UNITED STATES
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ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO 10 CFR 50, APPENDIX R, SECTIONS III.G.3 and III.L, ALTERNATE SHUTDOWN

COMMONWEALTH EDISON COMPANY

ZION NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-295 AND 50-304

1.0 INTRODUCTION

By letter dated September 10, 1987, the licensee submitted a revised Zion Station, Appendix R, Safety Shutdown Report, "Safe Shutdown Capability Reassessment and Proposed Modifications 10 CFR 50, Appendix R" July 1987, Revision 1. Previous to the July 1987 report, a long history of correspondence exists between the licensee and the staff relating to 10 CFR 50, Appendix R. All fire protection issues have been closed by the staff with the exception of Sections III.G.3 and III.L of Appendix R involving alternate safe shutdown in the event of a fire. In the staff's initial Safety Evaluation Report (SER) dated March 1983, related to alternate shutdown, it was concluded that the design was acceptable and met the requirements of Appendix R, Sections III.G.3 and III.L. However, that SER is no longer valid based on improvements and modifications made by the licensee to the alternate shutdown system design. This alternate shutdown evaluation is based on the revised 1987 report and a subsequent submittal dated September 15, 1988, related to the auxiliary building ventilation (HVAC) system.

2.0 EVALUATION OF ALTERNATE SHUTDOWN DESIGN

2.1 General Description

The alternate shutdown system is designed to provide safe shutdown capability which is separate and remote from the fire areas for which alternate shutdown is required. These areas are the main control room complex, inner and outer cable spreading rooms, and the auxiliary electric equipment rooms. For a fire in the main control room, the capability for simultaneous alternate safe shutdown of both units is required. For a fire in either units' auxiliary electric equipment room, control room evacuation is not required but reliance on alternate instrumentation may be required because vital control room instrumentation could be lost.

The alternate shutdown system is designed with the capability to perform the following:

1. Achieve and maintain subcritical reactivity conditions,
2. maintain reactor coolant inventory control,
3. achieve and maintain hot shutdown,
4. achieve cold shutdown conditions within 72 hours, and
5. maintain cold shutdown conditions thereafter.

The above will be accomplished without reliance on post-fire repairs for hot shutdown (Mode 3 in the Zion Technical Specifications) and limited repairs for cold shutdown (for certain fires) that can be accomplished in time to reach cold shutdown within 72 hours. Design modifications made for accomplishing alternate shutdown, include the following:

1. Addition of isolation switches in each units' inner and outer cable spreading rooms for RCS pressure boundary isolation valves.
2. Addition of transfer/isolation switches in each units' inner cable spreading room and enclosed stairway for some required instrumentation.
3. Addition of indication on each units' remote shutdown panels for wide range T_h and T_c for RCS loop "A."
4. Modifications to allow boron sampling.
5. Addition of isolation and control switches to allow local operation of diesel generators.
6. Addition of power supply for instrumentation associated with items 2 and 3.
7. Addition of local steam generator "A" pressure gauge in each units' steam tunnel.

2.2 Systems Used for Alternate Shutdown

The systems used for alternate shutdown in each unit consist of a diesel generator; chemical and volume control system (CVCS) including the refueling water storage tank (RWST); auxiliary feedwater (AFW) system including the condensate storage tank (CST) and atmosphic dump valves (ADVs); residual heat removal (RHR) system; and associated instrumentation. Necessary support systems include, the component cooling water (CCW) system, service water (SW) system and the emergency power distribution system.

Ventilation of equipment was also a support function of concern. Of particular concern were the charging pumps/motors which are in separate rooms with individual room coolers. All other alternate shutdown equipment of concern with respect to ventilation is located in a large open area of the auxiliary building and is assumed to be capable of functioning without ventilation.

In a May 5, 1985 submittal, the licensee performed a heat-up analysis for the worst case charging pump room with the door open and no available ventilation. The analysis was performed for a fire in the control room which disabled all ventilation in the charging pump rooms and the area (auxiliary building) outside the pump rooms. This analysis showed the charging pumps were capable of performing their safety function for the required 72-hour period.

However, a potential safe shutdown concern was identified with respect to a fire in the auxiliary building areas that could result in the loss of ventilation with additional heat-up due to the fire in the area. The heat-up analysis for the charging pump rooms did not include any heat input from a fire in the auxiliary building areas.

To eliminate any ventilation concerns, the licensee, by letter dated July 15, 1988, identified modifications which included rerouting and protecting (wrapping) power cables such that at least two auxiliary building exhaust fans will always be available following a fire. Procedural changes have also been incorporated for manual positioning of certain dampers to ensure adequate flow paths in the event a fire involves ventilation system panel OLP17 or its power and control cables where they are routed in the auxiliary building, cable spreading rooms and control room. The staff has reviewed the charging pump room heat-up analysis and auxiliary building ventilation exhaust system modifications and concludes that adequate ventilation of safe shutdown equipment will be available following a postulated fire in the auxiliary building or any of the areas requiring alternate shutdown.

2.3 Alternate Shutdown Method

The alternate shutdown method in the event of a control room fire includes the operation of isolation transfer switches located in the outer cable spreading rooms and enclosed stairway of each unit for isolation of RCS pressure boundary isolation valves and transfer of safe shutdown instrumentation indication to the remote shutdown panels. Emergency diesel generator (EDG) "B" for each unit along with the shared diesel generator, EDG "O," can be started and controlled locally in the event of a fire in the control room or in one of the inner/outer cable spreading rooms. Any two of the three EDG's can maintain safe hot shutdown conditions for both units. Local operation of pumps and valves is the primary means of aligning and starting alternate shutdown systems. Local operation of switchgear is available after deenergizing the control power by removal of fuses for the 4KV switchgear and manual operation of switches or breakers for other switchgear or motor control centers.

For a fire in the outer cable spreading room, auxiliary electric equipment room or the main control room, instrumentation indications that will be available at the remote shutdown panels via isolation transfer switches in the inner cable spreading room are pressurizer level, reactor coolant system pressure (wide range) and loop "A" steam generator level (wide range). Reactor coolant system hot leg (T_h) and cold leg (T_c) temperatures will also be available at the remote shutdown panels, but isolation transfer switches are not required since new cables are installed and routed independent of the fire areas of concern. Local steam generator pressure indication will be available in the main steam tunnel. For a fire in the inner cable spreading room, process monitoring instrumentation will be available in the control room and/or remote shutdown panels except for steam generator pressure. However, the local pressure guage for steam generator "A" will still be available. Isolation switches will also be provided in the inner and outer cable spreading rooms for disconnecting power from the pressurizer PORVs, normal letdown isolation valve and the excess letdown isolation valve to prevent or override spurious operation of these valves due to a fire induced hot short. Isolation transfer and control switches for local operation of the diesel generators will be located in the diesel generator rooms.

2.4 Evaluation

In the event of a fire in the main control room or the inner or outer cable spreading room that prevents safe shutdown from the control room, the only operator action relied on in the control room is a manual reactor scram if an automatic trip has not already occurred due to the fire. Other operator actions from the control room such as closing the main steam isolation valves (MSIVs) will be included in the alternate shutdown procedure but alternate means outside the control room are provided in the event that such operations cannot be performed from the control room. Following the reactor trip, manual start and control of the turbine driven auxiliary feedwater (AFW) pump will be used in conjunction with the steam generator code safety valves to maintain hot shutdown conditions as defined in the plant technical specifications. The AFW system will take suction from the condensate storage tank (CST). For a fire in the auxiliary electric equipment room, the shutdown can be accomplished from the control room, except that remote monitoring of some process variables at the remote shutdow panel and local operation of some components may be required.

For the worst case fire scenario in the control room, hot shutdown can be achieved and maintained with subsequent cooldown to cold shutdown conditions within 72 hours using only one steam generator. Although the capability exists to feed any or all of the four steam generators, only steam generator "A" has instrumentation that is independent of the control room. Modifications have been made to allow continued local manual operation of the atmospheric dump valve for steam generator "A". The dump valve capacity is 10 percent of the normal full power steam flow from one steam generator which will allow cooldown to the RHR cut-in temperature within the required 72-hour period under natural circulation conditions.

Prior to initiating AFW flow, the pressurizer PORVs and the normal and excess letdown isolation valves are closed from the inner and outer spreading rooms of each unit, and safe shutdown instrument indications are transferred to the remote shutdown panel. This isolates the reactor coolant system (RCS) since the reactor head vent valves and RHR suction isolation valves will have power removed during normal plant operation to prevent spurious operations. According to the 72-hour time line provided in Figure 6-7 of the licensee's safe shutdown report, these actions can be accomplished within 5 minutes after control room evacuation and AFW flow can be established within 15-20 minutes. However, plant conditions/ response may change priorities of what actions should be taken expeditiously.

RCS inventory control will be accomplished with one of the centrifugal charging pumps via the reactor coolant pump (RCP) seal injection flow path. Prior to starting the charging pump, a chemical and volume control system valve lineup is performed to isolate all water sources but the refueling water storage tank (RWST), thereby minimizing the likelihood of a dilution event during the shutdown. The valve lineup also assures that the RWST will not be inadventently drained due to spurious valve operations. The staff has reviewed the valve lineup proposed and concluded that if properly implemented, it will prevent a dilution event since the lineup and procedure have considered possible spurious signals due to hot shorts. The licensee has proposed not to monitor RWST level based on analyses that show sufficient inventory is available to reach cold shutdown within 72 hours without depleting the tank. For the RWST, the technical specification minimum level is well in excess of that required for a cooldown and the total needed for cold shutdown. For the CST, the amount of water necessary to cool down is dependent on how long it takes to go to cold shutdown which could vary due to unforeseen events. Since prior to completing lineups after a fire, it is possible to lose some inventory from the CST and time frames for AFW pump operation are speculative, the licensee proposed to switch the source of water to the service water system or establish CST level monitoring within 4 hours. The technical specification minimum CST level is well in excess of that required for 4 hours of AFW system operation during plant cooldown.

In Table 4-1 of the licensee's reassessment, certain condensate system valves were identified that could discharge CST inventory if they spuriously opened and operator actions were identified for resolution of this concern. Section 6 of the reassessment did not include the identified valves in the shutdown scenario and operator time tables. However, the licensee stated that the actual post-fire safe shutdown procedures will include actions to isolate the CST from systems other than the AFW system to preclude inadvertent loss of inventory.

The shared nature of the Zion units, provides a relatively simple method of support systems operation following a fire in one of the four areas (main control room, Units 1 and 2 inner and outer cable spreading rooms and auxiliary electric equipment rooms) requiring alternate shutdown. The service water system (SWS) and component cooling water (CCW) system are each normally operated in a cross-connected mode between units. Two SWS pumps and two CCW pumps are adequate to supply the cooling water needs for shutdown of both units following a fire. To ensure cooling of the diesel generators, normally open motor operated valves in the service water system supply and return lines will have their power removed during normal plant operation. Therefore, spurious operation of these valves due to a hot short cannot occur.

The licensee performed a breaker coordination study to confirm that no associated circuits of concern by common power supply existed at Zion. The study was limited to the safe shutdown power supplies consisting of the 4KV switchgear buses and emergency diesel generators, 480V load centers and motor control centers, 120 VAC instrument buses and inverters, and the 125 VDC distribution buses and emergency batteries. The study verified that adequate fault protection exists via protective relaying, circuit breakers and fuses. Additionally, the licensee has provided procedures to reinstate power to required circuits in the event that multiple high impedance faults occur which bypass breaker coordination and trip the feeder breaker instead.

Associated circuits of concern by common enclosure have been eliminated by installation of fire stops between safe shutdown raceways where a fire could propagate and damage redundant divisions, and by the installation of fire seals for electrical penetrations at their boundary equivalent to those required for the boundary.

Fire-induced spurious operations that could affect safe shutdown capability have also been taken into account and are either prevented by pre-fire actions, corrected or prevented by post-fire operator actions, and corrected/prevented by isolation transfer switches operated after a fire. To prevent spurious operation of the RHR suction valves, reactor vessel head vent valves, RCS loop isolation valves and the SWS valves in the "B" emergency diesel generators, power is removed from these valves during normal power operation such that a fire-induced hot short cannot cause them to change position. Isolation transfer switches have been provided for closure of the PORVs, excess letdown isolation valve and normal letdown isolation valve to prevent inadvertent depressurization and inventory loss.

Procedures have been developed to prevent spurious operations from affecting safe shutdown which include closing the auxiliary spray path to prevent possible depressurization, performing valve lineups for the chemical and volume control system and condensate transfer system to prevent inadvertent loss of RWST and CST inventory, providing local closure of the main steam isolation and bypass isolation valves, providing manual isolation of the atmospheric dump valves and closing the boron injection tank inlet isolation valves.

The alternate shutdown method at Zion is such that the isolation switches are only used to disconnect control power and, therefore, redundant fusing in the control circuits is not required. Manual operation of breakers and/or valves with control power removed is the primary means of equipment operation. An exception is the EDG local controls. A fire in the control room or in the inner/outer cable spreading room could result in tripping the normal DC control power breakers, thus preventing local control of the diesel. However, the system is designed with normal and reserve DC control power breakers such that if the normal control power breaker is tripped, the reserve control power can be used by pulling the copper fuse blocks from the normal control power slot and inserting it into the reserve side. The shutdown procedures identify that this operation may be necessary. Both the normal and reserve control power slots are located inside the diesel generator local control panels.

The alternate shutdown capability at Zion meets the requirement of achieving cold shutdown within 72 hours, with possible repairs being required for operation of a PORV or an RHR pump. A fire in the main control room or inner/outer cable spreading room, may cause damage to dc power cables disabling both PORVs. If it becomes necessary to increase the depressurization rate during a plant cooldown, repair of the dc power cables to the solenoid operated control valve for a PORV may be required. Additional power cables will be available to affect this repair. For fires in certain locations, redundant RHR pump motor power cables could be damaged. Additional power cables will be available for restoring power to an RHR pump. Repair procedures have been written to ensure proper cable connections are made and safely tested in a timely manner. Repair materials will be available on site. These repairs, if required, are only necessary for cold shutdown, and therefore, are acceptable.

The licensee stated that alternate safe shutdown of both units can be accomplished by nine operators. We have reviewed the proposed method of alternate shutdown and conclude that nine operators should be capable of bringing both units to safe hot shutdown and maintain safe hot shutdown until additional personnel arrive at the site to bring the plant to cold shutdown conditions. The required nine operators will be in addition to the five man fire brigade.

3.0 CONCLUSION

The staff reviewed the drawings for those systems necessary for alternate safe shutdown and considered the possible spurious operations that could occur to prevent those systems from performing their function and compared the results with the licensee's proposed operator actions to be included in the post-fire procedures. From this comparison, the staff concluded that the licensee's proposed modifications and alternate shutdown procedures are adequate to perform an alternate safe shutdown independent of the main control room, inner and outer cable spreading rooms, and the auxiliary electrical equipment rooms.

Based on the above evaluation of the proposed alternate shutdown capability at Zion, Units 1 and 2, the staff concluded that the requirements of Sections III.G.3 and III.L of Appendix R to 10 CFR 50 are satisfied for a fire in the main control room, inner and outer cable spreading rooms, or the auxiliary electrical equipment rooms. All other areas of the plant after completed modifications and with appropriate exemptions should be in compliance with Section III.G.2 of Appendix R and, thus alternate shutdown is not required for those areas.

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