervisor
R. Kundalkar	Engineering Vice President
J. Marchese	Maintenance
B. McDaniel	Fire Protection Supervisor
T. Quillen	Licensing
V. Rubano	Lead Mechanical Engineer
J. Sandy	Operations Lead
B. Sandel	Fire Training Coordinator
J. Scarola	Plant General Manager
J. Stall	Site Vice President
E. Weinkamp	Licensing Manager
K. Williams	Fire Protection Engineer
C. Wood	Work Control Manager

NRC

G. Belisle	Chief, Special Inspections Branch, Region II
R. Deem	Reactor Systems Engineer, BNL
J.S. Hyslop	PRA/IPEEE Analyst, SPSB/DSSA/NRR
J. Jaudon	Director, Division of Reactor Safety, Region II
P. Madden	Team Leader, FPES/SPLB/DSSA/NRR
L. Marsh	Chief, Plant Systems Branch, DSSA/NRR
M. Salley,	Fire Protection Engineer, FPES/SPLB/DSSA/NRR
K. Sullivan	Electrical Engineer, BNL
G. Wiseman	Fire Protection Inspector, Region II

LIST OF ACRONYMS USED

ADM	Administrative
ADV	Atmospheric Dump Valve
AFFF	Aqueous Film Forming Foam
AFW	Auxiliary Feed Water
AP	Administrative Procedure
APCSB	Auxiliary Power Conversion Systems Branch
ASTM	American Society of Testing Materials
BAMT	Boric Acid Makeup Tank
BTP	Branch Technical Position
BNL	Brookhaven National Laboratory
CARS	Cable and Raceway Data Management System
CCW	Component Cooling Water
CF-SM	Ceramic Fiber and Sheet Metal
CFR	Code of Federal Regulations
CLB	Current Licensing Basis
COR	Code of Record
CP	Charging Pump
CP&L	Carolina Power and Light
CR	Condition Report
CSR	Cable Spreading Room
CST	Condensate Storage Tank
CVCS	Chemical Volume and Control System
DSSA	Division of Systems Safety and Analysis
EDSFI	Electrical Distribution System Functional Inspection
ECCS	Emergency Core Cooling System
EEL	Essential Equipment List
ERFBS	Electrical Raceway Fire Barrier System
ELU	Emergency Lighting Unit
EOP	Emergency Operating Procedures
FHA	Fire Hazards Analysis
FM	Factory Mutual
FACP	Fire Alarm Control Panel
FPES	Fire Protection Engineering Section
FPER	Fire Protection Engineer Review
FPFI	Fire Protection Functional Inspection
FPL	Florida Power and Light
GDC	General Design Criterion
GL	Generic Letter
GMP	General Maintenance Procedure
gpm	Gallons Per Minute
HVAC	Heating Ventilating and Air Conditioning
HP	Health Physics
HSCP	Hot Shutdown Control Panel
I&C	Instrumentation and Control

LIST OF ACRONYMS USED - Continued

ICW	Intake Cooling Water
IEEE	Institute of Electrical and Electronic Engineers
IFI	Inspector Follow-up Item
IOM	Installation and Operation Manual
IN	Information Notice
IPEEE	Individual Plant Examination of External Events
ITR	Independent Technical Review
JPM	Job Performance Measure
LER	Licensee Event Report
LCO	Limiting Condition for Operation
LOCA	Loss of Coolant Accident
LOOP	Loss of Offsite Power
LPSI	Low Pressure Safety Injection
MCC	Motor Control Center
MCR	Main Control Room
MHIF	Multiple High Impedance Faults
MOV	Motor-Operated Valve
MS	Main Steam
MSIV	Main Steam Isolation Valve
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NOP	Normal Operating Procedure
NPP	Nuclear power Plant
NPSH	Net positive suction head
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
ONOP	Off-Normal Operating Procedure
OSHA	Occupational Safety and Health Administration
P&ID	Pipe and Instrument Diagram
PM	Preventative Maintenance
PMAI	Plant Manager Action Item
PORV	Power Operated Relief Valve
PRA	Probabilistic Risk Assessment
psi	pounds per square inch
psig	pounds per square inch gauge
PSL	Plant St. Lucie
QA	Quality Assurance
QC	Quality Control
RAB	Reactor Auxiliary Building
RES	Radiant Energy Heat Shield
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RCSGV	Reactor Coolant System Gas Vent System

LIST OF ACRONYMS USED - Continued

RG	Regulatory Guide
RHR	Residual Heat Removal
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RTD	Remote Thermal Detector
RWT	Refueling Water Tank
SCBA	Self-Contained Breathing Apparatus
SDC	Shutdown Cooling
SER	Safety Evaluation Report
SPLB	Plant Systems Branch
SPSB	Probabilistic Safety Assessment Branch
SRV	Safety Relief Valve
SSA	Safe-shutdown Analysis
STAR	St. Lucie Action Report
TS	Technical Specifications
TVA	Tennessee Valley Authority
UFSAR	Updated Final Safety Analysis Report
UL	Underwriters Laboratories, Inc.
URI	Unresolved Item
VCT	Volume Control Tank

INSPECTION PROCEDURES USED

IP 64100 Post-fire Safe-shutdown, Emergency Lighting and Oil Collection Capability at Operating an Near-term Operating Reactor Facilities

IP 64150 Triennial Post-fire Safe-shutdown Capability Reverification

IP 64704 Fire Protection Program

TIXXXX Fire Protection Functional Inspections

ITEMS OPENED, CLOSED, AND DISCUSSED

This report categorizes the inspection findings as unresolved items in or inspector followup items (IFI) accordance with the NRC Inspection Manual, Manual Chapter 0610. An unresolved item (URI) is a matter about which additional information is required to determine whether the issue in question is an acceptable item, a deviation, a nonconformance, or a violation. The NRC Region II office will issue any enforcement action resulting from its review of the URIs.

Opened/Discussed

URI 50-335, 389/98-201-01	Failure to Follow Combustible Control Procedures to Manage the Use and Temporary Storage of Transient Combustibles in Safety-related Areas (see Section F1.1).
IFI 50-335, 389/98-201-01	Review of Licensee Support of Fire Brigade Operations (see Section F2.1.1)
URI 50-335, 389/98-201-02	Failure of the Fire Hose Station Surveillance Program to Confirm Hose Station Coverage in Accordance with Requirements of the UFSAR (see Section F2.2)
URI 50-335, 389/98-201-03	Failure to Update the Fire Fighting Strategies to Reflect the Requirements of the Approved Fire Protection Program and 10 CFR Part 50, Appendix R (see Section F3.1)
URI 50-335, 389/98-201-04	Failure to Perform Fire Brigade Drills in Accordance with the Requirements of the Approved Fire Protection Program and 10 CFR Part 50, Appendix R (see Section F3.3)
URI 50-335, 389/98-201-05	Failure of the Fire Protection Plan to Address Appendix R Post Fire Safe-Shutdown Capability (see Section F5.1)
URI 50-335, 389/98-201-06	Failure to Conduct Timely Corrective Action for Identified Post-Fire Safe-Shutdown Procedural Deficiencies (see Report Section F6.3)
URI 50-335, 389/98-201-07	Failure of the Fire Protection Program and the Post-Fire Safe-Shutdown Analysis to Demonstrate Compliance with Appendix R to 10 CFR Part 50 (see Sections F7.1.1, F7.1.2, F7.1.5, F7.4.7, and F7.5)
URI 50-335, 389/98-201-08	Fire Barriers Not Qualified to Meet Plant Licensing Basis Requirements (see Section F7.3.1)
URI 50-335, 389/98-201-09	Fire Mitigation System Does not Meet Plant Licensing Basis Requirements/Commitments or Minimum Industry Codes and Standards for Systems Design and Testing (see Sections F7.4.1, F7.4.3, F7.4.4, and F7.4.5)