UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

# SAFETY EVALUATION REPORT

# VIRGIL C. SUMMER NUCLEAR STATION

# APPENDIX R PLANT MODIFICATION REVIEW

# DOCKET NO. 50-395

## I. INTRODUCTION

In Supplement No. 3 of the Virgil C. Summer Nuclear Station Safety Evaluation Report (SER) the staff provided its evaluation of the station's compliance with Appendix R to 10 CFR 50, Section III.G and III.L, relative to safe shutdown capability in the event of a fire.

Subsequent to the SER, Generic Letters 81-12 and 83-33 were issued which provided clarifications of the staff's interpretation of certain requirements of Appendix R including safe shutdown capability. Based on additional guidance and information obtained by the licensee at NRC Region II Appendix R fire protection workshop, the licensee reevaluated safe shutdown capability at the V.C. Summer Nuclear Station.

By letters dated May 29, September 4, 16, 20, November 1, and December 30, 1985, the licensee submitted the results of a reassessment of safe shutdown capability at V.C. Summer Nuclear Station. As a result of the reanalysis, the licensee proposed modifications to provide greater assurance of compliance with the requirements of Appendix R to 10 CFR 50 and to resolve associated circuits concerns. The proposed modifications fall into three categories. The objective of the first category is to prevent and/or mitigate spurious equipment operation caused by fire induced conductor to conductor or cable to cable faults. The original fire hazards analysis did not consider this to be a credible fire damage mechanism relative to safe shutdown equipment or cable selection. The objective of the second category of modifications is to facilitate local operator actions, i.e., modifications are proposed to reduce the need for post-fire repairs or jumper procedures for cold shutdown equipment before plant operators can manipulate equipment locally. The third Category of modifications resolve additional associated circuits concerns identified during the course of the fire hazards analysis.

## II. EVALUATION

### (a) Auxiliary Spray Valve Cable

Control cables associated with auxiliary spray valve (XVT-8145-CS) are routed through the following fire areas:

- Auxiliary Building fire area AB-1
- Control Building fire area CB-6, CB-10, CB-15 and CB-17
- Intermediate Building fire area IB-25
- Reactor Building fire area RB-1

A fire occurring in any of the above listed fire areas could potentially cause spurious operation of the auxiliary spray valve due to a hot short in the solenoid control cable. Inadvertent opening of this valve with a charging pump in operation could result in primary plant de-pressurization. To preclude this from happening, the licensee proposed to replace the control cables from the control room to the valve with cabling which includes a grounded shield. In addition, the licensee proposed to provide a second control power disconnect independent from the control room disconnect to preclude the potential for spurious auxiliary spray valve operation in the event of a control room fire. This modification has been scheduled to be completed by the end of the third refueling outage (second quarter of 1987). The staff has reviewed the proposed modification and found it to be acceptable. Further, the licensee has developed an interim wire cutting procedure that is functionally equivalent to the proposed second electrical disconnect. This compensatory action will remain in effect until the modification is complete. The staff finds this interim approach acceptable.

(b) Steam Generator Power Operated Relief Valve Cable

Control cables associated with the steam generator power operated relief valves (IPV-2000-MS, IPV-2010-MS and IPV-2020-MS) are routed through the following fire areas:

- Auxiliary Buidling fire area AB-1
- Control Building fire areas CB-1, CB-2, CB-4, CB-5, CB-6, CB-10, CB-12 CB-17 and CB-18
- Intermediate Building fire areas IB-20, IB-22 and IB-25

A fire occurring in any of the fire areas listed above could potentially cause spurious operation of the steam generator power operated relief valves due to a hot short in the control cables associated with either of the two control solenoids for each valve. Inadvertent opening of these valves could cause excessive cooldown and reactor coolant system shrinkage. To preclude the potential for spurious operation of the steam generator power operated relief valves from an external hot short, the licensee proposed to modify the control solenoids such that the PORV fails closed. In addition, the licensee proposed to provide a second control power disconnect in the cable spreading room, independent of the control room disconnect, to prevent spurious steam generator power operated relief valve operation in the event of a control room fire. This modification is scheduled to be completed by the end of the third refueling outage (second quarter of 1987). Until the above modifications are completed, the automatic fire detection and/or suppression systems presently in place will be supplemented with a 2-hour roving fire watch. Based on its review, the staff finds that the proposed modifications and the interim compensatory action of providing 2-hour roving fire watch in the areas of concern are acceptable.

(c) Excess Letdown Isolation Valve Cable

Control cables associated with the excess letdown isolation valves (XVT-8153-CS and XVT-8154-CS) are routed through the following fire areas:

- Control Building fire areas CB-1, CB-6, CB-12, CB-15 and CB-17
- Intermediate Building fire area IB-25
- Reactor Building fire area RB-1

A fire occurring in any of the above listed fire areas could cause spurious operation of both excess letdown isolation valves. Inadvertent opening of these valves could cause a loss of reactor coolant system inventory. To preclude the potential for spurious operation of both excess letdown isolation valves, the licensee proposed to explicitly identify the control power disconnects in the control room and install a second set of control power disconnects in the cable spreading room. The licensee contends that this will ensure closure of these valves since two independent hot shorts would have to occur to open the valves. This modification is scheduled to be completed by the end of the third refueling outage (second quarter of 1987). The staff has reviewed the proposed modification and found it to be acceptable. Further, the licensee has developed an interim post-fire shutdown procedure for a fire in the control room that will ensure the removal of control power to the valves. The staff finds the licensee's interim compensatory action acceptable.

(d) Main Steam Isolation and Bypass Valve Cable

Control cables associated with the main steam isolation and bypass valves (XVM-2801 A, B, C and XVT-2869 A, B, C-MS) are routed through the following fire areas:

- Control Building fire areas CB-1, CB-2, CB-4, CB-6, CB-10, CB-12, CB-15, CB-17 and CB-18
- Intermediate Building fire areas IB-20, IB-22 and IB-25

A fire occurring in any of the above listed fire areas could potentially cause spurious operation of the main steam isolation and bypass valves. Inadvertent opening of these valves due to external hot shorts could cause a loss of secondary side inventory. To preclude the potential spurious operation of the main steam isolation and bypass valves the licensee proposes to explicitly identify the control power disconnects in the control room and install a second set of disconnects in a separate fire area. The licensee contends that this will ensure closure of these valves. This modification is scheduled to be completed by the end of the third refueling outage (second quarter of 1987). The staff has reviewed the proposed modification and finds it to be acceptable. Further, the licensee's interim post-fire shutdown procedure is in place for a fire in the control room to ensure the removal of control power to the main steam isolation and bypass valves.

(e) Pressurizer Power Operated Relief Valve Cable

Control cables associated with the pressurizer power operated relief valves (IPV-444B, IPV-445A, and IPV-445B) are routed through the following areas:

- Auxiliary Building fire area AB-1
- Control Building fire areas CB-10, CB-15 and CB-18
- Intermediate Building fire areas IB-14, IB-20, IB-21, IB-22 and IB-25
- Reactor Building fire area RB-1

A fire occurring in any of the fire areas listed above could cause spurious operation of a pressurizer power operated relief valve. Inadvertent opening of a pressurizer power operated relief valve due to an external hot short could cause a loss of reactor coolant inventory. To preclude this, the licensee proposes to replace the control cabling from the control room to the valves with cable which includes a grounded shield. In addition, the licensee proposes to install a second set of control power disconnects independent of the control room disconnects to prevent spurious pressurizer power operated relief valve operation in the event of a control room fire. This modification is scheduled to be completed by the end of third refueling outage (second quarter of 1987). The staff has reviewed the proposed modification and finds it acceptable. Further, the licensee has instituted an interim wire cutting procedure which is functionally equivalent to the proposed second electrical disconnect. The staff finds the compensatory measure acceptable.

(f) Diesel Generator Control Transfer Switch Cables

Cables (DGM 29B, DGM 21B and DGM 22B) associated with the Train "B" diesel generator control transfer switch are routed through the cable spreading room, CB-15. A fire in the cable spreading room could result in external hot shorts which could render the Train "B" diesel generator inoperable in addition to damaging cabling associated with the Train "A" diesel generator. Thus, the ability to achieve and maintain hot standby conditions from the control room evacuation panel utilizing onsite power capability may be jeopardized. The licensee proposed to relocate cables DGM 21B and 22B outside the fire area of concern and isolate cable DGM 29B by modifying the circuit and utilizing additional contacts associated with the existing control transfer switch. This modification was completed at the end of the second refueling outage (fourth quarter of 1985). The staff has reviewed the modification and finds it acceptable.

(g) Current Transformer Circuits

A fire in either the control room or cable spreading room could damage both trains of switchgear required for safe shutdown by damaging the current transformer circuits. The fire could possibly cause the current transformer circuit to open, resulting in a secondary fire at the current transformer in the respective switchgear. By letter dated May 29, 1985, the licensee identified this condition to the NRC.

To preclude the potential for a secondary fire in the switchgear, the licensee proposes to install thyrite surge suppressors in the circuit in parallel with the current transformer. This will prevent an over voltage surge in the event of an open current transformer circuit. This modification is scheduled to be completed by April 1986. The staff has reviewed the proposed modification and finds it acceptable. Further, in a letter dated June 21, 1985, the licensee committed to provide a roving fire watch until the modification is completed. The staff finds the licensee's interim action acceptable.

(h) Power Cable Tray Separation

In the event of a fire in the southwest corner of elevation 412'-0" of the intermediate building, fire area IB-25, near column line 7.5/G.4, redundant cabling required for systems necessary to achieve and maintain hot standby conditions could be damaged. Tray 3088 which contains Train "A" DC control power to all essential safe shutdown systems interacts with Tray 4149 which contains Train "B" control power for the chilled water system and the component cooling water system. In addition, conduit VUC-2B which contains Train "B" control power cabling for the chilled water system and trays 1025, 2058 and 3128 which contain Train "B" power to the chilled water system and component cooling water system also interact with cable tray 3088. Since the chilled water system provides bearing cooling of the charging pumps, a fire in this area affecting the chilled water system could possibly render both charging pumps inoperable. By letter dated May 29, 1985, the licensee identified this condition to the NRC.

The licensee proposes to enclose cable tray 3088 in a 1-hour fire barrier throughout fire area IB-25. This modification is scheduled to be completed by the end of the first quarter of 1986. The staff has reviewed the proposed modification and finds it acceptable. Further, the licensee has committed to provide a roving fire watch until the modification is completed. The staff finds the licensee's interim action to be acceptable.

(i) Source Range Nuclear Instrumentation Cables

A fire in the north cable chase of the control building on elevation 436'-0", could damage all available source range nuclear instruments. By letter dated May 29, 1985, the licensee identified this condition to the NRC. In order to preclude the loss of all three source range instruments due to a fire in fire area CB-1, the licensee proposes to either enclose one train of source range cabling in a 1-hour fire barrier or install a power source selector switch for one train of source range instrumentation. This modification is scheduled to be completed by the end of the first quarter in 1986. The staff has reviewed the proposed modification and finds it acceptable. Further, the licensee has committed to provide a roving fire watch until the modification is completed. The staff finds the licensee's interim action to be acceptable.

(j) Emergency Lighting

The licensee requested deviation from Section III.J of Appendix R to 10 CFR 50 to the extent that it requires that all areas needed for operation of safe shutdown equipment and in access and egress routes thereto be provided with 8-hour battery powered emergency lighting units.

Discussion

To effect and maintain safe shutdown under certain fire scenarios, the licensee has indicated that operators would need to go between the turbine building, the service water pumphouse, and the circulating water pumphouse.

The yard lighting will provide the illumination of the external entrances and exits of the affected structures. No lighting is planned for general yard areas, since the provision of entrance lights to illuminate doors and stairwells and to serve as guide beacons is sufficient for safe travel between structures. This lighting, however, does not comply with the requirement of Section III.J of Appendix R specifying an 8-hour battery supply.

The yard area lighting is powered by the diesel generator busses. Therefore, the yard lighting can be maintained for the 8-hour time period specified in Section III.J of Appendix R. In all other locations, the licensee will meet Section III.J by providing individual 8-hour battery powered lighting units. The additional lighting units required to meet this are scheduled to be installed by June 30, 1986. In the interim, the existing emergency lighting is being supplemented by hand held lighting and an existing Central DC powered emergency lighting system.

Evaluation

We had several concerns with the licensee's proposed lighting configuration. The first was that hand held lights would be relied upon as the sole means of illumination. The licensee has confirmed that, while the operators will be carrying flashlights, they will only be relied upon to supplement the security lighting. And, if the flashlights become inoperable or could not be used while performing the safe shutdown function, the security lighting itself would supply sufficient illumination.

Our second concern was that the same fire which resulted in the need to go to the areas covered by the security or banked-battery lighting would cause the loss of this capability. The security lighting is supplied power from the diesel generator busses and is, therefore, not vulnerable to fire loss under the postulated fire scenario.

Our third concern was that the level of illumination would be sufficient to provide us with reasonable assurance that the safe shutdown function could be achieved. The licensee conducted a walkdown of the yard areas where the alternate lighting configuration was provided. This walkdown confirmed that an adequate level of illumination had been provided.

We were also concerned that the security lighting would not be maintained. However, this lighting is inspected and maintained as part of the plant security requirements. We find this acceptable.

Conclusion

Based on our review, we conclude that the use of the proposed emergency lighting systems and the field verification of the adequacy of the lighting provide an acceptable margin of safety equivalent to that provided by the technical requirements of Section III.J. Therefore, the licensee's request for a deviation is granted.

We also find that in the interim, the existing emergency lighting, supplemented by hand held lighting and an existing central DC powered emergency lighting system is acceptable until the additional 8-hour battery lights are installed.

(k) Service Water Booster Pump "M" Board Barrier

By letters dated September 20, 1985 and December 30, 1985, the licensee submitted information on the adequacy of a horizontal fire barrier over the "A-Train" service water booster pump, including commitments to modify the existing barrier by protecting the barrier's support assembly.

Discussion

The A-train service water booster pump is located on elevation 412' of the intermediate building. A horizontal barrier is installed above the pump to separate the A-train pump from redundant "B" train cables in raceways directly above the pump. This barrier is constructed of "Kaowool M-Board" supported by an unprotected steel uni-strut frame assembly suspended by rod hangers.

The in-situ fire load for this location is 43,000 BTU/ft$^2$ with a total BTU content of 471,145,000 BTUS. Area sprinkler protection and fire detection are provided above and below the barrier assembly. In addition, fusible-type water spray nozzles are provided for the cable tray stacks in the overhead. However, the area sprinkler protection is obstructed in the ceiling overhead by piping, electrical raceway and HVAC ducting. The sprinkler design does not meet the design guidance of NFPA 13 in that the system does not compensate for significant obstructions and overlapping obstructions exceeding 48 inches.

It was an NRC concern that in the event of an exposure fire in this area, sprinkler response to the fire condition could be delayed due to these obstructions. This, in conjunction with the non-fire rated structural steel supporting the M-Board barrier, could jeopardize the fire barrier design by causing structural deformation to the barrier support system. The failure of the barrier support system could cause both redundant trains of shutdown systems to be damaged by fire.

The licensee responded to this concern by letters dated September 20, 1985 and December 30, 1985, by committing to protect the support assembly for the M-Board barrier with material that will withstand a 1-hour fire exposure as determined by the test methods of ASTM E-119.

The licensee justified the adequacy of the modifications on the basis that "the addition of protective materials to the barrier supports will provide protection equivalent to a one-hour rating to ensure that the barrier will remain in place in the event of a fire. This will further ensure that the barrier will perform its fire protection function as a radiant energy shield between the service water booster pump A and the redundant cable trays."

Evaluation

The NRC staff's original concern was that because of the vertical alignment of redundant shutdown systems in this area and the unprotected support assembly of the horizontal barrier, a fire located near the floor would cause the horizontal barrier to fail and result in damage to both shutdown divisions. However, the area is protected by automatic fire detection and suppression systems. Therefore, it is reasonable to expect that a fire would be detected in its initial stages, before significant room temperature rise occurred. The plant fire brigade would be dispatched to put out the fire using manual fire fighting equipment. Pending arrival of the brigade, the horizontal barrier and the existing sprinkler system would act in concert to control fire spread, to limit temperature rise and to protect the shutdown-related systems from fire damage. Because the metal support assembly for the horizontal barrier will be completely protected by fire-rated material, there is reasonable assurance that the barrier will remain in place until the fire is suppressed.

Conclusion

Based on the above evaluation, the NRC staff concludes that the licensee's fire protection configuration in the Service Water Booster Pump area provides an acceptable level of fire safety. The NRC staff, therefore, concludes that upon implementation of the licensee's commitment to protect the support assembly for the horizontal barrier, this issue is resolved.

(1) Circuits Associated by Common Enclosure

By letter dated September 4, 1985, the licensee submitted a description of the approach used in their Appendix R reanalysis to demonstrate that adequate overcurrent protection exists for all cables including those which could be associated by common enclosure. Two reports were prepared by the licensee to demonstrate the adequacy of overcurrent protection.

Each report included detailed information of the plant design criteria and practices which were used to provide overcurrent protection for plant cabling. In order to demonstrate that the design criteria and practices were followed, the as-built conditions were evaluated using a statistical sampling technique to validate each report. The statistical procedure used was suitable to demonstrate a 95% confidence level that 95% of the power circuits have adequate overcurrent protection. The technique and acceptance criteria used were similar to those used to demonstrate the adequacy of pipe supports.

For the first report, the statistical evaluation used a population of circuits that included all power cables in the plant larger than 10 AWG, Class 1E associated, and Non-Class 1E. Fifty-nine circuits selected by random sample out of the 1834 circuits were then checked. Each circuit had adequate short circuit protection and long term ampacity. This provided 95% confidence that 95% of the circuits have adequate overcurrent protection and validated the licensee's design criteria and practices.

The second report dealt with cables limited to Class 1E and 1E associated circuits. A random sample of 59 out of 321 circuits were checked and each circuit had adequate short-circuit and overload protection. As in the first report, this provided a 95%/95% confidence in the circuits and validated the licensee's design criteria and practices.

Conclusion

We have evaluated the licensee's approach to circuits associated by common enclosure and find that the licensee has validated its design criteria and practices with a 95%/95% confidence level, therefore, we conclude that the licensee's design and approach to circuits associated by common enclosure are acceptable.

(m) Control Transfer Switches

For fires in the control room, relay room and cable spreading rooms which require control room evacuation, shutdown control will be directed from the control room evacuation panel (CREP). The following "B" Train equipment is necessary for safe shutdown and is subject to spurious operation due to fire induced hot shorts.

| EQUIPMENT TAG NO. | DESCRIPTION |
|---|---|
| MFN-97B-AH | Reactor Bldg. "B" Train Cooling Fan |
| MFN-97D-AH | Reactor Bldg. "B" Train Cooling Fan |
| XEG-1B-DG | "B" Diesel Generator |
| XFN-38B-AH | Chgr. Room Supply Fan "B" |
| XFN-45A-AH | DG "B" 50% Supply Fan |
| XFN-46B-AH | DG "B" 50% Supply Fan |
| XFN-46B-VL | Charging/SI Pump "B" Room Fan |
| XFN-49B-VL | RHR/Spray Pump "B" Fan |
| XFN-76-VL | ESF1DB Switchgear Room Fan |

| EQUIPMENT TAG NO. | DESCRIPTION |
|---|---|
| XFN-80B-AH | SWPH Supply Fan "B" |
| XFN-81B-VL | SW Booster Pump "B" Fan |
| XFN-106B-VL | CREP and "B" Speed Switch Room Supply Fan |
| XFN-133-VL | Aux. Bldg. "B" Switchgear Room Fan |
| XHX-1B-VU | "B" Chiller |
| XPP-1B-CC | CC Pump "B" |
| XPP-31B-RH | Residual Heat Removal Pump "B" |
| XPP-39B-SW | SW Pump "B" |
| XPP-43B-CS | Charging Pump "B" |
| XPP-45B-SW | SW Booster Pump "B" |
| XPP-48B-VU | Chilled Water Pump "B" |
| XSW1DB, U14 | Charging/SI Pump "C" Feeder "B" |
| XSW-1DA-ES, U1 | Normal Offsite Breaker |
| XSW-1DA-ES, U1 | Alt. Offsite Breaker |
| XSW-1DA-ES, U3 | "A" D.G. Breaker |
| XSW-1DB-ES, U3 | Alt. Offsite Breaker |
| XSW-1DB-ES, U16 | Normal Offsite Breaker |
| XSW-1DB1, U4C | Tie Breaker to XSW 1B3 |
| XSW-1DB-ES, U4 | XSW-1EB-ES Feeder Breaker |
| XSW-1DB-ES, U6 | FDR Breaker R.B. Spray PP 38B |
| XSW-1DB-ES, U7 | Unit Sub Feeder Breaker |

| EQUIPMENT TAG NO. | DESCRIPTION |
|---|---|
| XSW-1EB-ES, U3 | FDR Breaker for Unit Sub 1EB1 |
| XSW-1DB1-ES, U4B | ESF 480 Unit Sub Main Breaker |
| XSW-1DB1, U7B | FDR Breaker R.B Fan 96B |
| XSW-1DB1, U7C | FDR Breaker R.B. Fan 96D |
| XSW-1DB2-ES, U4B | ESF 480 Unit Sub Main Breaker |
| XSW-1EB1-ES, U4B | ESF 480 Unit Sub Main Breaker |

The licensee proposes to either modify this equipment by adding control transfer switches and local controls or develop jumper procedures to facilitate local manual operator action. The licensee, in a letter dated April 4, 1985, stated that repair procedures will be provided for equipment needed only to achieve cold shutdown, and for equipment not needed in the first 8 hours of shutdown. Additionally, for fires not requiring control room evacuation, local actions to a lesser extent will be required. In these cases, a different repair other than jumper procedures may be used, such as portable fans. These repair procedures will be only for equipment not needed in the first 8 hours of shutdown. These modifications have been scheduled to be completed by the end of the third refueling outage (second quarter of 1987). The staff has reviewed the proposed modifications and finds them acceptable. Further, the licensee's interim procedures which are functionally equivalent to the proposed modifications are in place and acceptable to the staff.

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