UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DENIAL OF EXEMPTION FROM SECTION III.G OF

APPENDIX R TO 10 CFR PART 50

BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3

DOCKET NOS. 50-259, 50-260, AND 50-296

1.0 INTRODUCTION

By letter dated May 10, 1993, Tennessee Valley Authority (the licensee) requested an exemption from Section III.G of Appendix R to 10 CFR Part 50. The licensee requested relief from Section III.G.2.b in that it requires certain redundant trains of equipment located in the same fire area, where automatic fire detection and suppression are provided, to be separated horizontally from each other by 20 feet or more.

In their request, the licensee specifically requested the exemption for lack of separation between redundant Residual Heat Removal Service Water (RHRSW) Division I and Division II cables in the Intake Pump Station (IPS) on elevation 550'-0". These cables are routed through a corridor in close proximity, with a maximum horizontal separation distance of 9 feet and a minimum distance of 6 feet with a horizontal run of approximately 180 feet. The Division I cables are routed in conduits along the south wall and the Division II cables are located in a four cable tray stack configuration routed along the north wall. The conduits are enclosed in a Thermo-Lag fire barrier with a nominal thickness of 5/8-inch. The fire resistive rating of this fire barrier has not been determined. The corridor area is protected by an automatic fire detection system. This detection system actuates the water control valve for the pre-action sprinkler system installed in the area. The fire load in this area is 42,000 BTUs/sq. ft., which could produce a fire severity of 32 minutes.

The licensee, in their analysis, did not take credit for the Thermo-Lag fire barrier. The licensee applied the fire modeling techniques of the Electric Power Research Institute (EPRI) Fire Induced Vulnerability Evaluation Methodology (FIVE) and performed a multi-compartment analysis taking into account limited fire growth within the cable trays.

2.0 EVALUATION

Certain fire protection features are necessary in order to assure reactor safety and assure that the plant has the ability to remove decay heat and maintain shutdown conditions. The RHRSW is one of these systems. The Division I and Division II RHRSW cables of concern are located on elevation 550'-0" in the IPS. These cables are routed through a corridor in close proximity, with a maximum horizontal separation distance of 9 feet and a

minimum horizontal separation distance of 6 feet with a horizontal run of approximately 180 feet. Division I is routed in conduits along the south wall and the Division II cables are located in a four cable tray stack configuration routed along the north wall. The conduits, routed along the south wall are enclosed in a Thermo-Lag fire barrier with a nominal thickness of 5/8-inch. The licensee has used Thermo-Lag fire barrier system in the intake pump structure to protect steel conduits which contain the RHRSW Division I cables. However, in lieu of qualifying the fire resistive capability of this barrier installation, the licensee has elected to treat this barrier as if it does not exist. The cables routed in the cable trays along the north wall are not IEEE 383 qualified. They are coated with Flammastic in an effort to improve the fire retardant properties of the cables.

The licensee did not demonstrate that the thermal characteristics of the plant specific cables were equivalent to the cables referenced in the analysis. The small-scale cable burn tests performed by Factory Mutual are bench tests that determine the critical heat flux for a cable. These tests provide limited data with regard to predicting fire propagation in the four cable tray stack configuration located in the area of concern. In addition, the licensee referenced a combustibility study conducted by Factory Mutual for EPRI. From this study, the licensee concluded that the critical temperature is related to the ignition temperature of the cable. The licensee is using 700°F as the critical temperature for cables in their analysis. This assumption is non-conservative relative to the short circuit temperatures of most cables. Most cables have short circuit temperature ratings in the area of 500°F. Therefore, cable functionality could be lost prior to cable ignition as a result of thermal degradation.

The licensee calculated the fire plume temperature and the ceiling jet temperatures using the calculation methods described in the FIVE methodology. In addition, the licensee evaluated compartment fire growth through the application of the Hazard I Code. This code has not been endorsed by the NRC for predicting fire growth and propagation conditions at nuclear power plants.

The staff is concerned that if a fire were to occur in the trays, it would develop a hot gas layer in the overhead of the room. This hot gas layer would intensify and the layer depth would continue to increase until the hot gases could be vented to other areas through open doorways and ventilation openings to the outside. In reviewing the available fuel and its configuration within this IPS area of concern, the staff concluded that the excessive fire temperatures would be concentrated in the room overhead above the door soffits. When postulating a fire in the cable trays, an increase in fire plume and ceiling jet temperatures at the ceiling level can be noted. In order to make a relative judgment about the fire conditions in this room, the fire plume and ceiling jet temperatures, the staff estimated these temperatures by using the FIVE methodology. A constant burn rate of 1181 Kw results in a postulated fire plume temperature in excess of 1600°F with a ceiling jet temperature, at 9 feet away from the center line of the fire plume, in the range of approximately 600°F.

In the staff's view, if a fire were to occur within this space, the installed Thermo-Lag fire barrier would be needed to provide passive fire protection for the RHRSW Division I cables until the sprinklers could actuate and final fire extinguishment could be accomplished by the plant fire brigade. Without a fire barrier enclosing one division of RHRSW cables, the diversity in fire safety is degraded. In addition, the licensee's analysis did not consider the potential hazards associated with the combustibility of the fire barrier material nor did it clearly establish a basis which demonstrates that 6 feet of horizontal spacial separation is sufficient to assure that one train of safe shutdown capability is free of fire damage. Since, the licensee elected in this request not to take credit for the RHRSW Division I fire barrier, they did not determine the fire resistive rating of this barrier. Without an engineering analysis that evaluates the installed configuration to acceptable tests, the barrier's ability to resist fire is indeterminate. Therefore, diversity in fire protection defense-in-depth has not been demonstrated.

Section III.G of Appendix R requires that automatic fire detection and suppression capability and a 1-hour fire barrier or 20 feet of combustible free spacial separation between redundant shutdown trains be provided in plant areas that do not meet the 3-hour fire barrier separation requirement. The licensee has not provided either the required spacial separation between the redundant RHRSW cable divisions or a qualified 1-hour fire barrier for one RHRSW cable division.

3.0 CONCLUSION

Based on this review, the staff finds that the spacial separation between the redundant RHRSW does not provide reasonable assurance that a postulated fire would not impact these safe shutdown functions. Therefore, due to the lack of separation and the unknown fire resistive rating of the installed barrier, the staff concludes that the level of fire protection provided for the RHRSW cables in the IPS does not provide an equivalent level of fire safety to that required by Section III.G of Appendix R to 10 CFR Part 50. The staff concludes, therefore, that the licensee's request for exemption is not acceptable and is, therefore, denied.

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Dated: January 18, 1994