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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO REQUEST FOR EXEMPTION FROM REQUIREMENTS OF

APPENDIX R TO 10 CFR PART 50

METROPOLITAN EDISON COMPANY

JERSEY CENTRAL POWER & LIGHT COMPANY

PENNSYLVANIA ELECTRIC COMPANY

GPU NUCLEAR CORPORATION

THREE MILE ISLAND NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-289

INTRODUCTION

By letter dated May 25, 1995, GPU Nuclear Corporation (GPUN), the licensee for the Three Mile Island Nuclear Station, Unit 1 (TMI-1), requested an exemption from certain technical requirements of Section III.G.2.c of Appendix R to 10 CFR Part 50. Section III.G.2.c of Appendix R requires the enclosure of cable and equipment and associated circuits of one redundant train in a fire barrier having a 1-hour rating. In addition, fire detectors and an automatic suppression system shall be installed in the fire area.

EXEMPTION REQUESTED

GPUN requested an exemption from the technical requirements of Section III.G.2.c of Appendix R to 10 CFR Part 50 to the extent that it requires enclosure in a fire barrier having a 1-hour rating of the 15-inch long, 9-inch wide and 6-inch high cable tray installed in Fire Zone 1 of the Intake Screen and Pumphouse. To support the request the licensee has performed an evaluation that concluded that the existing cable tray configuration protected with Thermo-Lag 330-1 material has a fire rating of 48 minutes.

EVALUATION

In accordance with 10 CFR 50.12, granting an exemption requires that special circumstances be present such as: (1) application of the regulation conflicts with other rules or requirements, (2) application of the regulation would not serve the purpose of the rule or is not necessary to achieve the purpose of the rule, (3) compliance would result in undue hardship or costs that

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significantly exceed those contemplated when the regulation was adopted, (4) the exemption would result in a benefit to public health and safety, (5) the exemption would provide only temporary relief from the regulation, or (6) there is present other circumstances not considered when the regulation was adopted for which it would be in the public interest to grant the exemption. The licensee has not demonstrated that any of these special circumstances exist concerning the subject cable tray in the Intake Screen and Pumphouse.

The fire testing performed by the nuclear industry has demonstrated that viable upgrades to 1-hour cable trays enclosed in Thermo-Lag fire barriers can be made such that the barrier is qualified to a full 1-hour rating as required by Section III.G.2.c of Appendix R. In a Staff Requirements Memorandum of June 27, 1994, "Options for Resolving the Thermo-Lag Fire Barrier Issue," the Commission approved the staff recommendation to return plants to compliance with existing NRC requirements. The Nuclear Energy Institute (NEI) has issued the "NEI Application Guide for the Evaluation of Thermo-Lag 330 Fire Barrier Systems," which provides information for simple barrier upgrades for configurations similar to the subject cable tray, such as NEI Test 2-8 and Texas Utilities Electric Company's Scheme 13-1. The staff believes that such upgrades can be made to the subject cable tray such that an exemption from the regulation would not be necessary.

The licensee has utilized the equivalent fire severity methodology based on the average combustible load in the fire zone for the evaluation of the fire hazard in the zone, the performance of the existing Thermo-Lag barrier installed on the cable tray and to credit existing sprinkler protection for increasing the cable qualification rating (CQR). This methodology is based on the assumptions that: (1) an equal area under the time-temperature fire exposure curve equates to equivalent fire performance, and (2) that combustible load is the only important factor that determines fire intensity. Both of these assumptions are incorrect, therefore this methodology cannot be used to evaluate the fire hazard or the performance of the Thermo-Lag protected cable tray in this area. The equal area concept is not valid for materials that undergo chemical decomposition or sublimation such as Thermo-Lag. For these types of materials, the total energy that the material is exposed to determines the materials performance, not the temperature, as assumed by the equal area concept. The equal area concept is also invalid for fires that develop more rapidly than the standard time-temperature curve, as would be expected for a combustible or flammable liquids fire. The assumption that combustible load is the only important factor is also incorrect. Important factors such as ventilation, fuel geometry, fuel type, compartment effects and proximity to the target are not considered in the equivalent fire severity method. The application of the equivalent fire severity methodology is limited to light hazard occupancies, where the combustibles are evenly distributed over the floor area, the fuel is normal cellulosic materials such as wood and paper, and the combustibles are located solely at the floor level. This is not representative of the configuration in the Intake Screen and Pumphouse.

The licensee references NUREG/CR-5546 "An Investigation of the Effects of Thermal Aging on the Fire Damageability of Cables," performed by

Sandia National Laboratories, as the basis for determining the thermal damage threshold temperature of cables enclosed in the Thermo-Lag barrier. This approach increases the time rating of the assembly beyond the time at which the temperatures recorded on the raceway exceeded the maximum specified in Supplement 1 to Generic letter 86-10. For this request, the licensee has determined a CQR of 48 minutes. This is a misapplication of the Sandia results, which were intended to evaluate the relative effects of aging, if any, on thermal damage threshold of identical cables. The results were not intended to establish the absolute damage temperature of cable, as is assumed in the GPUN evaluation. In addition, the Sandia test configurations did not place a current load on the cables, which would be necessary to establish the maximum temperature that the cables would remain functional. Therefore, the licensees determination of cable qualification temperatures for the purpose of increasing the fire rating of a barrier assembly is not technically valid.

The licensee references NEI Test 2-7 in their evaluation of the Thermo-Lag fire barrier enclosing the subject 9-inch cable tray. In this test, four different cable tray assemblies were tested, two 24-inch cable trays and two 6-inch cable trays. A 9-inch tray was not tested. The 24-inch cable trays exceeded the maximum allowable temperature specified in Supplement 1 to Generic Letter 86-10, at 21 minutes (Tray A) and at 23 minutes (Tray D). The 6-inch cable trays exceeded the temperature criteria at 48 minutes. The licensee states that the 9-inch tray has a fire rating based on the NEI test of 47 minutes, presumably based on the results of the 6-inch trays. Table 5-1 of the NEI Application Guide states that installed tray sizes not tested should be evaluated on the basis of smaller and larger tray sizes tested and states the basis for this bounding configuration is that, because of the structural effects of barrier performance, testing has not provided any correlation between tray size and temperature. Therefore, it is reasonable to conclude, if NEI Test 2-7 is representative of the configuration in the Intake Screen and Pumphouse, using the NEI Application Guide, that the actual rating of the 9-inch tray is between 20 and 47 minutes. therefore, the staff believes that the licensee's conclusion that the assembly has a rating of 47 minutes is not valid.

Supplement 1 to Generic Letter 86-10, specifies the acceptance criteria for the qualification of fire barriers installed to meet NRC fire protection requirements. This guidance specifies the maximum allowable temperatures recorded on the raceway enclosed in the barrier and the hose stream acceptance test criteria. The barrier assemblies tested in NEI Test 2-7 failed the temperature criteria and the hose stream test criteria. The licensee's evaluation did not address the hose stream aspects of the acceptance criteria specified in Supplement 1 to Generic Letter 86-10.

The important parameters for the evaluation of Thermo-Lag fire barriers developed by NEI, and provided to the licensee in a letter dated December 21, 1993, have not been addressed in the submittal. In a letter to the NRC dated October 31, 1995, the licensee stated that five fire barrier envelopes were dismantled and that important installation parameters were verified, no comparison to the industry tested configurations was provided in the submittal. The licensee's exemption request and supporting evaluation are dated May 5, 1995, approximately 5 months prior to the destructive

examinations. Any evaluation prepared by the licensee that uses generic test data to evaluate the fire performance of Thermo-lag barriers installed at the plant should specifically address each important installation parameter. For example, the total enclosed thermal mass of the plant installed configuration and the tested configuration should be evaluated.

CONCLUSION

On the basis of its evaluation, the staff concluded that the existing 9-inch cable tray protected with Thermo-Lag does not provide a level of safety equivalent to that achieved by compliance with Section III.G.2.c of Appendix R to 10 CFR Part 50, and that the licensee has not demonstrated that the special circumstances specified for an exemption under 10 CFR 50.12 have been met. Therefore, the licensee's request for an exemption from the technical requirements specified in section III.G.2.c of Appendix R to 10 CFR Part 50 for the 9-inch cable tray located in Fire Zone 1 of the Intake Screen and Pumphouse should be denied.

Principal Contributor: E. Connell

Date: January 5, 1996

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

December 29, 1995

Mr. Percy M. Beard, Jr.
Senior Vice President,
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ATTN: Manager, Nuclear
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SUBJECT: REVIEW OF EPRI TC TOOLS FIRE MODEL - (TAC NO. M85541)

By letter dated August 8, 1995, you submitted information on the development and use of the EPRI Tailored Collaboration Fire Modeling Tools methodology. The staff has completed its review of the submittal. Our comments are attached.

At a public meeting on October 19, 1995, you indicated that the EPRI methodology would not be used as the basis for evaluating the performance of Thermo-Lag barriers installed to meet NRC fire protection requirements at Crystal River; therefore, unless you change your position on the use of the EPRI methodology you need not respond to the attached comments. Since Crystal River is a Nuclear Energy Institute application guide lead plant, however, it is appropriate to forward our comments to you. We request that you forward these comments to your contact at EPRI.

If Florida Power Corporation chooses to use this methodology as the basis for evaluating Thermo-Lag fire barriers in the future, the staff will conduct a through review of the development and application of the methodology and its supporting technical bases. If you have any questions regarding this matter, please contact me at (301) 415-1494.

Sincerely,

George F. Wunder

George Wunder, Project Manager
Project Directorate II-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosure: As stated

cc w/enclosure: See next page

Enclosure 2

Enclosure

COMMENTS BY THE OFFICE OF NUCLEAR REACTOR REGULATION
EPRI TC TOOLS METHODOLOGY FOR EVALUATING THERMO-LAG FIRE BARRIERS

I. Introduction

By letter dated August 8, 1995, Florida Power Corporation (FPC) submitted a non-proprietary version of information regarding the development and use of the EPRI Tailored Collaboration (TC) Fire Modeling Tools at Crystal River, Unit 3, in response to questions raised by the NRC staff during an April 25, 1995, public meeting on the subject, and a request for additional information dated July 6, 1995. The following questions and comments are based on NRC staff review of the submittal of August 8, 1995.

II. Total Heat Load Concept

1. The EPRI methodology assumes that the fire barrier material's thermal properties remain constant throughout the fire exposure. Thermo-Lag undergoes sublimation, chemical decomposition, and charring throughout the fire exposure. Therefore, it is not reasonable to assume that the thermal properties are constant.

2. The radiative heat transfer equations used by EPRI are based upon the furnace gas temperatures and the exposed surface temperatures of the barrier only ($q \sim T^4$). The exposed surface temperature is generally not of interest when evaluating fire barrier performance, only the unexposed surface temperature is of value. The heat transfer from the exposed surface to the unexposed surface of the barrier is primarily through conduction. Since instrumentation is generally not provided on either the exposed or unexposed surface of the barrier (instrumentation is provided on the raceway), no test data is available to validate the EPRI methodology. The methodology does not account for radiation from the furnace enclosure and the emissivity of materials/gases and shape factors that affect radiative heat transfer. Provide a technical basis for the assertion that radiative heat transfer estimates calculated solely on the basis of recorded average furnace gas temperatures are correct and bounding of all heat transfer between the furnace environment and the barrier assembly.

3. The total heat load concept assumes that fire exposures with an equal area under the incident heat-flux-time curve (BTU/ft^2 over time) equates to equal fire severity, and therefore, equal fire barrier performance. This assumption may be nonconservative for fires that develop more rapidly than the ASTM E-119 exposure. This assumption does not consider the different heat release/exposure rates and the corresponding effect that thermal shock and uneven heating due to a rapidly increasing fire would have on the performance of the fire barrier assembly. Provide a technical basis for the assumption that the total heat load concept is bounding for fires that develop more rapidly than the ASTM E-119 exposure.

4. Based on observations of several fire tests conducted by the NRC and industry involving Thermo-Lag fire barriers, it is apparent that the primary failure mechanism of Thermo-Lag barriers is the opening of the assembly due to structural failure at joints or burnthrough of the material. The opening of the barrier results in temperatures (either single point or average) inside the assembly exceeding the maximum specified by Supplement 1 to Generic Letter 86-10. Provide a discussion how the EPRI methodology addresses structural failures and barrier burnthrough.

III. Impact of Room Characteristics

1. The EPRI methodology asserts that the room configurations used to develop and test correlations used by FIVE can be shown to be conservative when applied to typical power plant compartments. However, this does not appear to be correct for at least the two following configurations:

a. The EPRI methodology assumes that the presence of intervening objects near the ceiling level will decrease the temperatures associated with the plume and ceiling jet and potentially shield the component of interest. This assumption may be nonconservative. The restriction to fluid flow due to an intervening object can result in higher localized temperatures in the hot gas layer (pseudo room concept). If the fire barrier is located in this area it may see a more severe exposure than that predicted by the EPRI methodology. Provide a description of how the methodology addresses localized "hot spots" due to obstructions.

b. The methodology assumes that the presence of a corner in the room will diffuse and distort the ceiling jet causing it to mix more quickly with the hot gas layer, thereby reducing the overall room temperature. This appears to conflict with the conclusions presented by Zukowski (1981) and Hasemi/Tolunga (1984), that for a plume near a wall or corner the entrained air flow is reduced and the temperature is increased. Please resolve the apparent conflict.

2. Identify any differences between laboratory experiments and typical room configurations that may not be conservative, such as the use of heat release rate data from bench-scale tests which do not account for the radiation of energy to the fuel from the compartment boundaries and the sensitivity of the EPRI method to this data. The use of heat release rate data from bench-scale tests, such as the cone calorimeter (ASTM E-1354), is generally limited to comparing the flammability properties of different materials used in a similar application, where the consideration of compartment effects is excluded from the analysis, such as different fabric coverings on furniture. Provide a discussion on the applicability of bench scale data to predicting full-scale fire performance in an actual nuclear power plant compartment.

IV. Effects of Forced Ventilation

1. The methodology does not account for the increase in mass flow into the plume as a result of an increase in the deflection angle of the plume which results in an effectively "taller" plume which corresponds to more rapid fire development, higher room temperatures, and quicker fuel exhaustion. Air entrainment is dependent upon flame height. Provide a technical basis that demonstrates the methodology is conservative and bounding to address flame deflection angle.

2. The cable flammability data referenced from the projects completed by Factory Mutual for EPRI may be in error (Ref.: Ltr. to EPRI from A. Tewarson, FMRC dated 5/10/95). Provide a discussion how this data is used in the methodology and the sensitivity of the methodology to cable flammability data.

3. Plume generated wind velocity is not discussed in the EPRI methodology. This phenomenon was present at the HDR fire tests conducted in Germany where the actual recorded compartment temperatures significantly exceeded those predicted by the fire models. The increase in the deflection angle of the plume resulted in higher room temperatures due to increased air entrainment. Provide a description of how plume generated wind velocity and its corresponding effects of fire severity are addressed by the methodology.

V. Fire Propagation of Cable Trays

1. The EPRI methodology assumes an ignition temperature of 932° F for IEEE 383 rated cables. Sandia National Laboratory reported a piloted ignition temperature of less than 617° F for IEEE 383 rated cables in NUREG/CR 5546. Provide a sensitivity analysis for the methodology using the more conservative flammability data reported by Sandia.

VI. Combustibility and Flame Spread of Thermo-Lag in Hazard Tool

1. No technical basis is provided for the assumption that a burning efficiency of 0.5 to 0.7 is appropriate for Thermo-Lag. It is not clear how observed fire tests of Thermo-Lag barriers support this assumption. Provide a technical basis for this assumption.

2. The methodology states that in furnace tests the Thermo-Lag is burning if it is in an environment above 1000° F. In the fire endurance tests of Thermo-Lag barriers witnessed by the staff, the material ignited in less than 2 minutes, at this point the average furnace temperature is less than 500° F. Provide a sensitivity analysis for the methodology using a more conservative ignition temperature of 500° F.

VII. Overview of the Development of the Tool

1. The EPRI Tool focuses on the behavior of individual barrier segments to determine the fire rating of an entire assembly. The staff believes that the interface points between segments and the thermal mass enclosed

within the barrier are also important in establishing the fire rating of an assembly. These factors do not appear to be addressed by the EPRI Tool. Provide a discussion of how the methodology addresses interfaces between segments and the thermal mass enclosed within the barrier assembly.

2. The EPRI Tool implies that the configurations tested by NEI, TVA and TU Electric were similar. Although similar raceway configurations (e.g., 2-inch diameter conduit with LBDs in a U-shape) were tested, the test assemblies were significantly different. This was due largely to the different methods of fire barrier assembly. Provide a discussion of how the different methods of assembly that affect fire endurance performance and the structural integrity of the assembly are addressed by the EPRI methodology.

3. The staff position on important installation parameters is documented in the request for additional information of December 1993. These parameters were agreed to with NEI during the industry test program of Thermo-Lag fire barrier assemblies. The limited set of parameters identified in the EPRI methodology are not adequate to evaluate barrier performance.

4. The figures regarding postulated fire ratings for various fire barrier segments and configurations, which were discussed during the April 25, 1995 meeting, were not included in the non-proprietary version of the EPRI methodology. However, as discussed during the meeting, it does not appear that the limited test data, from dissimilar test assemblies and segments is adequate for deriving the figures. This staff concern was not addressed in the submittal of August 8, 1995.

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