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MEMORANDUM TO: K. Steven West, Chief
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Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: Patrick Madden, Senior Fire Protection Engineer
Fire Protection Engineering Section
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Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: SITE VISIT TO QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2, REVIEW OF PLANT AREAS IDENTIFIED BY THE IPEEE AS FIRE VULNERABILITIES AND THE INTERIM ALTERNATIVE SHUTDOWN METHOD (TAC NOs. M83665 and M83666)

On April 29-30, 1997, Patrick M. Madden and Edward A. Connell, Office of Nuclear Reactor Regulation; Harold Ornstein, Office of Analysis and Evaluation of Operational Data; Nathan Siu, Office of Nuclear Regulatory Research; Ronald Gardner and Doris Chyu, Region III; and Keith Walton, Resident Inspector Quad Cities, Region III, visited Quad Cities Nuclear Power Station, Units 1 and 2 and reviewed the plant areas associated with the more significant fire vulnerabilities and review the provisions of the Interim Alternative Shutdown Method (IASM).

On April 30, 1997, a site visit de-briefing meeting was held with the licensee. The NRC assessment team expressed the following views:

In the interim while long term fixes are being assessed, the licensee should consider reviewing the existing automatic fire protection suppression and detection systems to ensure that they are properly designed to mitigate or control their respective fire hazards and that they meet applicable industry fire protection standards.

The various operational methodologies used to achieve post-fire safe shutdown are complex, require extensive operator manual actions and work arounds, and require sharing systems, components, and equipment between units. The team requested that the licensee consider developing post-fire safe shutdown methodologies that are unit specific. Specifically, the team considered the use of equipment, components, or systems from the non-fire affected unit to shutdown the fire affected unit as a major contributor to the fire vulnerabilities at Quad Cities.

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Overall, the IASM was viewed as a positive compensatory measure. However, the team was concerned with: (1) the logistics and timing of implementing its hookup to its reactor injection path and to the connection of its alternative power supply to the ADS valves; (2) Emergency lighting in the reactor building area where the manual ADS wiring connections are required did not appear to be adequate with respect to supporting these operator actions. The lighting weaknesses may contribute to an increased potential for errors in performing the wiring tie-in of the alternate control power supply to the ADS valves.

In addition, the team was concerned with the known weaknesses associated with the capabilities of the IASM in that (1) its implementation requires the core to be completely uncovered (blown down below active fuel and depressurized below 250 psi); (2) fuel cladding damage is probable; (3) the potential for thermal shock to the vessel and fuel exists.

The attached trip report documents the team's impressions. On May 20, 1997, the team met with NRC management to discuss the results of the visit and its concerns regarding the recently identified fire vulnerabilities at Quad Cities.

Docket Nos.: 50-254 and 50-265

Attachment: As stated

ATTACHMENT

TRIP REPORT

TRIP DATES: April 29-30, 1997

NRC STAFF PERSONNEL:

Office of Nuclear Reactor Regulation (NRR):

Patrick M. Madden, Senior Fire Protection Engineer
Edward A. Connell, Senior Fire Protection Engineer

Office of Analysis and Evaluation of Operational Data (AEOD):

Harold Ornstein, Senior Reactor Systems Engineer

Office of Nuclear Regulatory Research (RES):

Nathan Siu, Senior Level Advisor for PRA

NRC Region III:

Ronald Gardner, Branch Chief, Engineering Specialist Branch 2
Doris Chyu, Reactor Inspector
Keith Walton, Resident Inspector Quad Cities

PLANT: Quad Cities Nuclear Power Station, Units 1 and 2

LICENSEE: Commonwealth Edison Company

SUBJECT: SITE VISIT TO REVIEW THE PLANT AREAS IDENTIFIED BY THE IPEEE AS FIRE VULNERABILITIES AND THE INTERIM ALTERNATIVE SHUTDOWN METHOD (TAC NOs. M83665 and M83666)

1. LICENSEE PERSONNEL CONTACTED:

J. Masterlink, Site Engineering
W. Lamb, Site Engineering
J. Brownell, Site Engineering
A. Chernick, Regulatory Assurance
L. Pearce, Station Manager
J. Hutchinson, Engineering Manager

2. BACKGROUND

In a letter dated February 17, 1997, Commonwealth Edison Company (ComEd), the licensee for Quad Cities, provided the NRC with the results of its Individual Plant Examination of External Events (IPEEE) Analysis. With respect to internal fires, the licensee identified potential vulnerabilities in the fire protection/post-fire safe shutdown programs and procedures which were not previously recognized. The licensee indicated that the IPEEE Core Damage Frequency (due to fire) was 5E-03. The licensee will be taking action to determine whether or not the ability to safely shutdown the reactor in the

control the spread of the oil fire, it could spread to an area not protected.

A large number of Unit 1 safe shutdown systems could be affected by this potential fire including, control cables for Unit 1 High Pressure Core Injection (HPCI), shared Residual Heat Removal (RHR) (trains A/B/C/D), Unit 1 Reactor Core Isolation Cooling (RCIC), Unit 1 Emergency Diesel Generator (EDG), Unit 2 EDG, and Unit 1/2 EDG. Therefore, the licensee's post-fire safe shutdown methodology places a heavy reliance on manual operator actions and the use of Unit 2 systems to shutdown Unit 1. On Unit 1, the licensee has installed and implemented a IASM as backup to the required post-fire safe shutdown method and to compensate for the unavailability of Unit 2 systems during outage periods.

3.3 *Air Compressors Electrical/Oil Fire - CDF = 5.23E-04*

In this area the ignition sources result from 10 separate air compressors located on the Turbine Building ground floor. All the compressors are located in the center of the plant (fire zone 8.2.6.C). Each compressor contains enough oil to ignite the cables in the cable trays located above the compressors. This plant location is common to Units 1 and 2 and has Division I and II safe shutdown cables for both units. The majority of the compressors are in areas without automatic fire detection. The fire involves lube oil, it can develop rather quickly and thermal cable damage can occur rapidly due to the high heat release rate of the oil.

A large number of Unit 1 and 2 safe shutdown systems affected by this potential fire including, control cables for Unit 1 HPCI, shared RHR (trains A/B/C/D), Unit 1 RCIC, Unit 1 EDG, Unit 2 EDG, and Unit 1/2 EDG. Therefore, the licensee's post-fire safe shutdown methodology relies heavily on manual operator actions to shutdown both units using their respective plant systems. Currently on Unit 1, the licensee has installed and implemented a IASM as backup to the required post-fire safe shutdown method. Prior to the re-start of Unit 2, IASM capabilities will be provided for Unit 2.

3.4 *Turbine Oil Reservoir Fire - CDF = 2.99E-04*

In this area the ignition sources result from 8 different pumps on top of the two turbine lube oil reservoirs. These reservoirs contain approximately 13,000 gallons of oil and are diked. Fire protection features consist of a deluge system actuated by thermal detectors and ceiling mounted smoke detectors. Both tanks are located in the center of the plant (fire zone 8.2.7.C) and critical cable trays are located above the reservoirs. This location is considered common and has Division I and II cables safe shutdown for both units. This fire can develop rather quickly and thermal cable damage can occur rapidly and prior to the reservoir deluge system actuating. This is due to the high heat release rate of the oil.

A large number of Unit 1 and 2 safe shutdown systems can be arfected by this potential fire. For example, the fire could damage control cables for Unit 1 HPCI, shared RHR (trains A/B/C/D), Unit 1 RCIC, Unit 1 EDG, Unit 2 EDG, and Unit 1/2 EDG. For this area, the licensee's post-fire safe shutdown methodology relies heavily on manual operator actions to shutdown both units

control of the fire by the fire brigade due to close proximity of equipment and cabling. The room is enclosed by 3-hour fire barriers and its tightness will contribute to the rapid development of a hot gas layer which could lead to damage to some or all of the components with in the compartment.

Both redundant trains of safe shutdown cabling for both units are located in this room. This area is designated as an alternative safe shutdown area. This fire requires both units to be shutdown from outside the control room. This post-fire safe shutdown methodology relies heavily on manual operator actions (e.g., isolating power sources by racking out breakers, pulling control power fuses for critical components in order to isolate spurious operations, and manual valve manipulations to align critical flow paths) to shutdown both units using their respective plant systems. Unit 1 has installed and implemented a IASM as backup to the required post-fire safe shutdown method. Prior to the re-start of Unit 2, IASM capabilities will be provided for Unit 2.

3.9 *DC Switchgear Room B Transient Fire - CDF = 8.16E-05*

Due to the small area and volume of DC Switchgear Room B, a transient fire could develop quickly and expose all equipment located within it in a short amount of time. Damage is expected to occur prior to fire control by the fire brigade. The limited volume of this room could facilitate the rapid development of a hot gas layer which would damage the equipment located within the room.

Potential fire damaged equipment includes both Division I and II DC control power because of alternate power feed into this room. Both redundant trains of safe shutdown cabling for both units are located in this room. This area is designated as an alternative safe shutdown area. This fire requires both units to be shutdown from outside the control room. This post-fire safe shutdown methodology relies heavily on manual operator actions (e.g., isolating power sources by racking out breakers, pulling control power fuses for critical components in order to isolate spurious operations, and manual valve manipulations to align critical flow paths) to shutdown both units using their respective plant systems. Unit 1 has installed and implemented a IASM as backup to the required post-fire safe shutdown method.

3.10 *DC Switchgear Room A Transient Fire - CDF = 8.16E-05*

See the DC Switchgear Room B fire description above. Prior to the re-start of Unit 2, IASM capabilities will be provided for Unit 2.

3.11 *Unit 2 Reactor Feed Pump Oil Fire - CDF = 3 x 7.88E-05*

See the Unit 1 feed pump fire description above. Prior to the re-start of Unit 2, IASM capabilities will be provided for Unit 2.

hookup to its reactor injection path and its connection of its alternative power supply to the ADS valves; (2) Emergency lighting in the reactor building area where the manual ADS wiring connections are required did not appear to be adequate with respect to supporting these operator actions. The lighting weaknesses may contribute to an increased potential for errors in performing the wiring tie-in of the alternate control power supply to the ADS valves.

In addition, the team was concerned with the known weaknesses associated with the capabilities of the IASM in that: (1) its implementation requires the core to be completely uncovered (blown down below active fuel and depressurized below 250 psi); (2) fuel cladding temperatures heating up to 1800° F and damage is probable, and (3) the potential for thermal shock to the vessel and fuel exists.

The team was concerned with the reliability of the pumps (diesel fire pumps) and their capacity with respect to supporting this core cooling function. The team suggested that the licensee re-visit the adequacy of the IASM.

The team noted that the licensee should assess additional short term actions focused on reducing the potential for fire in the most vulnerable plant areas.

5. CONCLUSIONS

On the basis of its reviews and walkdowns, the team concluded a major contributor to the fire vulnerabilities is the normal post-fire safe shutdown method (for fires in general plant areas) which relies on the utilization of equipment/systems from the non-fire affected unit. On the basis of its review of the Quad Cities fire protection program, the staff had accepted this shutdown method. The staff also accepted a method which relied heavily on a large number of manual operator actions (e.g., load shedding; manual valve lineups; manual operation of pumps from load centers) and a number of exemptions from the technical requirements of appendix R. It appears that these factors also contribute to the fire vulnerabilities that exist at Quad Cities.

Based on the "as-built"conditions the team does not view the Quad Cities IPEEE fire analysis as being overly conservative.

6. NRC TEAM RECOMMENDATIONS

6.1 Related to Quad Cities

a. Enhanced compensatory measures (e.g., roving 15 minute fire watches)

b. Enhanced administrative controls (e.g., strict controls over combustibles and hot work)

c. Improved staging of specialized fire fighting equipment which may be needed to combat a fire (e.g., locate foam fire fighting agents and application equipment, spare breathing air cylinders, etc., in adjacent fire safe areas).

improvements, and the conditions placed on shared post-fire safe shutdown systems when one unit is operating and the other unit is shutdown.

1. Describe the fire protection compensatory measures (e.g., roving fire watches) and any enhancements that have been made to them as a result of the recently identified fire vulnerabilities. Specifically, describe how they provide reasonable assurance that they are adequate to monitor and act upon any changes in the known fire hazards and assure that no new fire hazards are not introduced into the areas of concern.

2. Describe the fire prevention administrative controls (e.g., controls over combustibles and hot work in these areas) and any enhancements that have been made to them as a result of the recently identified fire vulnerabilities. Specifically, for the areas of concern, describe if there has been any changes made to impose stricter controls over the introduction of fire hazards or ignition sources into these areas.

3. Certain fire hazards may need specialized fire fighting equipment to suppress and control the potential fire Describe any actions that were taken to assess the need for such equipment. Specifically, describe actions taken to improve the availability and staging of such equipment (e.g., locate foam fire fighting agents and application equipment, spare breathing air cylinders, etc.) by moving, distributing and locating it to plant areas that are near the respective fire vulnerabilities.

4. The staff is concerned about the fire protection provided for the MG sets, specifically with the water curtain separating MG set 1A and 2B. The staff views that the risk associated with this area may be higher than has been estimated by the IPEEE. A water curtain is not sufficient to protect personnel and equipment from radiant heat generated by a potential lube oil fire. In addition, the staff is concerned with the application and design considerations associated with water curtain and the potential fire interaction with the other automatic fire suppression systems in the area of concern (see 50.72 report No. 32317). Describe the additional short term fire protective features being considered which will provide assurance that a fire will limit the number of fire suppression systems actuated by a fire in this area and shield plant equipment and personnel from the maximum possible radiant heat flux generated.

5. Describe the administrative controls that were used prior to the identification of the fire vulnerabilities, which assure the operability of required post-fire safe shutdown systems when a unit is operating and the other is shutdown. For example describe the conditions where this equipment may not be available, the time limits that this equipment may be out of service, and the actions taken to restore this equipment. Since the recent identification of the fire vulnerabilities, describe what actions you have taken to provide reasonable assurance that the operability of post-fire safe shutdown systems for the operating unit is maintained when a unit is shutdown or in a degraded condition.