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JPN-93-011

U. S. Nuclear Regulatory Commission
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SUBJECT: James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Fire Protection Program
Safe Shutdown Power Supply AC-DC Coordination Analysis

Reference: 1. NYPA letter, R. E. Beedle to the NRC, dated December 22, 1992, (JPN-92-074), regarding the Safe Shutdown Power Supply AC-DC Coordination Analysis.

Attachment: 1. AC/DC Electrical Distribution System Coordination Analysis, Revision 1

Dear Sir:

Reference 1 provided a description of the AC and DC electrical distribution system coordination analysis performed in conjunction with the James A. FitzPatrick Nuclear Power Plant 10 CFR 50, Appendix R, Safe Shutdown Capability Assessment. The submittal required two corrections (described below) and thus is being resubmitted (Attachment 1) with revision bars.

The prior submittal, which indicated that there were four MCCs that lacked adequate coordination with their supply breakers, was based on the original methodology used during the original plant design. Subsequent analysis determined that this original methodology was incorrect and also indicated that there were an additional three MCCs that lacked adequate coordination with their supply breakers. Of the three additional MCCs, only 71MCC-262 resulted in Appendix R noncompliance. FitzPatrick personnel generated an occurrence report and informed the NRC of the Appendix R noncompliance by phone on January 21, 1993. The lack of adequate coordination associated with 71MCC-262 was promptly corrected. The first paragraph on page 2 and the second paragraph on page 3 have been revised; and Reference 5 on page 5 has been added.

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The second correction is typographical. The first sentence on page 2 had the word "breaker" used twice. The second "breaker" has been deleted.

If you have any questions, please contact Mr. J. A. Gray, Jr.

Very truly yours,

Ralph E. Beedle

cc: Regional Administrator
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ATTACHMENT 1

JAMES A. FITZPATRICK NUCLEAR POWER PLANT
NEW YORK POWER AUTHORITY
DOCKET 50-333

AC/DC Electrical Distribution System Coordination Analysis, Revision 1

A breaker coordination analysis, using the 10 CFR 50 Appendix R circuit fault protection criteria, was performed for the AC/DC electrical distribution system to determine the effects of fire-induced electrical faults on cables associated by common power supply. The results were incorporated into the FitzPatrick 10 CFR 50 Appendix R Safe Shutdown Capability Assessment (Reference 1).

Background

The FitzPatrick Safe Shutdown Capability Assessment demonstrates that at least one shutdown method is available following the postulated fire in each fire area of the plant. A fire area is a region of the plant isolated from other areas of the plant by fire barriers, spatial separation, or water curtains in accordance with 10 CFR 50, Appendix R or an NRC approved exemption. The assessment assumes loss of all equipment within the area subject to the Appendix R fire, except where justified by a specific evaluation and/or exemption. However, fire-induced cable faults within the fire area may disable equipment located in other areas of the plant if the cable is fed from a common power source (load center, distribution panel, or motor control center).

Each power source is protected by a supply circuit breaker and each branch circuit supplied from the power source is protected by a branch circuit breaker. The available short-circuit current in a branch circuit during a fire-induced electrical fault is dependent upon the total available short-circuit power from sources and the impedance of the cable between the branch circuit breaker and the point of the fault. The shorter the distance between these two points, the lower the impedance, and the higher the fault current. Low impedance may generate a sufficiently high fault current to potentially trip the power source supply breaker before the branch breaker due to a race to trip between the two breakers. In this situation, equipment fed from all branch circuits associated with the power source will become unavailable.

A potential problem does not exist if there is adequate electrical coordination between the supply and branch circuit breakers. Adequate coordination exists if there is sufficient cable impedance to assure that the fault current is below the trip setpoint of the supply breaker. If adequate electrical coordination does not exist, the equipment fed from other branch circuits will be considered unavailable for the duration of the event or until corrective measures are taken.

Methodology

The 4160VAC and 600VAC Electrical Distribution System Analysis evaluated the breaker time-current characteristic curves (CALC-E drawings and ECAFs - References 4 and 5), and the worse-case fault current to determine if adequate coordination exists. The CALC-E drawings and the ECAFs depict time-current characteristic curves for both the main and feeder breakers of a given load center. In cases where the curves do not overlap, the breakers are coordinated regardless of the fault current.

The 120VAC/125VDC Electrical Distribution System Analysis calculated the length of cable required for adequate coordination. The point on the cable providing the minimum impedance needed to assure breaker coordination is referred to as the "coordination point." A fire-induced fault at a location on the cable beyond the coordination point will assure adequate coordination. A cable fault at a location on the cable before the coordination point would not assure breaker coordination, in which case all equipment fed from the power source is considered unavailable.

The routings of the associated cables were checked to determine which fire areas they pass through. If a cable stayed in the same fire area as the power source to which it was connected, no further evaluation was required since the power source and the equipment it supplied are considered lost in the Appendix R separation analysis. For cables entering different fire areas, a coordination analysis was performed as follows:

1. The branch circuit coordination cable length was calculated. This is the minimum length of cable necessary for providing sufficient cable impedance to assure that the fault current is below the trip setpoint of the supply breaker, thus allowing selective coordination between the branch and supply breakers.

2. The fire areas where the branch circuit cable coordination point occurs was determined by locating the coordination point on the conduit plans using the cable and raceway lists, and correlating the point to a location on the fire area drawings.

Coordination Criteria

1. A branch circuit breaker will coordinate with its power source supply breaker during an Appendix R fire only if the fire occurs in a fire area beyond the calculated coordination point; i.e., the cable coordination point is reached prior to the point where the cable enters the area with the assumed Appendix R fire.

2. If the branch circuit cable coordination point is located in the area with the Appendix R fire, coordination between the branch and supply circuit breakers will not be achieved since the fire may damage the cable before the coordination point.

3. If the branch circuit cable coordination length exceeds the actual cable length, coordination between the branch and supply circuit breakers can not be achieved.

If the fire-induced fault occurs at a point on the cable before the coordination point then there is a race to trip between the branch and supply circuit breakers. In this situation, the Safe Shutdown Capability Assessment conservatively assumed that the supply breaker trips first

rendering inoperable safe shutdown equipment fed from other branch circuits associated with the same power source. The analysis identified branch circuit cables lacking adequate coordination. This information was entered into the "Integrated Nuclear Data Management System" computerized database used in the 1992 Safe Shutdown Capability Assessment.

Summary of Results

4160 VAC and 600 VAC Electrical Distribution System Coordination Analysis

Breaker coordination at the 4160V and 600V levels was determined using coordination time-current characteristic curves for the safe shutdown power supplies. Short circuit current values were identified on the CALC-E drawings and ECAFs (References 4 and 5). The review concluded that except for seven motor control centers (MCCs) all of the remaining safe shutdown power supplies at the 4160V and 600V level have proper breaker coordination in the event of an Appendix R fire. The and seven MCCs lacking adequate coordination with their supply breakers are 71MCC-153, 155, 163, 165, 253, 262 and 263. A computer analysis (described in Section 6 of the 1992 Safe Shutdown Capability Assessment Report) considers this lack of coordination on safe shutdown capability. The Safe Shutdown Method Survivability Report described in Section 6.3.7 of the Safe Shutdown Capability Assessment (Reference 1) identifies the surviving safe shutdown methods available for each fire area. The Report demonstrates that at least one safe shutdown method would survive a fire in each area. The lack of adequate coordination associated with 71MCC-262 was promptly corrected.

120 VAC Electrical Distribution System Coordination Analysis

The analysis considered the branch circuit cable coordination length values for all of the 120 VAC power sources (nine distribution panels) supplying safe shutdown equipment except for panel 71ACUPS-2. Panel 71ACUPS-2 was not evaluated because it is supplied from an evaluated power source (71ACUPS-1) and does not feed safe shutdown equipment. The fault current limit associated with the coordination length for each branch circuit cable was determined from the manufacturer's time-current curves for the branch and supply circuit breakers. This fault current limit corresponds to the point at which the time-current characteristics of the branch breaker overlaps with the time-current characteristics of the supply breaker.

The calculated coordination lengths were compared to the cable routing to determine the fire area where the branch circuit cable coordination point occurs. The analysis identified 15 branch circuit cables that were not coordinated with the supply circuit breakers. A computer analysis (described in Section 6 of the 1992 Safe Shutdown Capability Assessment Report) considers this lack of coordination on safe shutdown capability. The Safe Shutdown Method Survivability Report described in Section 6.3.7 of the Safe Shutdown Capability Assessment (Reference 1) identifies the surviving safe shutdown methods available for each fire area. The Report demonstrates that at least one safe shutdown method would survive a fire in each area.

125 VDC Electrical Distribution System Coordination Analysis

The analysis considered the branch circuit cable coordination length values for all of the 125VDC power sources (six distribution panels and five battery MCCs) supplying safe shutdown equipment. Branch circuits on panels 71DCA4 and 71DCB4 were not evaluated in the analysis since their power source supply cables have sufficient impedance to achieve coordination.

The fault current limit associated with the coordination length for each branch circuit cable was determined from the manufacturer's time-current curves for the branch and supply circuit breakers. This fault current limit corresponds to the point at which the time-current characteristics of the branch breaker overlap with the time-current characteristics of the supply breaker. The coordination length is the calculated length of cable needed to limit the fault current below the point where the curves overlap.

For MOV loads, a short circuit was postulated between the conductors at the end of the coordination length, regardless of whether or not the cables are routed in separate raceways. A Thevenin equivalent resistive circuit was calculated from the point of the fault to the power supply and the calculated coordination lengths were compared to the cable routing to determine the fire area location where the branch circuit cable coordination point occurs.

The analysis identified nine branch circuit cables that did not achieve selective coordination between the branch and supply circuit breakers. A computer analysis (described in Section 6 of the 1992 Safe Shutdown Capability Assessment Report) considers this lack of coordination on safe shutdown capability. The Safe Shutdown Method Survivability Report described in Section 6.3.7 of the Safe Shutdown Capability Assessment (Reference 1) identifies the surviving safe shutdown methods available for each fire area. The Report demonstrates that at least one safe shutdown method would survive a fire in each area.

References

1. 1992 Safe Shutdown Capability Assessment for the James A. Fitzpatrick Nuclear Power Plant, transmitted by letter dated October 26, 1992, (JPN-92-064), R. E. Beedle to the NRC.

2. 120 VAC Electrical Distribution System Coordination Calculations: JAF-CALC-ELEC-00468 Rev. 1, 11-19-92; 00469 Rev. 0,10-7-92; 00470 Rev. 1, 11-19-92; 00471 Rev. 1, 11-19-92; 00472 Rev. 1, 11-19-92; 00473 Rev. 1, 12-9-92; 00474 Rev. 0, 10-7-92; 00475 Rev.0, 10-7-92; 00476 Rev. 0, 10-7-92; 00640 Rev. 0, 11-13-92.

3. 125 VDC Electrical Distribution System Coordination Calculations: JAF-CALC-ELEC-00457 Rev. 0, 10-16-92; 00458 Rev. 0, 10-16-92; 00459 Rev. 0, 10-16-92; 00460 Rev. 0, 10-16-92; 00461 Rev. 0, 10-19-92; 00462 Rev. 1, 10-15-92; 00463 Rev. 1, 10-15-92; 00464 Rev. 1, 10-16-92; 00465 Rev. 1, 10-16-92; 00466 Rev. 1, 10-16-92; 00467 Rev. 1, 10-16-92; 00725 Rev. 0, 11-5-92.

4. Time-Current Characteristic Curves 11825-CALC-E-117, 10/31/74; 118, 10/31/74; 119, 10/31/74; 120, Rev. 2, 9/15/92; 122, Rev. A, 12/12/85; 123, 10/31/74; 124, 10/31/74; 125, 10/31/74; 126, 10/31/74; 129, Rev. A, 12/12/85; 130, 10/31/74; 163, 10/31/74; 164, 10/31/74; 165, Rev. 1, 9/22/89; 166, 8/5/92; 167, Rev. 1, 9/20/89; 168, 10/31/74; 169, 10/31/74; 170, Rev. 1, 8/16/91; 172, Rev. 1, 9/20/84; 245, Rev. 1, 11/2/90; 251, Rev. 1, 11/2/90; 252, 10/31/74.

5. Electrical Coordination Adequacy Forms JAF-ECAF-MCC262-OA2, Rev. 0; MCC253-OC1, Rev. 0; MCC253-OC5, Rev. 0; MCC263-OB4, Rev. 0; MCC263-OC5, Rev. 0; MCC153-G2A, Rev. 0; MCC163-C2A, Rev. 0; MCC155-OH2, Rev. 0; MCC165-OB2, Rev. 0