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NATIONAL LABORATORY

Building 130

July 11, 2001

Ms. R. Nease
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011

Reference: Triennial Fire Protection Baseline Inspection, Arkansas Nuclear One, Unit 1.
Inspection Report No.: 50-313/01-06

Dear Ms. Nease:

The enclosed technical letter report (TLR) describes the results of my activities during the Triennial Fire Protection Baseline Inspection performed at Unit 1 of the Arkansas Nuclear One Nuclear Power Station (ANO-1). The inspection effort focused on an assessment of the adequacy of fire protection features provided for five specific fire zones that, based on the inspection team's review of the licensee's IPEEE submittal and fire protection program documentation, were determined to have fire-risk significance. The specific fire zones selected for review included:

1. Fire Zone 197-X (Turbine Building) located in Fire Area B
2. Fire Zone 97-R (Cable Spreading Room) located in Fire Area G
3. Fire Zone 98-J (Emergency Diesel Generator Corridor) located in Fire Area I
4. Fire Zone 99-M (North Switchgear Room) located in Fire Area I
5. Fire Zone 34-Y (Pipe Penetration Room) located in Fire Area C

As described in the Inspection Plan, dated June 5, 2001, my primary area of responsibility was to assess the adequacy of the licensee's Post-fire Safe Shutdown Circuit Analysis. As you are aware, however, the specific activities and assignments delineated in the Inspection Plan were modified to meet the needs of this inspection. As a result, inspection assistance was also provided in the following areas: Systems Required to Achieve and Maintain Post-fire Safe Shutdown, and Alternative Shutdown Capability. The results of my review of each of these areas are discussed in the attached report.

It was a pleasure to work with you and other members of the inspection team. Please do not hesitate to contact me at 631-344-7915 if you have any additional questions.

Sincerely,

Kenneth Sullivan,
Nuclear & Infrastructure System Division
Energy Sciences & Technology Department

cc: J. Higgins
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Energy Sciences & Technology Department

Report Input to U.S. Nuclear Regulatory Commission Region IV

Triennial Fire Protection Baseline Inspection of Arkansas Nuclear One Power Station Unit 1

(JCN: J-2843 Task 4)

Licensee:	Entergy Operations	
Facility:	Arkansas Nuclear One, Unit 1	
NRC Inspection Report No.:	50-313/01-06	
Inspection Conducted:	June 11 - 15, 2001 and June 18 - 22, 2001	
NRC Inspectors:	R. Nease	Region IV (Team Leader)
	R. Mullikin	Region IV
	C. Johnson	Region IV

BNL Technical Specialist:

~~K. Sullivan~~ ~~Date~~

Introduction

The inspection effort focused on an assessment of the adequacy of fire protection features provided for five specific fire zones that, based on the inspection team's review of the licensee's IPEEE submittal and fire protection program documentation, were determined to have fire-risk significance. The specific fire zones selected for review included:

6. Fire Zone 197-X (Turbine Building) located in Fire Area B
7. Fire Zone 97-R (Cable Spreading Room) located in Fire Area G
8. Fire Zone 98-J (Emergency Diesel Generator Corridor) located in Fire Area I
9. Fire Zone 99-M (North Switchgear Room) located in Fire Area I
10. Fire Zone 34-Y (Pipe Penetration Room) located in Fire Area C

1.0 Systems Required to Achieve and Maintain Post-fire Safe Shutdown

a. Inspection Scope

For the selected fire areas, the inspection team evaluated the licensee's post-fire safe shutdown methodology to determine if systems and components required to achieve and maintain safe shutdown conditions had been properly identified.

b. 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.
- 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 above 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 above 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 so that repair of the systems necessary to achieve and maintain cold shutdown conditions, from either the control room or emergency control station(s), can be completed within 72 hours.

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 containment and primary coolant system pressure boundary must be maintained.

The following paragraphs provide a detailed evaluation of the licensee's approach to meet the above post-fire safe shutdown performance goals, as referenced in the licensee's Fire Hazard Analysis (FHA), Revision 6, dated April 10, 2000.

Reactivity Control Function

The reactivity control function is required to maintain the reactor core in subcritical conditions (Keff < 0.99) from reactor trip through cold shutdown. This requires compensating for any positive reactivity increases due to Xenon decay, Reactor Coolant System (RCS) cooldown, or any boron dilution in the RCS. Initial reactivity control will be provided by operator initiation of a reactor manual trip from the control room . The reactor may also be tripped from outside the main control by operator action to trip the control rod drive (CRD) feeder breakers. Monitoring reactivity may be accomplished by using either the neutron flux instrumentation provided in the control room or at the Safety Parameter Display System (SPDS) display located in the Technical Support Center (TSC). Additional boration necessary to assure greater than 1% shutdown margin during cooldown and subsequent xenon decay will be provided by intermittent operation of the Makeup/High Pressure Injection Pumps (HPI) pumps drawing suction from the Borated Water Storage Tank (BWST). 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

During a post-fire shutdown, RCS inventory and pressure will be controlled by isolating all potential leakage paths and intermittently operating the HPI pumps. RCS pressure reduction and cooldown is accommodated by intermittent operation of the Electromatic Relief Valve (ERV). If all leakage paths are isolated, RCS makeup will only be needed to offset inventory shrinkage resulting during cooldown and to provide sufficient boration to assure greater than 1% shutdown margin. Steam generator overcooling pathways will be controlled to regulate RCS inventory shrinkage by tripping the main feedwater pumps, controlling Emergency Feedwater (EFW) flow, closing the Main Steam Isolation Valves (MSIVs), tripping and verifying tripped the main turbine, and controlling the Atmospheric Dump Valves (ADVs).

Decay Heat Removal and Secondary Side Pressure and Level Control

Following a reactor scram, decay heat will be removed from the reactor via the steam generators by natural circulation cooldown. 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 off-site power. During natural circulation, adequate primary to secondary heat transfer, RCS subcooling, and make-up inventory must be maintained. The Emergency Feedwater (EFW) system is required to control steam generator inventory discharged as steam from the safety relief valves and the ADVs. The EFW system consists of one motor-driven pump (P7B) and one turbine-driven pump (P7A). The pumps are interconnected to permit supply of emergency feedwater from either or both of the pumps. The condensate storage tank (CST) serves as the initial source of secondary water to the EFW system. The Service water (SW) system serves as a backup source of water to the CST. Steam released from the steam generators will be controlled by the ADVs and/or the mechanical safety relief valves. Controlled operation of the ADVs will be utilized to achieve the desired RCS cooldown rate.

Process Monitoring

The following process monitoring instrumentation is available in the control room and on the SPDS "Alternate Shutdown" display located in the TSC:

- Source Range Flux
- RCS Pressure
- RCS Hot and Cold Leg Temperatures
- Steam Generator Level
- Steam Generator Pressure
- Pressurizer Level
- CST 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 and RCS subcooling margin.

At ANO the Safety Parameter Display System (SPDS) is designed and configured to provide an assured indication of the above listed process monitoring functions in the event of fire requiring control room evacuation and implementation of an alternative shutdown capability. In addition, the following local indicators are available:

- P7A EFW Pump Discharge Pressure
- Main Steam Line Pressure
- Decay Heat Pump Suction Temperature
- Steam Generator Pressure (at ADV area)
- CST (T41) Level

Support Systems

The systems and equipment used to achieve the safe shutdown functions require miscellaneous supporting functions, such as ac/dc power, lubrication, and process cooling. The support systems required to maintain acceptable performance of the safe shutdown equipment are:

- Service Water System
- Emergency Diesel Generators
- Diesel Fuel Oil Transfer System
- Emergency (Engineered Safeguards) AC Power Distribution System
- Uninterruptible DC Power Distribution System
- Emergency Lighting
- Radio Communications
- SPDS

Cold Shutdown

The reactor coolant system temperature and pressure will be reduced by natural circulation cooldown using the ADVs and the EFW system as described above. Once the RCS temperature has been reduced to less than 280° F, the RCS will be depressurized and the Decay Heat Removal (DHR) System initiated. The DHR system will be used to reduce RCS temperature to 200° F and maintain cold shutdown.

c. Conclusions

No findings of risk significance were identified.

2. Fire Protection of Safe Shutdown Capability
(Reviewed by other inspection team members)

3. Post-fire Safe Shutdown Circuit Analysis

a. Inspection Scope

On a sample basis, an evaluation was performed to verify that cables of equipment required to achieve and maintain hot shutdown conditions in the event of fire in selected fire zones had been properly identified and either adequately protected from the potentially adverse effects of fire damage or analyzed to show that fire-induced faults (e.g., hot shorts, open circuits, and shorts to ground) would not prevent safe shutdown. During the inspection a sample of redundant components associated with systems required to achieve and maintain hot shutdown conditions were selected for review. The sample included components of the EFW, RCS Makeup, and Service Water systems. From this list of components ANO cable routing data (PDMS cable database output) depicting the routing of power and control cables associated with each of the selected components was reviewed. Additionally, on a sample basis the team verified the adequacy of electrical protective device (e.g., circuit breaker, fuse, relay) coordination and the adequacy of electrical protection provided for non-essential cables which share a common enclosure (raceway, junction box, conduit, etc.) with cables of equipment required to achieve and maintain safe shutdown conditions.

b. Findings

10 CFR 50.48, "Fire Protection," and Appendix R to 10 CFR 50, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979" establish specific fire protection features required to satisfy General Design Criterion 3, "Fire Protection" (GDC 3, Appendix A to 10 CFR 50). Section III.G of Appendix R requires fire protection for equipment important to safe shutdown. An acceptable level of fire protection may be achieved by various combinations of fire protection features (barriers, fire suppression systems, fire detectors, and spatial separation of safety trains) delineated in Section III.G.2. For areas of the plant where compliance with the technical requirements of Section III.G.2 can not be achieved, licensee's must either seek an exemption from the specific requirement(s) or provide an alternative shutdown capability in accordance with Section III.G.3 of the regulation. The objective of this protection is to assure that one train of equipment needed for hot shutdown would be undamaged by fire and that systems needed for cold shutdown could be repaired within 72 hours.

By letter dated March 22, 1983, the NRC staff issued its Safety Evaluation (SE) of the licensee's request for an exemption from the technical requirements of Section III.G of Appendix R for various Unit 1 fire zones including fire zone 98J. With regard to Fire Zone 98J (Corridor, Elevation 372') the SE states:

> *"The licensee has indicated that enclosure of the corridor A-Train conduits in a one-hour rated fire barrier and separation of the D.C. Equipment Room from the corridor will be provided. With these modifications, the area will comply with Section III.G of Appendix R, and no exemption is needed."*

By letter dated August 27, 1978, the NRC staff issued a Safety Evaluation (SE) describing fire protection at Unit 1 ANO. In its evaluation of Switchgear Room fire zones (Fire Zone 99M) the staff states:

> *"The licensee has proposed to provide fire retardant board or blanket barriers to prevent fire from involving redundant cables required for safe shutdown in each of the switchgear rooms"* (emphasis added).

By letter dated May 13, 1983, the NRC staff issued a Safety Evaluation (SE) on the safe shutdown capability of ANO Units 1 and 2. This SE evaluated the safe shutdown capability of both units against the requirements of Sections III.G and III.L of Appendix R to 10 CFR 50. With regard to areas of the plant not requiring an alternative shutdown capability (i.e., areas other than the main control room and cable spreading room) Section C of the SE states:

> *"All other areas of the plant not required to have alternative safe shutdown will comply with the requirements of Section III.G.2 of Appendix R, unless an exemption request has been approved by the staff."*

Contrary to the above, the inspection team determined that cables of redundant trains of equipment required for hot shutdown were found to be susceptible to damage in the event of fire in Fire Zones 99J (Emergency Diesel Generator Access Corridor) or 99M (North Switchgear Room). On a sample basis, the inspection team selected redundant components of potentially fire-risk significant systems. The specific systems selected for review include EFW, RCS Makeup, and Service Water. From a review of cable routing information for selected components of these systems, it was determined that an unmitigated fire in Fire Zones 98J or 99M had the potential to adversely affect the operability of redundant trains of components credited in the licensee's FHA for achieving and maintaining hot shutdown conditions. Specific examples for each fire zone are outlined below. It should be noted that this list is not all inclusive.

Fire Zone 98J, EDG Access Corridor

- Control cables associated with redundant Emergency Diesel Generators (EDGs K4A and K4B).
- Control cables of redundant EDG lockout relays (actuation would not preclude a manual start of the EDG but would prevent a normal local start at the EDG control panel and require additional operator actions to bypass).
- EDG Output breakers (both trains) - damage to control cables could lead to a loss of both EDG power supply trains.
- Service Water (SW) to EDG Jacket Cooler valves (CV 3806 and CV 3807)- control cable damage could prevent automatic opening of these normally closed valves upon EDG start. This occurrence (EDG start without SW) would require operators to trip EDGs and enter a SBO condition to prevent mechanical damage to EDG.
- Control cables associated with Redundant EFW pumps P7A and P7B
- EFW system valves - control cable damage may result in a loss of EFW flow to both Steam Generators.
- EFW Pump P7B Suction Valves (CV2800, 2803, 3850) - fire damage to control cables could cause spurious closure leading to pump damage on loss of suction.
- Redundant Turbine-driven EFW pump steam supply valves - Fire damage to control cables could cause the valves to spuriously close resulting in a loss of motive steam to the TDEFW Pump.
- Fire damage to redundant control cables of Makeup Pumps (P36A, B and C) could result in loss of operability from the main control room.

- Steam Generator Dump Valves and Block Valves - (CV 2668/CV2676 [SG-A] and CV2618/CV2619[SG-B]). Fire damage to control cables could cause loss of relief function or loss of relief control.
- Damage to control cables of CV-3643 may result in a diversion of Service Water flow to the Auxiliary Cooling Water flow-path.
- Pressurizer ERV and ERV Block valves (PSV-1000 and CV-1000) - Control cable damage may cause loss of controlled pressure relief - It should be noted that per the pre-fire plan for this area, the ERV (PSV 1000) is normally closed and affected cables will not cause spurious opening.
- Control cables associated with the three redundant Service Water Pumps, P4A, B, and C.

Fire Zone 99M, North Switchgear Room

- Redundant Service Water Pumps, P4A (Control cables), P4B (Power and Control cables) and P4C (Power and control cables)- loss of operability due to cable damage may require a trip of operating EDGs to prevent mechanical damage due to loss of SW cooling. It should be noted that the potential for fire to cause a LOOP has not been analyzed by ANO. Rather, the ANO FHA assumes off-site power is unavailable for all fire zones . Tripping EDGs would place the plant in an SBO condition.
- EDG Output breakers (both trains) - Potential for loss of both EDG power supply trains. EDG K4B output breaker is located in this zone. Control cables for redundant EDG (K4A) output breaker may also be affected by fire in this zone.
- Redundant EFW pumps P7A (Instrument Cable) and P7B (Control Cable) - Potential for loss of operability of both EFW pumps.
- Damage to control cables of redundant divisions of EFW flow valves may result in a loss of EFW flow to either Steam Generator.
- EFW Pump P7B Suction Valves (CV2800, 2803, 3850) are susceptible to spurious closure which could lead to pump damage on loss of suction.
- Redundant Makeup Pumps: P36A (Control cable), P36B (Power and Control cables) and P36C (Power and control cables)

In lieu of providing protection for one redundant train in each zone, the ANO FHA credits manual operator actions as a means of mitigating the effects of fire damage. No immediate operator actions are implemented to prevent the failure of potentially affected equipment. Rather, the licensee credits a symptom-based approach which relies on the operator's ability to detect each mal-operation as it occurs and perform manual actions as necessary to mitigate its effects. To alert operators of the potential effects of fire damage in each zone the licensee has developed a "pre-fire plan" for each zone. Due to the number of components that may be affected as a result of fire and uncertainty regarding the timing and synergistic impact that potential failures may have on the operators ability to accomplish required shutdown functions, the inspection team was unable to confirm the adequacy of protection provided for one train of systems required to achieve and maintain hot shutdown conditions in these areas.

c. Conclusion

Based on the above, Fire Zones 98J and 99M do not appear to meet the fire protection licensing basis documented in Safety Evaluations dated March 22, 1983 (for Fire Zone 98J), August 27, 1978 (for Fire Zone 99M) and May 13, 1983 (for both areas).

4.0 ALTERNATIVE POST-FIRE SAFE SHUTDOWN CAPABILITY

a. Inspection Scope

As part of this inspection the BNL technical specialist reviewed the capability of systems and components identified by the licensee as being required to achieve alternative shutdown to satisfy the reactor performance goals established in the licensing basis for the plant. Additional aspects of this inspection area were evaluated by other members of the inspection team.

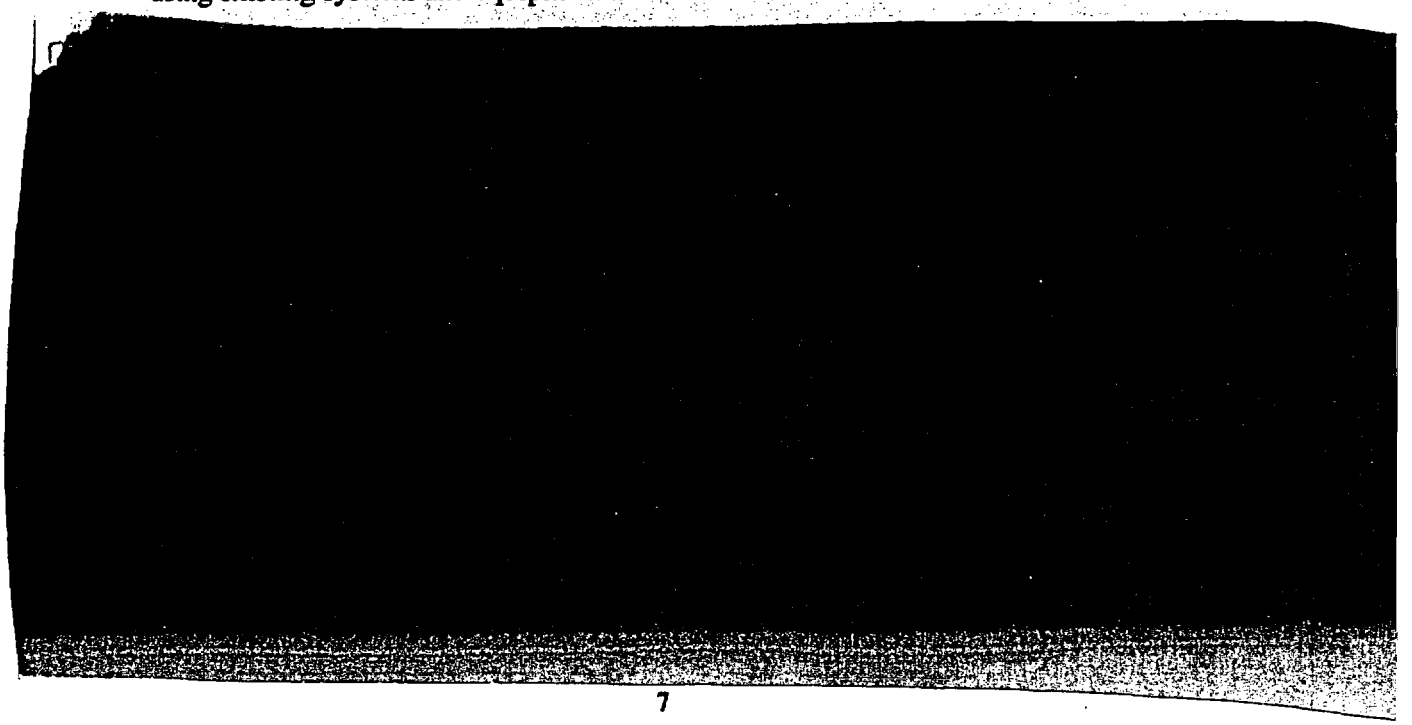
b. Observations and Findings

Unlike most operating plants, ANO Unit 1 is not provided with an alternative shutdown control panel with controls and displays for safe shutdown systems and having an extensive isolation transfer capability. As a result, alternative shutdown must be accomplished by manual operator actions performed at various local shutdown stations (e.g., operating a pump from the switchgear) or at the equipment (e.g., repositioning motor-operated valves to the desired position for shutdown).

Specific performance goals for the alternative shutdown capability are delineated in Section III.L.2 of Appendix R to 10 CFR 50. For Pressurized Water Reactors (PWR) , Section III.L.2.b requires the reactor coolant makeup function to be capable of maintaining the reactor coolant level within the level indication in the pressurizer.

By letter dated May 13, 1983, the NRC staff issued a Safety Evaluation (SE) on the safe shutdown capability of ANO Units 1 and 2. This SE evaluated the safe shutdown capability of both units against the requirements of Sections III.G and III.L of Appendix R to 10 CFR 50. With regard to the ability of ANO to meet the shutdown performance goals of Section III.L, paragraph A of the "Evaluation" Section of the SE states:

> "The performance goals for post fire safe shutdown for reactivity control, reactor coolant makeup, reactor coolant pressure control and decay heat removal can be met using existing systems and equipment..."



available to isolate letdown and establish RCS makeup in a manner that would enable pressurizer level to be maintained within the level indication of the pressurizer. On Thursday of the second week of the inspection (June 21, 2001) the licensee provided a copy of the revised calculation to the inspection team. [redacted] In a subsequent conference call with the Licensee, Region IV, and BNL, the morning of July 6, 2001, the licensee stated that in the revised calculation, 0 inches in the pressurizer was at the lower instrument tap. [redacted]

c. Conclusion

[redacted] Therefore, no findings of risk significance were identified.

5.0 OPERATIONAL IMPLEMENTATION OF ALTERNATIVE POST-FIRE SAFE SHUTDOWN CAPABILITY

(Reviewed by other inspection team members)

6.0 COMMUNICATIONS FOR IMPLEMENTATION OF ALTERNATIVE POST-FIRE SAFE SHUTDOWN CAPABILITY

(Reviewed by other inspection team members)

7.0 EMERGENCY LIGHTING FOR IMPLEMENTATION OF ALTERNATIVE POST-FIRE SAFE SHUTDOWN CAPABILITY

(Reviewed by other inspection team members)

8.0 COLD SHUTDOWN REPAIRS

(Reviewed by other inspection team members)

List of Persons Contacted During the Inspection

W. Walker	Fire Protection Engineer	ANO
M. Cooper	Licensing Engineer	ANO
G. Dobbs	Electrical Engineering Supervisor	ANO
D. Williams	Systems Engineer	ANO
R. Kulbeth	Electrical Engineer	ANO

List of Documents Reviewed During Inspection

Letter dated 3/22/83 From: R. Clark and J. F. Stolz (NRC) To: J. M. Griffin (AP&L) concerning exemptions to certain requirements of Appendix R to 10 CFR 50
Letter dated 8/22/78 From: R. Reid (NRC) To: W. Cavanaugh (AP&L) concerning facility modifications for fire protection.
Letter dated 5/13/83 From:. Clark and J. F. Stolz (NRC) To: J. M. Griffin (AP&L) concerning Safety Evaluation of safe shutdown capability of ANO Units 1 and 2.
Calculation No. 85-E-0072-03, Revision 1, 3/18/99, "Time to loss of subcooling or Loss of Pressurizer Liquid Inventory From Plant Trip With No Makeup Available Under Various RCS Leak Path Scenarios"
ANO Fire Hazards Analysis, Revision 6, 4/10/00
Calculation 85-E-0086-01, Revision 3, 11/18/97, "Safe Shutdown Capability Assessment" Volumes 1 and 2
PDMS Cable Routing Data: "SS Equipment with Associated Cable Routing," 6/14/01
Procedure No. 1203.002, "Alternate Shutdown" Change No. 015-02-0
Piping and Instrument Diagram (P&ID) Drawing Series M-204, Emergency Feedwater
Piping and Instrument Diagram (P&ID) Drawing Series M-206, Steam Generator Secondary System
Piping and Instrument Diagram (P&ID) Drawing Series M-210, Service Water System
Piping and Instrument Diagram (P&ID) Drawing Series M-217, Emergency Diesel Generator
Piping and Instrument Diagram (P&ID) Drawing Series M-230, Reactor Cooling System
Piping and Instrument Diagram (P&ID) Drawing Series M-231, Makeup and Purification System
Electrical Drawing Series E-1, Station One Line Diagram
Electrical Drawing Series E-5, Single Line Meter and Relay Diagram 4160V System Engineered Safeguard
Electrical Drawing Series E-8, Single Line Meter and Relay Diagram 480V load Centers
Electrical Drawing Series E-17, Red Train Vital AC and 125V DC Single Line and Distribution