Commonwealth Edison Company
1400 Opus Place
Downers Grove, IL 60515

November 18, 1996

ComEd

U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Document Control Desk

Subject: Braidwood Nuclear Power Station Units 1 and 2
Byron Nuclear Power Station Units 1 and 2
Dresden Nuclear Power Station Unit 1
Dresden Nuclear Power Station Units 2 and 3
LaSalle County Nuclear Power Station Units 1 and 2
Quad Cities Nuclear Power Station Units 1 and 2
Zion Nuclear Power Station Units 1 and 2

Response to NRC Final Report on Spent Fuel Storage Pool Safety Issues

NRC Docket Nos. 50-454 and 50-455
NRC Docket Nos. 50-456 and 50-457
NRC Docket No. 50-010
NRC Docket Nos. 50-237 and 50-249
NRC Docket Nos. 50-373 and 50-374
NRC Docket Nos. 50-254 and 50-265
NRC Docket Nos. 50-295 and 50-304

Reference: NRC Letters to I. Johnson, Resolution of Spent Fuel Storage Pool Safety Issues: Issuance of Final Staff Report and Notification of Staff Plans to Perform Plant-Specific, Safety Enhancement Backfit Analyses, dated September 25 and 26, 1996.

The referenced letters informed ComEd of issues concerning spent fuel storage pool safety. The NRC staff offered to consider comments received by November 15, 1996, addressing the following:

- the staff's understanding of the plant design,
- the safety significance of the design features,
- the cost of potential modifications to address the design features, or
- the existing protection from the design concerns which may be provided by administrative controls or other means.

A001 1/1

This letter provides the ComEd response to these issues, addressing each of the ten issues stated in the Referenced letters for each station. As detailed in the individual station attachments, the NRC's understanding of the ComEd plant designs is generally accurate and we agreed with the NRC evaluation of issues that apply to ComEd stations. ComEd also self-identified several other applicable issues. For those identified issues, we then performed an evaluation of potential safety enhancements, considering both procedure changes and plant modifications.

At this time, ComEd is still assessing the results of our evaluations. However, we will be pursuing a number of procedure changes to enhance the existing protection from the identified design concerns.

ComEd appreciates the opportunity to provide the results of our evaluations on these issues. Should you have any questions on this matter, please contact us.

Respectfully,

John B. Hosmer

John B. Hosmer
Vice President Engineering

Attachments:
A) Byron and Braidwood Evaluation of SFP Storage Safety Issues
B) Dresden Unit 1 Evaluation of SFP Storage Safety Issues
C) Dresden Units 2 and 3 Evaluation of SFP Storage Safety Issues
D) LaSalle County Evaluation of SFP Storage Safety Issues
E) Quad Cities Evaluation of SFP Storage Safety Issues
F) Zion Evaluation of SFP Storage Safety Issues

cc:
A. Beach, Regional Administrator - RIII
R. Capra, Project Directorate - NRR
R. Assa, Braidwood Project Manager - NRR
G. Dick, Byron Project Manager - NRR
J. Stang, Dresden Project Manager - NRR
D. Skay, LaSalle Project Manager - NRR
R. Pulsifer, Quad Cities Project Manager - NRR
C. Shiraki, Zion Project Manager - NRR
C. Phillips, Senior Resident Inspector - Braidwood
S. Burgess, Senior Resident Inspector - Byron
C. Vanderniet, Senior Resident Inspector - Dresden
M. Huber, Senior Resident Inspector - LaSalle
C. Miller, Senior Resident Inspector - Quad Cities
R. Westberg, Acting Senior Resident Inspector - Zion
Office of Nuclear Facility Safety - IDNS

ATTACHMENT A
Byron/Braidwood Evaluation of SFP Storage Safety Issues

Issue

1. **Absence of Passive Antisiphon Devices on Piping Extending Below the Top of Stored Fuel**

This issue is related to a potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. The Spent Fuel Pools at Byron and Braidwood Stations do not have any piping systems or components that extend below the top of stored fuel in the pool. The SFP cooling water return lines do enter the top of the Spent Fuel Pools and extend down to >5'4" above the top of any stored fuel assemblies at Byron Station and >6' at Braidwood Station. In addition, these lines are equipped with passive anti-siphon devices at normal pool level that prevent the drain down of the Spent Fuel Pool due to an inadvertent siphoning event.

2. **Transfer Tube(s) Within SFP Rather than Separate Transfer Canal**

This issue is concerned with transfer tubes that are normally open during refueling operations. When these openings are below the top of the stored fuel, any drain path from the refueling cavity has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Byron and Braidwood Stations do not have a Transfer Tube which penetrates the Spent Fuel Pool. Both stations are designed with a separate Transfer Canal which contains the Fuel Transfer Tube. The design configuration of the Transfer Canal at both stations is such that a potential draindown of the Spent Fuel Pool due to failure of the Transfer Canal gate seal and the Cask Fill Area gate seal along with an open Transfer Tube, would not expose any stored fuel assemblies to air. In this scenario, there would still be 2'6" of water at Byron Station and 3'2" of water at Braidwood Station above the top of any stored fuel assemblies.

3. **Piping Entering Pool Below Top of Stored Fuel**

This issue concerns a pipe break that has the potential to drain coolant to such an extent that fuel could be exposed to air.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Byron and Braidwood Stations have no piping that enters the Spent Fuel Pool at or below the top of the stored fuel assemblies.

4. Limited Instrumentation for Loss of SFP Coolant Events

This issue concerns insufficient instrumentation to reliably alert operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. At both Byron and Braidwood Stations, there is reliable instrumentation that provides control room indication to the operators when the water level in the Spent Fuel Pools reaches either the high or low level setpoints. In addition, instrumentation is provided to measure the temperature of the water in the Spent Fuel Pools and to give local indication as well as annunciation in the control room when normal temperatures are exceeded. Instrumentation is also provided to give local indication of the temperature of the Spent Fuel Pool water as it leaves either heat exchanger. Local instrumentation is also provided at locations upstream and downstream from each Spent Fuel Pool filter so that the pressure differential across these filters can be determined. Finally, instrumentation is provided to measure and give local indication of the flow in the outlet line of each Spent Fuel Pool filter. Both Byron and Braidwood Station Operating Procedures require that monitoring of the SFP local instrumentation is performed as part of the Operator Equipment Daily Rounds. In total, the available instrumentation, both local and in the control room, provides adequate indication to the operators of a sustained loss of spent fuel cooling.

5. Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

This issue is a concern where SFP coolant inventory is not easily isolated following events that breach the SFP liner.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. At Byron and Braidwood Stations, a failure of the SFP liner that allows leakage of the pool water past the liner (such as the rupture of a seam) as a result of a seismic event would not have any adverse effects on fuel in the pool or on any safety-related equipment in the plant. Continuous drains are provided at most liner weld seams for leak detection. These drains are interconnected and any leakage through the liner is channeled to five 1-1/2 inch drain pipes . The drain piping is embedded in the concrete structure up to Spent Fuel Pool column-row W, where it joins the auxiliary building floor drain system. At the point where the drain piping emerges from the concrete wall, five isolation valves and sight glasses (one per drain line) are provided. Any leakage past the liner would be collected by the drain piping and stopped by the valves. No other liner leakage paths exist. Both Byron and Braidwood Station Operating Procedures require that monitoring of potential SFP leakage is performed as part of the Operator Equipment Daily Rounds.

6. Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling, the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short period of time (e.g. 4-10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Byron and Braidwood Stations are both two (2) unit sites. Each site has a shared Spent Fuel Pool that is located in a separate fuel handling building located between and adjacent to both unit containment buildings. The ventilation systems for the fuel handling buildings at both Byron and Braidwood Stations are designed to ensure that there is no impact on safety related equipment in other areas of the station such as the operating unit. At both sites, the Fuel Handling Building and Spent Fuel Pool ventilation system flows to a common discharge plenum in the Auxiliary Building. From there, the air mixture is exhausted to the unit discharge stacks. The Auxiliary Building ventilation systems at each site are designed as once through systems and are not operated in a recirculation configuration. In addition, the Spent Fuel Pools at each station are serviced by two (2) independent, Safety Category I trains of Spent Fuel Pool cooling. Only one train of the cooling system is required to cool the Spent Fuel Pool. Both trains are capable of being powered from safety related emergency sources of electrical power and station emergency operating procedures provide for this possibility. Therefore, the probability of an extended loss of Spent Fuel Pool cooling is very low. Finally, the design basis fuel pool analyses demonstrated that, in the case of a complete loss of fuel pool cooling following a full core off-load, sufficient time is available to restore cooling capability before bulk pool boiling occurs.

7. Absence of Onsite Power Supply for Systems Capable of SFP Cooling

This issue is concerned with a sustained loss of offsite power at plants without an onsite power supply for SFP cooling that may lead to inadequate decay heat removal.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Both Byron and Braidwood Stations have two (2) independent, Safety Category I trains of Spent Fuel Pool cooling. Both trains are capable of being powered from safety related emergency sources of power and station emergency operating procedures provide for this possibility.

8. Limited SFP Decay Heat Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the Spent Fuel Pool.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Byron and Braidwood Stations are currently analyzed for full core offloads which are part of the current licensing basis. Both

sites have two (2) independent, Safety Category I trains of Spent Fuel Pool cooling. In addition, there are administrative controls in place at each station via the Technical Specifications and procedures that ensure that the design basis for the Spent Fuel Pool is maintained.

9. Infrequently Used Backup SFP Cooling System

This issue is concerned with reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. Both Byron and Braidwood Stations have two (2) independent, Safety Category I trains of Spent Fuel Pool cooling. Only one train of the cooling system is required to cool the Spent Fuel Pool. Both trains are capable of being powered from safety related emergency sources of electrical powers and station emergency operating procedures provide for this possibility. Because of the redundancy and reliability of the cooling system, there is no backup SFP cooling system arrangement at either site.

10. Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

Byron and Braidwood Response:

This issue is not applicable to Byron and Braidwood Stations. At both Byron and Braidwood Stations, instrumentation is provided to measure the temperature of the water in the Spent Fuel Pools and to give local indication as well as annunciation in the control room when normal temperatures are exceeded. Instrumentation is also provided to give local indication of the temperature of the Spent Fuel Pool water as it leaves either heat exchanger. In addition, there is reliable instrumentation that provides control room indication to the operators when the water level in the Spent Fuel Pools reaches either the high or low level setpoints. Instrumentation is also provided at locations upstream and downstream from each Spent Fuel Pool filter so that the pressure differential across these filters can be determined. Finally, instrumentation is provided to measure and give local indication of the flow in the outlet line of each Spent Fuel Pool filter. Both Byron and Braidwood Station Operating Procedures require that monitoring of the SFP local instrumentation discussed here is performed as part of the Operator Equipment Daily Rounds. In total, the available instrumentation, both local and in the control room, provides adequate indication to the operators of a sustained loss of spent fuel cooling

ATTACHMENT B
Dresden Unit 1 Evaluation of SFP Storage Safety Issues

Issue

1. **Absence of Passive Antisiphon Devices on Piping Extending Below the Top of Stored Fuel**

This issue is related to a potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air

Dresden Unit 1 Response:

This issue has been addressed at Dresden Unit 1and is not applicable. Anti-siphon vents have been installed in all of the system piping lines which could possibility siphon the Unit 1 Fuel Pool or Transfer Basin. The anti-siphon vents are inspected periodically to insure they remain operable.

2. **Transfer Tube(s) Within SFP Rather than Separate Transfer Canal**

This issue is concerned with transfer tubes that are normally open during refueling operations. When these openings are below the top of stored fuel, any drain path from the refueling cavity has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

Dresden Unit 1 Response:

This issue has been addressed at Dresden Unit 1and is not applicable. The transfer tube is no longer in use. All of the fuel has been transferred from the reactor to the Fuel Storage Pool and Transfer Basin. The transfer tube has been capped and sealed inside of the Fuel Transfer Tunnel. This cap is now part of the Fuel Transfer Basin boundary.

3. **Piping Entering Pool Below Top of Stored Fuel**

This issue concerns a pipe break that has the potential to drain coolant to such an extent that fuel could be exposed to air.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The Dresden Unit 1 Fuel Pool and Transfer Basin do not have any piping which enters the pools at or below the top of the stored fuel assemblies.

4. **Limited Instrumentation for Loss of SFP Coolant Events**

This issue concerns insufficient instrumentation to reliably alert operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. Dresden Unit 1 has a low level switch which alarms in the Dresden Unit 2/3 Control Room when the water depth in the Fuel Pool falls to 23'-7". The Technical Specification limit for the Unit 1 Fuel Pool is 18'.

5. **Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping.**

This issue is a concern where SFP coolant inventory is not easily isolated following events that breach the SFP liner.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The Dresden Unit 1 Fuel Pool and Transfer Basin do not have a liner or a leakage detection system.

The Unit 1 Fuel Pool and Transfer Basin extend below grade and any leakage from the pool and basin would be into the surrounding ground. The ground would be expected to slow leakage from the pool. The top of active fuel stored in the Fuel Pool and Transfer Basin is below normal ground water elevation. Water leakage from the Fuel Pool or Transfer Basin would stop when level reaches ground water elevation. This will assist in keeping the fuel covered during any Fuel Pool or Transfer Basin failure. The Unit 1 Fuel Pool low level alarm (Set at approximately 18' - 7" above the top of the fuel), ARMs (Area Radiation Monitors) and operator rounds (water level record once a shift) would detect any gross leakage.

The Unit 1 Clean Demin System (normal make-up) and the Fire Protection System (emergency make-up) would be used to make up any leakage and keep the fuel covered.

6. **Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]**

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short time (e.g. 4 -10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The Unit 1 Fuel Pool, Fuel Building and ventilation systems are not shared with Units 2/3. The decay heat rate from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired.

7. **Absence of Onsite Power Supply for Systems Capable of SFP Cooling**

This issue is concerned with a sustained loss of offsite power at plants with out an onsite power supply for SFP cooling that may lead to inadequate decay heat removal.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The decay heat rate from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired.

8. Limited SFP Decay Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the spent fuel pool.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The reactor core has been completely unloaded. Unit 1 Technical Specifications prohibit fuel from being loaded into the reactor core. The decay heat raie from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired.

9. Infrequently Used Backup SFP Cooling System

This issue is concerned with reliance on infrequently operate backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. Dresden Unit 1 does not have a backup SFP cooling system and the primary cooling system is no longer required to be operated due to the low decay heat rate of the stored fuel and has been retired.

10. Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The decay heat rate from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired. Fuel Pool and Transfer Basin temperatures are recorded once a shift by operations during the Unit 1 rounds. They vary between the upper 90's °F in the late summer and upper 70's °F in the winter.

8. Limited SFP Decay Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the spent fuel pool.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The reactor core has been completely unloaded. Unit 1 Technical Specifications prohibit fuel from being loaded into the reactor core. The decay heat rate from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired.

9. Infrequently Used Backup SFP Cooling System

This issue is concerned with reliance on infrequently operate backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. Dresden Unit 1 does not have a backup SFP cooling system and the primary cooling system is no longer required to be operated due to the low decay heat rate of the stored fuel and has been retired.

10. Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

Dresden Unit 1 Response:

This issue is not applicable to Dresden Unit 1. The decay heat rate from the stored fuel is so small that the Unit 1 Fuel Pool Cooling System is no longer required and has been retired. Fuel Pool and Transfer Basin temperatures are recorded once a shift by operations during the Unit 1 rounds. They vary between the upper 90's °F in the late summer and upper 70's °F in the winter.

ATTACHMENT

2

Medical Center

Pennsylvania

tifies that

inverni, M.D.

rily performed the duties of

ardiology

to June 30, 1977

dersigned have affixed their

dical Center this thirtieth

Chairman, Medical Staff Board

Harry Goldberg

Head, Section of Cardiology

Chairman, Division of Medicine

9611210053-1

Albert Einstein

Philadelphia,

This certi

Helio J. Ma

has faithfully and satisfacto

Fellow-C

from *July 1, 1975*

In Witness Whereof *the un*

signatures and the seal of the M

day of *June,* *19 77.*

President

Vice-President and General Director

ATTACHMENT C

Dresden Units 2 and 3 Evaluation of SFP Storage Safety Issues

I. ComEd EVALUATION OF ISSUES

A. Issue 1 - Absence of Passive Anti-siphoning Devices on Piping Extending Below the Top of Stored Fuel

This issue is related to a potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. The only piping entering the spent fuel pool is the Fuel Pool Cooling system discharge lines. These lines extend six (6) feet below the water surface in the Dresden 2 and 3 spent fuel pools. Each discharge line is equipped with an anti-siphoning opening approximately six (6) inches below the water surface. If the anti-siphoning holes were to become plugged during a siphoning event, there would be sufficient water coverage above any fuel assembly in the spent fuel pool (e.g. approximately 16 feet above fuel stored in the racks, approximately 1 foot above fuel in an "up" position on the grapple, and approximately four (4) feet above fuel in an "up" position on the Fuel Preparation Machine). In addition, procedural controls are in place to address a rapid loss of pool coolant, such as, placing fuel in a safe condition, verifying integrity of anti-siphoning holes, and providing makeup to the spent fuel pool.[1, 2]

B. Issue 2 - Transfer Tube(s) Within SFP Rather Than Separate Transfer Canal

This issue is concerned with transfer tubes that are normally open during refueling operations. When these openings are below the top of stored fuel, any drain path from the refueling cavity has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. The units are not equipped with a transfer tube. Each unit is designed with a separate transfer canal between the reactor cavity and the spent fuel pool. The transfer canals are structured to prevent a drain down lower than the top of any stored fuel in the spent fuel pool.

C. Issue 3 - Piping Entering Pool Below Top of Stored Fuel

This issue concerns a pipe break that has the potential to drain coolant to such an extent that fuel could be exposed to air.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. The units have no piping that enters the spent fuel pool at or below the top of the stored fuel assemblies.

D. Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events

This issue concerns insufficient instrumentation to reliably alert operators to a loss of spent fuel pool coolant inventory or a sustained loss of spent fuel pool cooling.

Dresden Units 2 and 3 Response:

This issue is applicable to Dresden 2 and 3. The spent fuel pools do not have direct indication or alarm for a low spent fuel pool level; however, the units are equipped with low-level alarms in the Fuel Pool Cooling system surge tanks. Refer to Section II for further discussion.

E. Issue 5 - Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

This issue is a concern where spent fuel pool coolant inventory is not easily isolated following events that breach the spent fuel pool liner.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. Drain troughs are located beneath the spent fuel pool liner which direct leakage to the spent fuel pool liner drain network. These drains lead to the reactor building floor drain system. The drain outlets are valved open and a flow glass is provided downstream of each valve. Any leakage past the liner could be isolated to limit the spent fuel pool coolant inventory loss. This arrangement aids in locating problem areas and controls flow to the reactor building floor drain sumps. These drain sumps are capable of removing up to 100 gpm, which is greater than any anticipated liner crack leakage (Section 15.7.4 of the UFSAR). The condensate transfer system is normally used to supply makeup water to the spent fuel pool. Under normal conditions, one pump can supply all the necessary makeup requirements which is in excess of any leakage that could conceivably occur.

F. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the spent fuel pool may be sufficiently high that the pool could reach boiling in a short period of time (e.g., 4 - 10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

Dresden Units 2 and 3 Response:

This issue is applicable to Dresden 2 and 3. The spent fuel pools for Dresden 2 and 3 are located in a common area (refuel floor). Communication between the fuel pool area and areas housing safety related equipment does exist through shared ventilation systems and structures. Refer to Section II for further discussion.

G. Issue 7 - Absence of Onsite Power Supply for Systems Capable of SFP Cooling

This issue is concerned with a sustained loss of offsite power at plants without an onsite power supply for spent fuel pool cooling that may lead to inadequate decay heat removal.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. Both units have two (2) trains of Fuel Pool Cooling. Additional cooling capacity is available by aligning one (1) train of Shutdown Cooling to the Fuel Pool Cooling system via spool pieces. The Fuel Pool Cooling pumps and Shutdown Cooling pumps are powered from safety-related busses. In addition, abnormal operating procedures provide guidance to re-establish spent fuel pool cooling during a partial or complete loss of AC power.[3, 4]

H. Issue 8 - Limited SFP Decay Heat Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the spent fuel pool.

Dresden Units 2 and 3 Response:

This issue is not applicable to Dresden 2 and 3. Dresden Station is currently analyzed for full core offloads which are part of the current licensing basis.[5, 6, 7] There are administrative controls in place that ensure the licensing and design bases of spent fuel pool cooling is maintained.[8, 9]

Both units have two (2) trains of Fuel Pool Cooling. The system maximum heat load capacity is approximately 7.25 MBTU/hr.[7] To remove the decay heat from a full core discharge, one (1) train of Shutdown Cooling must be aligned to the Fuel Pool Cooling system via spool pieces. The heat removal capability of each Shutdown Cooling heat exchanger at rated conditions is 27 MBTU/hr.[7] Based on a preliminary assessment assuming reduced cooling flow rates and maximum temperatures, the heat removal capability of one (1) Shutdown Cooling train and one (1) Fuel Pool Cooling train is approximately 22.8 MBTU/hr compared to the maximum heat load with a full core discharge of about 22.6 MBTU/hr.[5] Results from recent Fuel Pool Cooling heat exchanger inspections, however, suggest performance degradation of these heat exchangers. The above assessment will be verified by a formal calculation prior to the next refueling outage (D3R14).

I. Issue 9 - Infrequently Used Backup SFP Cooling Systems

This issue is concerned with reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary spent fuel pool cooling system or low relative capacity of the primary cooling system.

Dresden Units 2 and 3 Response:

This issue is applicable to Dresden 2 and 3. To remove the maximum heat load from a full core discharge, one (1) train of Shutdown Cooling must be aligned to the Fuel Pool Cooling system via spool pieces. Refer to Section II for further discussion.

J. Issue 10 - Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of spent fuel pool cooling.

Dresden Units 2 and 3 Response:

This issue is applicable to Dresden 2 and 3. Indication of coolant temperature is provided in the Main Control Room, including a high-temperature alarm. The temperature sensors are located in the suction piping of the Fuel Pool Cooling systems. Without continuous operation of the Fuel Pool Cooling pumps, temperature indication in the Main Control Room would be lower than actual, which could delay operator identification of a significant loss of cooling event. Refer to Section II for further discussion.

II. Discussion of Identified Issues

The identified issues are discussed in the following order:

Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events;

Issue 10 - Limited Instrumentation for Loss of Cooling Events;

Issue 9 - Infrequently Used Backup SFP Cooling Systems; and

Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

A. Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events

1. Introduction:

As previously discussed, this issue concerns insufficient instrumentation to reliably alert operators to a loss of spent fuel pool coolant inventory. Although Dresden 2 and 3 do not have direct indication or alarm for a low spent fuel pool level, the units are equipped with low-level alarms in the Fuel Pool Cooling system surge tanks. With continuous operation of the Fuel Pool Cooling pumps, the surge tank low-level alarm is the equivalent to a spent fuel pool low-level alarm because the surge tank would rapidly drain once the spent fuel pool level decreases below the surge tank openings. The Fuel Pool Cooling system pump low-discharge pressure alarm would also alert the operators to a change in system performance. However, with the Fuel Pool Cooling pumps secured, a decrease in water level could go undetected by the operators in the Main Control Room. Also, the power source for a unit's surge tank level alarm would be load shed during a loss of offsite power. The installation of direct indication and alarm for low spent fuel pool level would alert the operator of a loss of coolant inventory without delay. Below is an evaluation of this potential safety enhancement.

2. Cost of Modification:

A preliminary estimate was conducted to determine the cost of permanently installing direct indication, including an alarm for low spent fuel pool level to alert the operator of a loss of coolant event without delay. The cost of this modification is estimated to be approximately $50,000.00 per unit. The cost is expected to be higher if a reliable power source is used (i.e., the power source does not load shed during a loss of offsite power).

The cost of this modification and others described in this report is based on the following considerations:

- Direct costs such as hardware, design, engineering, and installation of the modification;
- Indirect costs such as administrative and general expenses, training, procedure and surveillance changes, and occupational exposure; and
- Long term continuing costs such as engineering support added as a result of the modification and long-term maintenance costs.

3. Protective Measures:

During operator rounds, spent fuel pool level is checked and recorded once per shift.[10, 11] In addition to this administrative control, alarms are available in the Main Control Room to alert the operators of a potential loss of coolant event (e.g., below-normal level and low-level in the surge tanks). The annunciator procedures associated with these alarms direct an operator to the affected spent fuel pool to evaluate the water level and provide makeup to the surge tank.[12, 13] If level in the surge tank cannot be recovered and continues to decrease, the Fuel Pool Cooling pumps will eventually trip on low-low level in the surge tank or low-pump suction pressure. Another alarm in the Main Control Room will alert the operators of this condition. The associated annunciator procedure directs the operator to: 1) take corrective action to the clear trip signal; 2) monitor local pool water temperature; and 3) enter the applicable abnormal operating procedure, if cooling cannot be restored.[14] Although not explicitly required to be monitored, the operator will also be aware of level condition while monitoring local temperature indication on the refuel floor, which is required to be checked once per hour when forced cooling is not available.[3]

Since there is an increased potential for a loss of coolant inventory during refueling outages as system boundaries expand to include the reactor cavity and the spent fuel pool, direct indication of level in the reactor cavity and spent fuel pool (with the gates removed) is provided in the Main Control Room. A process computer alarm for the desired level band (corresponding to normal spent fuel pool level) will alert the operators of any inventory loss.[2] To minimize the potential to drain the reactor cavity and spent fuel pool during unit outages, the shutdown risk management program at Dresden 2 and 3 provides a defense-in-depth for inventory makeup capability through pre-outage reviews of planned equipment outages, on-going reviews of the shutdown plant conditions, and increased awareness of plant conditions during plant outages.[9] If a decrease in level is detected, recovery actions and various make-up sources (e.g., Condensate Transfer system, Clean Demineralized Water system, Fire Protection Water system, Unit 2 Condensate system, Low Pressure Injection system, Core Spray system, etc.) are delineated in station procedures.[1, 2]

4. Safety Significance:

The safety significance of the limited instrumentation for loss of spent fuel pool coolant events is minimal. As discussed above, a direct alarm would be unavailable if no pumps for fuel pool cooling are in operation. A review of Problem Identification Forms (PIFs) since January 1995 revealed several unplanned occurrences of this condition. A few of these PIFs documented the loss of one or all Fuel Pool Cooling pumps during normal system operation and while backwashing the fuel pool filter. These trips have been attributed to system design, inadequate procedures, and poor material condition. Recent procedural enhancements and material condition improvements as a result of these findings should eliminate these pump trips.

During this period of recent system operation, the unplanned unavailability of all pumps for spent fuel pool cooling appears to have been less than 0.2% of the time. During periods that spent fuel pool cooling is unavailable, the once per hour local check of fuel pool temperature and level makes it highly likely that any significant loss of spent fuel pool coolant would be detected during the hourly checks or upon restart of one of the pumps.

Additional planned unavailability of spent fuel pool cooling can occur, but station practice has been to schedule work requiring extended unavailability of spent fuel pool cooling for periods when the full core is not off-loaded. The impact of such planned work is minimal because of the long time to boil that would be available.

Provided that the spent fuel pool gates are installed, any leakage would likely be at a rate lower than that analyzed for a spent fuel cask drop event. Section 15.7.4 of the UFSAR gives an estimated leakage rate of 10 to 80 gpm for that event. Even leakage at 80 gpm would not result in a significant drop in pool level between hourly checks. (Operations would, of course, be immediately notified should a fuel pool cask actually be dropped during a cask move.)

If leakage (greater the 5 gpm) between the fuel pool gates were to develop, an alarm would alert the operator of this condition. The associated annunciator procedure would direct the operator to monitor and maintain spent fuel pool water level.[19] Diverse and sufficient makeup sources, as previously discussed, are available to the operator to maintain level (e.g., Condensate Transfer system, Clean Demineralized Water system, Fire Protection Water system, Unit 2 Condensate system, etc.).

During refueling with the reactor vessel head and spent fuel pool gates removed, a potential for a more rapid draindown exists. As discussed above, however, during those conditions a reactor cavity level alarm is available and would alert operators to a loss of spent fuel pool coolant even when no pumps for fuel pool cooling are in operation.

5. Summary and Conclusion:

Because the Dresden low spent fuel pool alarm is based on water level in the spent fuel pool surge tanks, this alarm capability is lost if all pumps for spent fuel pool cooling are lost. This has minimal safety significance, because a review of recent system operation indicates that unplanned unavailability of spent fuel pool cooling has occurred very infrequently. Furthermore, during refueling operation when a potential exists for loss of spent fuel pool coolant due to a reactor cavity draindown event, a reactor cavity level alarm would be in service. Therefore, no further action on this modification is warranted at the present time. However, administrative controls to locally monitor pool level during periods without forced spent fuel pool cooling or during a loss of AC power will be included in site procedures.

B. <u>Issue 10 - Limited Instrumentation for Loss of Cooling Events</u>

1. Introduction:

As previously discussed, this issue is related to instrumentation of limited capability to alert operators to a sustained loss of spent fuel pool cooling. At Dresden 2 and 3, indication and alarm for high spent fuel pool temperature are provided in the Main Control Room. The temperature sensors are located in the suction piping of the Fuel Pool Cooling systems. Power for the instrumentation is from the Instrument Bus and should not be lost during a loss of offsite power. Without continuous operation of the Fuel Pool Cooling pumps, however, temperature indication in the Main Control Room would be lower than actual due to temperature stratification, which could delay operator identification of a significant loss of cooling event. The installation of direct

indication and alarm for high spent fuel pool temperature would alert the operator of a loss of cooling event without delay. Below is an evaluation of this potential safety enhancement.

2. Cost of Modification:

A preliminary estimate was conducted to determine the cost of permanently installing direct indication, including an alarm for high spent fuel pool temperature to alert the operator of a loss of cooling event without delay. The cost of this modification is estimated to be approximately $175,000.00 per unit. A significant portion of the cost is attributed to conduit and cable design and routing requirements.

3. Protective Measures:

During operator rounds, the spent fuel pool water temperature is checked and recorded once per shift.[10, 11] In addition to this administrative control, temperature indication is available in the Main Control Room to alert the operators of a potential loss of cooling event, including an alarm that initiates at 100°F. The annunciator procedure associated with this alarm directs the operator to place another Fuel Pool Cooling train into service. If necessary, one (1) train of Shutdown Cooling would also be placed in the spent fuel pool cooling mode.[15] If the increase in pool temperature is due to a loss of forced spent fuel pool cooling, local temperature indication is required to be monitored once every hour since control room indication can be erroneous due to water stagnation.[3]

Additional temperature indication is available when the Shutdown Cooling train is lined up to the spent fuel pool. To sufficiently alert the operator of a loss of spent fuel cooling capacity, the Shutdown Cooling train high-temperature alarm setting is adjusted to a lower value. Although a planned outage activity, the requirement to perform this setpoint adjustment is not procedurally controlled. Therefore, this requirement will be proceduralized prior to the next refueling outage (D3R14).

4. Safety Significance:

The safety significance of limited instrumentation for loss of spent fuel pool cooling events is minimal. As discussed above, spent fuel pool suction temperature indication in the Main Control Room is lost when neither Fuel Pool Cooling pump is in operation for a unit. When a core is off-loaded, however, an additional temperature indication is available in the Main Control Room to alert operators to loss of spent fuel pool cooling, specifically, temperature indication for the Shutdown Cooling train lined up to the spent fuel pool.

For these reasons, during periods when a full core has been off-loaded, temperature indication would only be lost if both Fuel Pool Cooling pumps and the Shutdown Cooling pump lined up to the spent fuel pool were lost. As discussed for the safety significance of Issue 4, however, unplanned loss of all pumps used for spent fuel pool cooling is expected to occur very infrequently. Furthermore, should spent fuel pool cooling be lost, operators would be required to check the spent fuel pool temperature once per hour.

5. Summary and Conclusion:

Because the Dresden spent fuel pool temperature alarm is based on water temperature in the suction piping of the Fuel Pool Cooling pumps, this alarm capability is lost if the Fuel Pool Cooling pumps are lost. During periods when the full core is off-loaded, an alternative temperature alarm is available from the Shutdown Cooling train being used for spent fuel pool cooling. The fact that neither alarm is based on a direct reading of the spent fuel pool

temperature has minimal safety significance, because a review of recent system operation indicates that a unit's spent fuel pool cooling pumps are unavailable very infrequently. Furthermore, upon loss of all spent fuel pool cooling pumps, operators would be required to check the spent fuel pool temperature once per hour. Therefore, no further action on this modification is warranted at the present time.

C. Issue 9 - Infrequently Used Backup SFP Cooling Systems

1. Introduction:

This issue, as previously discussed, is concerned with reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary spent fuel pool cooling system or low relative capacity of the primary cooling system. At Dresden 2 and 3, additional fuel pool cooling capacity is provided by aligning one (1) train of Shutdown Cooling to the Fuel Pool Cooling system, which is required by the current licensing basis to remove the decay heat from a full core discharge and maintain the spent fuel pool water temperature at or below 145°F. The pumps in both systems are powered from safety-related busses; therefore, during a loss of offsite power these pumps are capable of being powered from the Emergency Diesel Generators. If the Shutdown Cooling pump experiences a mechanical failure, however, aligning another train of Shutdown Cooling to the Fuel Pool Cooling system would require the removal of flanges and installation of spool pieces which could be accomplished within eight (8) hours during an emergency situation. Permanent installation of the spool pieces, including isolation valves would permit initiation of the spent fuel pool cooling mode of Shutdown Cooling without delay. Below is an evaluation of this potential safety enhancement.

2. Cost of Modification:

A preliminary estimate was conducted to determine the cost of permanently installing spool pieces, including isolation valves in the Shutdown Cooling system to allow initiation of the system's fuel pool cooling mode without delay. The cost of this modification is estimated to be approximately $220,000.00 per unit. Due to space limitations, piping modifications may be required if the double isolation valve concept is adopted. Therefore, other alternatives are also under consideration.

3. Protective Measures:

Prior to offloading fuel from the core, procedural controls require that one (1) train of Shutdown Cooling is aligned to the Fuel Pool Cooling system to ensure adequate heat removal capacity is available during peak heat load conditions in the spent fuel pool from a full core discharge.[8, 9] During a loss of fuel pool cooling event, the applicable abnormal operating procedure would direct the operator to monitor local indication of the spent fuel pool temperature once every hour and stop the transfer of fuel assemblies into the spent fuel pool, if pool temperature exceeds 120°F. The procedure also directs the operator to align another train of Shutdown Cooling to the Fuel Pool Cooling system, if the train designated for spent fuel pool cooling becomes inoperable and cannot readily be repaired. Based on a conservative heatup rate of 6.5°F/hr[3] without forced cooling, bulk boiling of the spent fuel pool is expected to occur after 14 hours (starting from an initial pool temperature of 120°F) which is sufficient time to place the other train of Shutdown Cooling in the spent fuel pool cooling mode or initiate other corrective actions. For example, if the pool temperature is predicted to exceed 140°F and the reactor cavity is flooded, removal of the fuel pool gates would be required to provide additional water as a heat sink.[3] If the loss of spent fuel pool cooling was due to a loss of offsite power, the operator is also directed to the applicable procedure to initiate restoration of power to the Fuel Pool Cooling and Shutdown Cooling pumps.[4]

In addition to the above procedural controls, other alternative cooling means have been utilized at Dresden Station. For example, during the D2R14 outage an alternative contingency cooling system was installed to backup the Unit 2 Fuel Pool Cooling system while a tube leak in 2B Shutdown Cooling heat exchanger (which was lined up to the spent fuel pool) was being repaired. During this period, the Fuel Pool Cooling system was able to maintain pool temperature below 110 °F with a full core offload in the spent fuel pool.

4. Safety Significance:

Based on a review of Problem Identification Forms since January 1995, the unplanned unavailability of all pumps for spent fuel pool cooling appears to have been less than 0.2% of the time during this period of recent system operation. During periods that spent fuel pool cooling is unavailable, a series of procedural actions are available to the operators to restore cooling and prevent unacceptable consequences. In the unlikely event of a loss of offsite power, onsite power is available to all pumps for spent fuel pool cooling. In addition, the availability of the systems necessary to ensure spent fuel pool cooling are protected by the station's shutdown risk management program. For these reasons, the safety significance of this issue is minimal. (Refer to Issue 6 for further discussion.)

5. Summary and Conclusion:

Prior to offloading a full core into the spent fuel pool, administrative controls ensure additional heat removal capacity is provided by aligning one (1) train of Shutdown Cooling to the Fuel Pool Cooling system. These systems are powered from safety related-busses which are powered from the Emergency Diesel Generators during a loss of offsite power. During a loss of spent fuel pool cooling, abnormal operating procedures provide various means for restoring spent fuel pool cooling. Taking into account the availability of spent fuel pool cooling systems and the administrative controls in place, no further action on this modification is warranted at the present time.

D. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

1. Introduction:

This issue, as previously discussed, concerns multi-unit sites with shared systems and structures. The spent fuel pools for Dresden 2 and 3 are located on the refuel floor in the Reactor Building. There are open paths from the refuel floor to areas housing safety systems for both units. With one unit in a refueling outage, the decay heat load in the spent fuel pool may be sufficiently high that the pool could reach boiling in a short period of time following a complete loss of cooling. The heat and vapor generated could propagate to the systems required for shutdown of the operating unit. Because plant modifications to totally eliminate any communication between the fuel pool area and areas housing safety related equipment are impractical, this response will focus on the time to boil following a complete loss of cooling. It also discusses other protective measures that enhance the reliability of alerting operators to a sustained loss of spent fuel pool cooling.

2. Time to Boil:

Licensing calculations demonstrate that one (1) train of Shutdown Cooling and one (1) train of Fuel Pool Cooling are capable of maintaining the spent fuel pool water temperature at approximately 136°F with a full core discharge.[5] To ensure compliance to the licensing and

design bases of spent fuel pool cooling, procedural controls for core offloads are in place with the following requirements:

- One (1) train of Shutdown Cooling must be aligned to the Fuel Pool Cooling system prior to commencing core offload;
- The reactor must be shutdown for at least 100 hours prior to commencing core offload; and
- Core offload must be completed no sooner than 10 days after shutdown.[8, 9]

In the event of a complete loss of spent fuel pool cooling, the water temperature would increase at a rate of approximately 6.5°F/hr (i.e., from a starting temperature of 150°F to 212°F in approximately 9.6 hours).[5, 6] Since administrative controls prohibit moving fuel assemblies into the spent fuel pool when the pool temperature exceeds 120°F, bulk boiling of the pool with a full core discharge is predicted to occur no sooner than 14 hours after a complete loss of spent fuel pool cooling. Therefore, sufficient time exists to align another train of Shutdown Cooling to the Fuel Pool Cooling system or initiate other auxiliary cooling up to and including the "feed and bleed" provisions in the loss of fuel pool cooling procedure.[3]

In addition to these administrative controls, ComEd has performed realistic calculations of the expected time to boil for the spent fuel pool.[16] These calculations indicate that bulk boiling (using 200 °F as the criterion) would take greater than 18 hours, if a complete loss of fuel pool cooling were to occur shortly after discharging a full core into the spent fuel pool. The maximum heat load is based on the licensing basis offload wait time and rate restrictions, as described previously. The calculations also credit the heatup as starting from the initial fuel pool temperature of 120°F, which is the site administrative limit at which heat addition to the fuel pool is terminated. These are best estimate calculations which account for heat transfer to structures, as opposed to the licensing calculations which assume adiabatic pool conditions.

3. Reliability and Availability of Active Cooling:

The Fuel Pool Cooling and Shutdown Cooling pumps are powered from safety related busses. During a loss of offsite power, these pumps are powered by the Emergency Diesel Generators. The associated cooling water systems can also be powered from the Emergency Diesel Generators. The Reactor Building Closed Cooling Water pumps are powered by the same safety related busses as the Shutdown Cooling pumps. Although not safety related, the Service Water pumps can be powered from the Emergency Diesel Generators by backfeeding their associated busses from the diesel powered emergency busses.[4] In addition to the Emergency Diesel Generators, a Station Blackout diesel generator dedicated to Unit 2 can also be aligned to supply power to the needed spent fuel pool cooling components. The Unit 3 dedicated Station Blackout diesel generator will be operational following the next Unit 3 refueling outage.

In addition, the availability of the systems necessary to ensure spent fuel pool cooling are protected by the station's shutdown risk management program, which specifically identifies protected equipment and maintains a site wide awareness of these protected equipment, including equipment needed for decay heat removal.[9]

4. Environmental Impact:

Dresden Station recognizes that there will be some environmental impact on plant equipment during a complete loss of spent fuel pool cooling. Based on industry discussions in 1994, the main concern with this issue is the possibility that a loss of spent fuel pool cooling on one unit (due to loss of offsite power) could occur when the full core has been off-loaded and could be

concurrent with a loss of coolant accident (LOCA) on the other unit. Under these circumstances, restoration of spent fuel pool cooling would require restoration of offsite power or lining up onsite AC power sources to the non-safety related systems needed for spent fuel pool cooling. If spent fuel pool cooling is not restored prior to the spent fuel pool temperature approaching boiling, high temperatures and high humidity could occur and threaten equipment required to cope with the LOCA. Boiling of a spent fuel pool could also threaten secondary containment integrity. Even though the postulated scenario is beyond the plant's design and licensing bases, the spectrum of contingency actions available to restore cooling allow the operators the capability to adequately prevent unacceptable consequences.[3]

5. Safety Significance:

A consideration of the expected frequencies for LOCA and Loss of Offsite Power (LOOP) events, detailed below, shows that this scenario is extremely unlikely to result from independent causes.

Based on the initiating event frequencies in the modified Dresden Individual Plant Examination (IPE) submitted to the NRC in June 1996 [17], the frequency for small-, medium-, or large-break LOCAs is 4.1E-3/yr while the frequency of any type of LOOP is 6.7E-2/yr. The frequency (on a per year basis) of a concurrent LOCA plus LOOP, where concurrent is defined as the LOCA occurring within 24 hours after the LOOP, is calculated by multiplying the total LOOP frequency times the probability that an independent LOCA would occur within the next 24 hours.

Probability of a LOCA occurring within next 24 hours after a LOOP

= Total LOCA Frequency * 24 hours * (1 yr / 8760 hours)

= 4.1E-3/yr * 24 hours * (1 yr / 8760 hours)

= 1.12E-5

Therefore,

Frequency of Concurrent LOOP plus LOCA

= LOOP Frequency * Probability of LOCA in next 24 hours

= 6.7E-2/yr * 1.12E-5

= 7.5E-7/yr

Assuming that a unit's core is off-loaded 10% of the time, therefore, gives the frequency of the main scenario of concern as follows:

Frequency of Concurrent LOOP plus LOCA with Core Off-Loaded

= 0.1 * Frequency of Concurrent LOOP plus LOCA

= 0.1 * 7.5E-7/yr

= 7.5E-8/yr [18]

Note that the above discussion is based on the assumption of independent causes. This assumption excludes consideration of a massive earthquake in excess of the safe shutdown

earthquake as a possible common cause of a LOCA plus LOOP. Such an earthquake would be very unlikely and would itself threaten the equipment required for safe shutdown. For these reasons, massive earthquakes need not be considered in addressing Issue 6.

6. Summary and Conclusions:

Based on IPE initiating event frequencies, the frequency of a LOOP (while the unit's core is off-loaded) concurrent with a LOCA is approximately 7.5E-8/yr, or approximately once in 13,000,000 years. This frequency is considered to be insignificant.

Even if this unlikely event should occur, restoration of offsite power would be likely in time to restore spent fuel pool cooling prior to reaching boiling. Due to Dresden's diverse sources of offsite power (i.e., both a 138 kV switchyard and 345 kV switchyard), the Dresden IPE determined that the probability of failing to recover offsite power within 6 hours following a LOOP was approximately 2%. Furthermore, even if offsite power was not restored promptly, Dresden has three Emergency Diesel Generators and two Station Blackout (SBO) Diesel Generators available to deal with a concurrent LOOP plus LOCA. (Note: The SBO Diesel Generator installation is complete for Unit 2 and nearly complete for Unit 3.)

In conclusion, the probability of the main scenario of concern, i.e., a concurrent LOOP (while the unit's core is off-loaded) concurrent with a LOCA, is insignificant. Even if this scenario were to occur, the probability is high that offsite power would be restored prior to spent fuel pool boiling. For these reasons, the safety significance of Issue 6 is judged to be minimal.

III. SUMMARY

The following spent fuel pool storage issues were found to be applicable to Dresden 2 and 3:

1. Limited instrumentation for loss of spent fuel pool coolant events;

2. Limited instrumentation for loss of spent fuel pool cooling events;

3. Infrequently used backup spent fuel pool cooling systems; and

4. Shared systems and structures at multi-unit sites [environmental effects of high temperature in the spent fuel pool].

Based on the low probability of an initiating event, the administrative controls in place, and the availability of various means to cool the spent fuel pool from onsite power, these concerns do not warrant any further investigation. However, the following additional administrative controls are deemed to be warranted:

1. Finalizing heat exchanger performance calculations, and incorporating compensatory actions into station procedures, if needed;

2. Proceduralizing local monitoring of pool level during a loss of forced spent fuel pool cooling or a loss of AC power; and

3. Proceduralizing adjustments to the Shutdown Cooling train high-temperature alarm when the train is aligned to the spent fuel pool.

These actions will be completed prior to the next refueling outage (D3R14).

ATTACHMENT C
Dresden Units 2 and 3 Evaluation of SFP Storage Safety Issues

REFERENCES:

1. DFP 0850-01, "Slow or Rapid Water Level Loss in Fuel Pool/Reactor Cavity"
2. DOP 1900-03, "Reactor Cavity, Dryer/Separator Storage Pit and Fuel Pool Level Control"
3. DOA 1900-01, "Loss of Fuel Pool Cooling"
4. DGA 12, "Partial or Complete Loss of AC Power"
5. QUAD-1-79-234, "Licensing Report Dresden Nuclear Power Plant Units 2 and 3 Spent Fuel Rack Modification"
6. UFSAR Section 9.1.2, "Spent Fuel Storage"
7. UFSAR Section 9.1.3, "Spent Fuel Cooling"
8. DFP 0800-01, "Master Refueling Procedure"
9. DAP 18-05, "Shutdown Safety Management"
10. Appendix F, "Unit 2 Turbine Building and Reactor Building Rounds Logsheet"
11. Appendix G, "Unit 3 Turbine Building and Reactor Building Rounds Logsheet"
12. DAN 902(3)-4 C-24, "Fuel Pool Skimmer Tk Lvl Below Norm"
13. DAN 902(3)-4 D-24, "Fuel Pool Skimmer Tk Lvl Lo"
14. DAN 902(3)-4 G-24, "Fuel Pool Pp Trip"
15. DAN 902(3)-4 A-23, "SDC HX/Fuel Pool Wtr Temp Hi"
16. BSA-M-96-15, Spent Fuel Pool Time-to-Boil Analysis Using GOTHIC for LaSalle, Quad Cities, and Dresden
17. Dresden Individual Plant Examination Summary Report, Revision 1, June 1996.
18. DRE96-0225, Dresden Frequency Estimate for Concurrent Loss of Coolant Accident (LOCA) and Loss of Offsite Power (LOOP) Event, November 1996.
19. DAN 902(3)-4 H-24, "Fuel Pool Gates Seal Flow Hi"

ATTACHMENT D

LaSalle County Evaluation of SFP Storage Safety Issues

I. ComEd EVALUATION OF ISSUES

A. Issue 1 - Absence of Passive Anti-siphoning Devices on Piping Extending Below the Top of Stored Fuel

This issue is related to a potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air.

LaSalle County Response:

This issue is not applicable to LaSalle Station. The spent fuel pools at LaSalle Station do not have any piping systems or components that extend below the top of the stored fuel in the spent fuel pool (SFP). The SFP cooling and emergency RHR water return lines enter at the top of the spent fuel pools and terminate above the top of any stored fuel assemblies. In addition, these lines are equipped with passive anti-siphon devices at normal pool level that would prohibit the drain down of the spent fuel pool due to an inadvertent siphoning event.

B. Issue 2 - Transfer Tube(s) Within SFP Rather than Separate Transfer Canal

This issue is concerned with transfer tubes that are normally open during refueling operations. When these openings are below the top of the stored fuel, any drain path from the refueling cavity has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

LaSalle County Response:

This issue is not applicable to LaSalle Station. LaSalle does not have a Transfer Tube. The transfer canals between the units' fuel pools and the reactor vessel are structured to prevent a drain down lower than the top of any stored fuel in the spent fuel pool.

C. Issue 3 - Piping Entering Pool Below Top of Stored Fuel

This issue concerns a pipe break that has the potential to drain coolant to such an extent that fuel could be exposed to air.

LaSalle County Response:

This issue is not applicable to LaSalle Station. LaSalle has no piping that enters the spent fuel pool at or below the top of the stored fuel assemblies.

D. Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events

This issue concerns insufficient instrumentation to reliably alert operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

LaSalle County Response:

This issue on loss of SFP coolant inventory is not applicable to LaSalle Station. At LaSalle, there is reliable instrumentation that provides control room indication and annunciation to the operators when the water level in the spent fuel pools reaches either the high or low level

setpoints. The issue on instrumentation to reliably alert operators to a sustained loss of SFP cooling is addressed in item 10 below.

E. Issue 5 - Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

This issue is a concern where SFP coolant inventory is not easily isolated following events that breach the SFP liner.

LaSalle County Response:

This issue is not applicable to LaSalle Station. Any failure of the SFP liner that allows leakage of the pool water past the liner would be detected by continuously monitored drains provided for leak detection. Any leakage past the liner would be collected by the drain piping and could be isolated by manual isolation valves that are provide in the system to limit the SFP coolant inventory loss.

F. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short period of time (e.g. 4-10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

LaSalle County Response:

This issue is applicable to LaSalle Station. LaSalle is a multi-unit site with shared systems and structures. Communication between the fuel pool area and areas housing safety related equipment does exist through shared structures. Refer to Section II, Discussion of Identified Issues, for further discussion.

G. Issue 7 - Absence of Onsite Power Supply for Systems Capable of SFP Cooling

This issue is concerned with a sustained loss of offsite power at plants without an onsite power supply for SFP cooling that may lead to inadequate decay heat removal.

LaSalle County Response:

This issue is not applicable to LaSalle Station. LaSalle has a high capacity safety related SFP cooling assist mode of RHR that is dependent only on onsite emergency power. In addition, each unit has two (2) semi-independent trains (consisting of a 100% pump and heat exchanger) of fuel pool cooling. Following a LOOP, onsite power is available for the SFP cooling pumps through existing cross-ties. Station air, service water, and control power to the panel controlling the demineralizer and bypass flow for both units (0PL12J panel) are also needed. During normal plant configuration, both service water and station air would be readily available from the other unit. If unavailable, both can be aligned through existing onsite power cross-ties. Control power, however, is currently only provided by Unit 1, 6.9 kV power, which has no onsite emergency power available. This power can easily be reestablished with a temporary alteration done outside of the reactor building. However, no procedural guidance currently exists on this

temporary alteration. As a result on this deficiency, LaSalle will either proceduralize a method to restore power, or perform a modification to provide control power from either unit's normal offsite power, 6.9 kV supply.

H. Issue 8 - Limited SFP Decay Heat Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the spent fuel pool.

LaSalle County Response:

This issue is not applicable to LaSalle Station. LaSalle is currently analyzed for full core offloads, which is part of the current licensing basis. Both units have two (2) semi-independent trains of spent fuel pool cooling, each capable of removing 14.5 MBTU/hr at 95 °F lake temperature. Administrative procedures ensure the heat load of the core is less than the removal capacity of 1 train of FPC, taking into consideration actual lake temperature. For emergency full core offloads with a calculated maximum heat load of 42 MBTU/hr, RHR can be aligned in the spent fuel pool cooling assist mode and remove all decay heat alone. Calculations for available recovery times discussed in Section II below show more than ample time for recovery.

I. Issue 9 - Infrequently Used Backup SFP Cooling System

This issue is concerned with reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

LaSalle County Response:

This issue is not applicable to LaSalle Station. LaSalle Station has two (2) semi-independent high capacity trains of spent fuel pool cooling. Only one train of the cooling system is required to cool the spent fuel pool during the maximum normal heat load. The maximum normal heat load includes refueling activities up to and including a full core discharge. Procedural controls are in place in LFS-100-4 to ensure this requirement is met prior to performing fuel moves to the spent fuel pool from the reactor. In addition, both trains are capable of being powered from onsite power with the limitations discussed above in Section I.G. As such, LaSalle does not rely on or use the SFP cooling assist mode of RHR unless in an emergency core offload condition.

J. Issue 10 - Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

LaSalle County Response:

This issue is applicable to LaSalle Station. LaSalle does not have a direct control room annunciation for high fuel pool temperature. However, sufficient secondary parameters and indications are available to alert the operator to a sustained loss of SFP cooling. Refer to Section II, Discussion of Identified Issues, for further discussion.

II. Discussion of Identified Issues

A. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

1. Introduction:

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short period of time (e.g. 4-10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems. Because plant modifications to totally eliminate any communication between the fuel pool area and areas housing safety related equipment are impractical, this response will focus on the time to boil following a loss of cooling. It also discusses other protective measures that enhance the reliability of alerting operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

2. Time to boil upon a loss of SFP cooling:

ComEd has performed realistic calculations of the expected time to boiling for both a single isolated SFP and both SFP's connected. These calculations are based on estimates of actual conditions, and take credit for heat transfer to the SFP structure, as opposed to licensing calculations which assume adiabatic pool conditions. Additional assumptions include an initial pool temperature of 120 °F (the design basis limit for a normal full core offload), both pools at the maximum capacity with the pool in question containing 764 freshly discharged bundles with a decay heat calculated 220 hours after shutdown (100 hr required decay time plus 5 days to offload core), and an ending pool temperature of 200 °F. The analyses indicate that bulk boiling would take greater than 18 hours to occur for a single pool, and greater than 25 hours to occur if the pools were connected. Current abnormal procedures for loss of fuel pool cooling contain provisions to connect the fuel pools if temperature exceeds 120 °F, effectively extending the time to boil to the connected pool case.

3. Reliability and availability of SFP cooling:

Following a LOOP, SFP cooling can be reestablished on onsite power by either restoring the fuel pool cooling system through manipulations described in Section I.G. above, or through the FPC assist mode of RHR. While both methods would require alterations in their respective systems, either could be accomplished in the time frame allowed prior to bulk boiling. Since the major concern for a defueled unit is the fuel in the SFP, priority would exist for both the electrical power from the emergency supply and the physical realignments necessary. The availability of the relied upon systems is protected by the station's shutdown risk program, which specifically addresses risk margins for decay heat removal. The details of the above actions are explicitly presented in LaSalle's abnormal procedures, with the exception of restoring control power to the 0PL12J panel. As discussed earlier, LaSalle will be resolving this deficiency by proceduralizing the temporary alteration or providing redundant power.

4. Environmental impact on the non-refuel Unit's Essential Equipment:

Following a postulated loss of fuel pool cooling where restoration actions are not credited, it is conceivable that the resultant high temperatures and humidity could impact the reliability of equipment important to safety. Since LaSalle County Station is a two (2) unit BWR with a common refueling floor, the event would have a similar impact on the other unit's equipment

reliability. Based on the spectrum of contingencies available to the operator, however, propagation of this event into unacceptable consequences is unlikely.

5. Scenario Probabilities:

The probability of a LOCA occurring on one unit during the same 24-hour time period as a LOOP event for a refuel outage unit was estimated to be 7.7E-7/yr. Applying the fraction of time that the plant is expected to have a full core discharge in the pool with substantial decay heat (10% of the time) further reduces the probability to 7.7E-8/yr. For this "initiating event frequency" to propagate into actual impact to the plant or environs, the probability of a complete inability to recover fuel pool cooling would also have to be included.

6. Summary and Conclusions:

While LaSalle Station is a multi-unit site with shared systems and structures, an appreciable concern does not exist at this site. Taking into account the actual time to boil, the low probability of an initiating event, and the availability of redundant means to cool the SFP from onsite power, this concern does not warrant further consideration at this time.

B. Issue 10 - Limited Instrumentation for Loss of Cooling Events

1. Introduction:

As previously discussed, this issue is related to instrumentation of limited capability to alert operators to a sustained loss of spent fuel pool cooling. At LaSalle, indication and alarms are provided to indicate a complete loss of fuel pool cooling. However, no direct indication or alarm for actual fuel pool temperature is provided in the control room. During events where the fuel pool temperature increases while the FPC system stays in operation, a delay could exist in operator identification and response to mitigate the consequences of a loss of SFP cooling capacity.

2. Safety Significance of Modification:

A modification to provide direct control room indication of fuel pool temperature with the addition of an annunciator alarm would provide additional assurance that the delay from the initiation of an event and operator response would be minimized. This would only prove to be limiting during a degradation of the SFP cooling heat removal capacity, or when the SFP cooling capacity is exceeded during refueling activities.

3. Cost of Modification:

Although detailed analysis of the cost of a modification have not been performed, preliminary estimates based on engineering judgment indicate the modification cost at about $150,000. Specifics on any actually installed modification could affect the actual cost incurred by ComEd.

4. Other Protective Measures:

During operation of the FPC system, fuel pool cooling suction and heat exchanger outlet temperatures are provided to the control room via three computer points. Associated with these computer points are computer alarms starting at 100 °F. In addition to this protection, during refuel outages a thermocouple is placed into the outage unit's fuel pool to provide a computer indication of fuel pool temperature. This computer point also provides computer alarm indication

at 100 °F. During non-outage times, LOA-FC-101/201 directs the operator to install this thermocouple if cooling can not be immediately recovered.

5. Summary and Conclusion:

Although LaSalle does not have direct SFP temperature indications to the control room at all times, sufficient redundant indications on whether the SFP cooling system is running or degraded are provided. In addition, administrative controls on monitoring available temperature indications and providing additional computer indication during times when the fuel pool temperature may change more rapidly, provide adequate assurance that a loss or degradation of SFP cooling will be quickly recognized and responded to in a timely manner. Therefore, this concern does not warrant further consideration at this time.

ATTACHMENT E
Quad Cities Evaluation of SFP Storage Safety Issues

I. ComEd EVALUATION OF ISSUES

A. Issue 1 - Absence of Passive Anti-Siphoning Devices on Piping Extending Below the Top of Stored Fuel

CONCERN: Potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. Return piping to the Fuel Pool extends 3 feet below the normal water level of 37 feet - 9 inches. Should siphoning action occur, the Fuel Pool water level would drain to 36 feet - 9 inches. At that point, the anti-siphoning devices located on the return piping would stop the siphoning action. Should the anti-siphoning devices become plugged during the event, water would continue to drain to a depth of 34 feet - 9 inches, leaving a water level of 21 feet above the stored fuel.[1,2,3]

B. Issue 2 - Transfer Tube(s) Within the SFP Rather Than a Separate Transfer Canal

CONCERN: Transfer tubes are normally open during refueling operations. When these openings are below the top of stored fuel, any drain path from the refueling cavity has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. Transfer tubes are not used. Quad Cities is designed with a transfer canal that precludes the potential to reduce coolant inventory where spent fuel assemblies could be exposed to the atmosphere.[1,6]

C. Issue 3 - Piping Entering Pool Below Top of Stored Fuel

CONCERN: A pipe break has the potential to drain coolant to such an extent that fuel could be exposed to air.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. The Unit 1 and 2 fuel pools are designed in such a manner that no piping penetrates the liner below the top of the stored fuel. Accidental drainage from a pipe break at or below the elevation of the stored fuel assemblies is not possible.[1]

D. Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events

CONCERN: Insufficient instrumentation to reliably alert operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. Units 1 and 2 Fuel Pools have direct level instrumentation with Control Room alarms at Panel 901 (2) -4; B-24, "Fuel Pool Storage Hi/Lo Level."[5,12]

E. Issue 5 - Absence of Leak Detection Capability and Absence of Isolation Valves In Leakage Detection System Piping

CONCERN: SFP coolant inventory is not easily isolated following events that breach the SFP liner.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. The liner plate leak detection system consists of a series of interconnected channels behind the welded connections terminating in four sumps, one in each corner of each pool. The sumps are routed to the reactor building sump floor drain via the floor drain system. Each sump is connected independently to the floor drain system through a manually operated gate valve with a sightglass downstream of each valve. This arrangement aids in locating problem areas and controls flow to the reactor floor drain sumps. These drain sumps are capable of removing up to 100 gal/min which is greater than any anticipated seam or liner crack leakage.[10]

F. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

CONCERN: Multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short period of time (e.g. 4-10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

QUAD CITIES RESPONSE: As identified by the NRC, this issue applies to Quad Cities Station. Quad Cities Station is considered to be acceptable with no further actions. Utilizing current procedures and configuration, calculations show that time to boil would take greater than 25 hours if no actions were taken. A discussion of the specific components of this issue and the Quad Cities evaluation is contained in Section II. [13]

G. Issue 7 - Absence of Onsite Power Supply for Systems Capable of SFP Cooling

CONCERN: A sustained loss of offsite power at plants without an onsite power supply for SFP cooling that may lead to inadequate decay heat removal.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. The Fuel Pool Cooling and its support system, Reactor Building Closed Cooling Water (RBCCW), can be powered from the Emergency Diesel Generator (EDG) by backfeeding their associated busses from the diesel powered emergency bus. In addition to the unit dedicated EDG, a unit dedicated Station Blackout (SBO) diesel generator can also be aligned to supply power to the Fuel Pool Cooling and RBCCW systems. Also, additional capacity is available by aligning one train of Residual Heat Removal (RHR) via spool pieces. RHR is safety related and is powered by safety related power sources and an Emergency Diesel Generator (EDG) dedicated to that unit.[11]

H. Item 8 - Limited SFP Decay Heat Removal Capability

CONCERN: Plants that have less heat removal capability and shorter recovery times than similar plants following full core discharges into the spent fuel pool.

QUAD CITIES RESPONSE: This issue is not a concern at Quad Cities Station. Each unit has two (2) trains of spent fuel pool cooling. Each train is capable of maintaining design based

temperatures during periods of normal heat loads. The Residual Heat Removal (RHR) system may be connected in parallel with the Fuel Pool Cooling system via spool pieces to assist in cooling the pool during periods of high heat loads. Operating experience has shown that the increased heat loads during refueling operations have been adequately maintained solely by the fuel pool heat exchangers without the use of the RHR system. As a contingency, prior to each refueling outage, work packages are prepared and equipment is staged for expedient installation of the RHR spool per procedure QCFHP 0100-01. The connection time to tie in the RHR system is approximately four hours. At Quad Cities Station, the Unit 1 and Unit 2 pools are cross connected via the transfer canal. This essentially doubles the water volume and heat transfer area for conduction to structures. In addition, there are administrative procedural controls in place to halt any fuel movement should the pool temperature exceed 125 °F.[1,4,7,11]

I. Issue 9 - Infrequently Used Backup SFP Cooling Systems

CONCERN: Reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

QUAD CITIES RESPONSE: This issue is not applicable at Quad Cities Station. Quad Cities has two (2) semi-independent high capacity trains of spent fuel pool cooling. Only one train of the cooling system is required to cool the spent fuel pool during the maximum normal heat load. The maximum normal heat load includes refueling activities up to and including a full core discharge. Procedural controls are in place in QCFHP 0100-01 to ensure all requirements are met prior to performing fuel moves to the spent fuel pool from the reactor. In addition, both trains are capable of being powered from onsite power. The RHR system can be connected to the Fuel Pool system via spool pieces should additional cooling capacity be required. However, prior to the refueling outage, all work packages are prepared and equipment is staged to connect the RHR system to the Fuel Pool Cooling system. These spool pieces have been installed in the past to verify the procedure steps for their installation and RHR assist mode of operation. Backup cooling from RHR is not normally required and its use necessitates RHR shutdown (suspending in-reactor decay heat removal), several system adjustments, and potential operational difficulties such as pool level control. Because of this situation, the spool pieces are prepared for expedient installation but are not installed. Quad Cities also cross-ties the two units' pools which permits automatic heat removal sharing by the non-refueling unit's Fuel Pool Cooling system, as well as that second unit's backup cooling means.

J. Issue 10 - Limited Instrumentation for Loss of Cooling Events

CONCERN: Instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

QUAD CITIES RESPONSE: Although not identified by the NRC, this issue applies to Quad Cities Station. See Section II for further discussion of this issue.

II. Discussion of Identified Issues (Issue Numbers 6 and 10)

A. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

1. Introduction:

The current status of Quad Cities Station is adequate with regard to this issue, with no further actions necessary. Quad Cities Station has taken a number of actions to maximize the time to boiling upon loss of fuel pool cooling, and to verify that there is minimal potential for pool boiling to affect the function of essential systems and structures.

The disposition of this issue is substantially the same for Quad Cities Station as the previously reviewed status of Pennsylvania Power and Light's Susquehanna Station, with respect to system configuration, time to pool boiling and the low probability and risk levels associated with the issue. The specific components of this issue and evaluation are summarized below.

2. Time to boil upon loss of all active cooling:

Quad Cities procedures require that both fuel pools be crosstied through the common cask access canal prior to the start of core offload. This doubles the water volume and heat transfer area for conduction to structures. In addition, it increases the ability to use the procedural contingencies for auxiliary cooling up to and including the "feed and bleed" provisions in the loss of pool cooling procedures. In this way, any cooling or heat losses from either pool assist in the heat removal from the pool containing the freshly offloaded fuel.

ComEd has performed realistic calculations of the expected time to boiling for the connected (2 pool) configuration. These calculations indicate that bulk boiling would take greater than 25 hours if a complete loss of active pool cooling were to occur shortly after a freshly burned full core was transferred to the fuel pool. This corresponds to the peak heat input to the fuel pools, accounting for the licensing basis offload wait time and rate limits, which are procedurally enforced. It also credits the heatup as starting from the initial fuel pool temperature of 125 °F, which is the site administrative limit at which heat addition to the fuel pools is terminated. These are best estimate calculations which account for heat transfer to structures, as opposed to the licensing calculations which assume adiabatic pool conditions.[13]

3. Reliability and availability of active cooling means:

The Quad Cities licensing requirements for full core offload heat load on the fuel pools include the availability of the Residual Heat Removal (RHR) assist mode to the fuel pool cooling system (FC). This requirement is enforced by the station refueling procedures, specifically QCFHP 100-01.

The RHR cooling source for the refueling unit's fuel pool is Safety Related and is powered by safety related power sources and an Emergency Diesel Generator (EDG) dedicated to that unit. Although not safety related, the associated cooling water systems of Reactor Building Closed Cooling Water (RBCCW) and Service Water (WS) can be powered from the EDG by backfeeding their associated busses from the diesel powered emergency bus. In addition to the unit dedicated EDG, a unit dedicated Station Blackout (SBO) diesel generator can also be aligned to supply power to the needed FC, RBCCW and WS components to restore cooling. In combination with the above described pool interconnection through the cask pit, restoration of power to either unit's fuel pool cooling system will provide cooling to both pools. Given the hypothetical LOCA /

LOOP situation, the SFP cooling would be given the highest priority for electrical power or cooling load on the shutdown non-LOCA unit.

The availability and status of the systems necessary to ensure FC operation are protected by the station's Outage Risk Management program, which specifically identifies protected equipment and maintains a site wide awareness of the relative risk margins for critical concerns, including decay heat removal in the spent fuel pool.

The Quad Cities procedure for loss of fuel pool cooling, QCOA 1900-03 specifies a series of actions which are progressively more significant, as conditions warrant. Included in these actions is a procedure which allows one unit's fuel pool cooling system to be aligned to the opposite unit's pool.

4. Environmental impact on the non-refuel Unit's Essential Equipment:

The Quad Cities ventilation system arrangement is similar to Susquehanna with respect to the Reactor Building Ventilation connection at the common unit refueling floor.

In March 1996, a walkdown was conducted by the Quad Cities System Engineers for the Reactor Building Ventilation (VR) and Standby Gas Treatment (VG) Systems. This walkdown verified that no VR ductwork had openings (grillwork), or low points directly above any essential equipment that could cause fuel pool evaporation to condense in the ductwork and drain onto the essential equipment, which would impair the ability to achieve reactor cooldown in the event of a LOCA on the non-refuel unit. The VG discharge line was walked down with the exception of one section of horizontal run into the station vent stack. This walkdown verified that no low points are present which could allow condensation to build up and block off the VG discharge path.

The potential for a steam environment on the refuel floor which migrates into the VR ductwork and impairs the non-refuel unit's ECCS equipment requires that the pool steaming rate be a significant fraction of the maximum condensation rate achievable by the refuel floor metal walls. This condition would be necessary because there is no significant pressurization source on the refuel floor to drive the steam environment into the ductwork, so the infusion rate is limited by the grillwork surface area. Event scenarios where the VR fans remain operating are not of concern since active (fan driven) airflow will only discharge to the station ventilation stack, not other areas of the reactor building. In addition to this minimal steaming environment potential, the Environmental Qualification requirements of the potentially affected ECCS equipment provides significant resiliency to possible degradation or disablement.

The postulated scenarios do not have the characteristics necessary to pose a credible challenge to ECCS or critical safety functions on the non-refuel unit. The most severe postulated scenario is a LOOP plus LOCA on the non-refuel unit simultaneous with an unrecoverable loss of pool cooling on the offloaded refuel unit. The nature of fuel pool cooling challenge and the spectrum of contingency actions available to restore cooling, coupled with the adequate time available to perform these actions, allow the plant operators the capability to adequately prevent unacceptable consequences.

5. Scenario Probabilities:

The probability of a LOCA occurring during the same 24-hour time period as a LOOP event was estimated for Quad Cities to be about 5.4E-7/yr. Also, the fraction of time that the plant is expected to have a full core offloaded in the pool needs to be taken into account. Conservatively, this is estimated to be two months during every 24-month cycle, the fraction would be 1/12, or

0.083. If the LOCA/LOOP frequency is then multiplied by the probability of having a full core offloaded in the pool at the same time, the combined frequency is approximately 4.5E-8/yr. This "initiating event frequency" would then be further reduced by incorporating the probability of a complete inability to recover fuel pool cooling. Note that the above 2 month interval for full core offload is reasonable because the offloaded core decay heat is continuously decreasing, and within 2 months will be approximately 1/2 of its peak value, effectively doubling the time to boil and significantly improving the capability for recovery actions. [7,8]

B. Issue 10 - Limited Instrumentation for Loss of Cooling Events

1. Introduction:

As previously discussed, this issue relates to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling. Since there is no direct indication of fuel pool temperatures with alarms in the Control Room, this issue is applicable to Quad Cities Station.

2. Safety Significance of Modification:

Each Fuel Pool at Quad Cities has temperature indication at all times except on rare occasions when both fuel pool cooling pumps for that unit's pool are tripped. In the event of both pumps being in a tripped condition, proceduralized compensatory actions are in place to take appropriate actions to expeditiously return all components to service and monitor the pool temperature. Also, during an outage, a thermocouple is procedurally installed to provide local indication of temperature at all times, even if both pumps trip. Additionally, because of the canal crosstie between the Fuel Pools, the opposite unit's Fuel Pool temperature indication would provide temperature indication unless both of that unit's pumps were also tripped. This indication has been seen to be a close representation of the opposite unit's pool temperature, with worst assumed offset of 30 °F. Since the time period is short when existing temperature instrumentation is not available and compensatory actions are established to monitor pool temperature during those times, the relative increase in safety significance gained by a modification would be very small.

3. Cost of Modification:

The addition of direct pool temperature instrumentation would require a relatively expensive modification, estimated to be $150,000 per unit. This includes all design work, installation labor costs, instrumentation costs and document changes that would be required.

4. Other Protective Measures:

Although no direct temperature indications exist, other instrumentation is available within the Fuel Pool system. Current temperature instrumentation is present on the Fuel Pool pump suction lines and also on the discharge lines of the Heat Exchangers. These indications would not be available should the pumps become inoperable. Since the pump trips would alarm in the Control Room, Panel 901(2) - 4, G-24, Operations would have immediate notification that Fuel Pool Cooling temperature instrumentation was lost and compensatory actions were required. Procedure QCOA 1900-03 provides compensatory actions which increase in severity until normal operations are restored. [9]

5. Summary and Conclusions:

Based on the cost of this modification, the minimal safety benefit, and the effective protective measures, no further action on this modification is warranted at the present time.

ATTACHMENT E
Quad Cities Evaluation of SFP Storage Safety Issues

REFERENCES:

1. UFSAR Section 9.1.2.2.3, Spent Fuel Storage Pool
2. Modification M4-1(2)-81-010, Fuel Pool Cooling Diffusers
3. ComEd Drawing B-263, Sht. 2, Reactor Bldg. Pool Sects. & Details
4. UFSAR Section 9.1.2.1, Design Bases
5. QCOS 1900-2, Fuel Storage Pool Level Alarm Testing
6. Drawing 729E433, G.E. Refueling Facilities Arrangement
7. QCFHP 0100-01, Master Refueling Procedure
8. QCOP 1900-22, Fuel Pool Cooling Pump Discharge Cross Tie
9. QCOA 1900-03, Loss of Fuel Pool Cooling with Unit Shutdown for Refueling
10. UFSAR Section 9.1.2.2.3.1, Spent Fuel Storage Pool Liner and Sumps
11. UFSAR Section 9.1.3.1, Design Bases
12. UFSAR Section 9.1.2.3, Safety Evaluation
13. Calculation: BSA-M-96-15, "Spent Fuel Pool Time-to-Boil Analysis Using GOTHIC for LaSalle, Quad Cities, and Dresden"

ATTACHMENT F
Zion Evaluation of SFP Storage Safety Issues

I. ComEd EVALUATION OF ISSUES

A. Issue 1 - Absence of Passive Anti-siphoning Devices on Piping Extending Below the Top of Stored Fuel

This issue is related to a potential misconfiguration of a particular system piping arrangement that could have the potential to siphon coolant to such an extent that spent fuel assemblies could be exposed to air.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. The spent fuel pool at Zion Station does not have any piping systems or components that extend below the top of stored fuel in the pool. The SFP cooling water return line does enter the top of the spent fuel pool and extends down to several feet above the top of the stored fuel assemblies. However, this line has a passive anti-siphon hole located eight inches (8") below the normal pool level that would prohibit an inadvertent siphoning event. On any loss of SFP water level the anti-siphon hole is checked for blockage (AOP - 6.2).

B. Issue 2 - Transfer Tube(s) Within SFP Rather than Separate Transfer Canal

This issue is concerned with transfer tubes that are normally open during refueling operations. When these openings are below the top of the stored fuel, any drain path from the SFP has the potential to reduce coolant inventory to an extent that stored fuel could be exposed to air.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station does not have a transfer tube within the SFP. Both units are designed with a common transfer canal, separate from the SFP, that precludes the potential to reduce coolant inventory to the point that spent fuel assemblies could be exposed to the atmosphere. The bottom of the weir gate between the transfer canal and the SFP is 3 feet above the top of the fuel stored in the SFP. If the transfer canal completely drained down and the weir gate was open, the fuel would remain covered. The weir gate can be re-installed to prevent further drain down of the SFP, if loss of level in the transfer canal is occurring (AOP - 6.2).

C. Issue 3 - Piping Entering Pool Below Top of Stored Fuel

This issue concerns a pipe break that has the potential to drain coolant to such an extent that fuel could be exposed to air.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station has no piping that enters the spent fuel pool at an elevation that is at or below the top of the stored fuel assemblies.

E. Issue 4 - Limited Instrumentation for Loss of SFP Coolant Events

This issue concerns insufficient instrumentation to reliably alert operators to a loss of SFP coolant inventory or a sustained loss of SFP cooling.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station has instrumentation that provides control room indication to the operators when the water level in the spent fuel pool reaches either the high or low limit setpoints. In addition, the Zion Operations Department performs rounds to monitor the local SFP level indicators twice per shift (four times a day) per procedure PTO Appendix X (U-1). The operators are given specific procedural guidance for maintaining SFP level, including specific criteria for reporting to Operating Management.

E. Issue 5 - Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

This issue is a concern where SFP coolant inventory is not able to be isolated following events that breach the SFP liner.

Zion Response:

Although not identified by the NRC, this issue is applicable to Zion Station. The SFP liner and Transfer Canal liner are provided with continuous drains that detect leakage past the liner welds (such as a through wall crack of a liner seam). Continuous leak channels are provided at the liner weld seams for leak detection. These channels from the SFP liner and Transfer Canal liner are interconnected, and any leakage through the liner is channeled to one of six (6) 1½" drain lines. These six (6) drain lines then empty into the 6" drain header to the Auxiliary Building Equipment Drain Tank (ABEDT). Each 1½" drain line is equipped with a sight glass. By identifying which drain line has flow, the part of the SFP or Transfer Canal Liner with the leakage can be determined. Neither the individual drain lines nor the 6" drain header are equipped with isolation valves that would stop leakage across the SFP or Transfer Canal Liner. Hence, this issue is applicable to Zion Station. See the discussion in Section II for more details.

F. Issue 6 - Shared Systems and Structures at Multi-Unit Sites [Environmental Effects of High Temperature in the SFP]

This issue concerns multi-unit sites with shared systems and structures. With one unit in refueling the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short period of time (e.g. 4-10 hours) following a loss of cooling. Communication between the fuel pool area and areas housing safety related equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or degradation of those systems.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion is a two (2) unit site with a shared spent fuel pool that is located in a separate Fuel Handling Building. The Fuel Handling Building is located between and adjacent to both units. The exhaust flow from the Fuel Handling Building is combined with exhaust flow from other parts of the Auxiliary Building

and discharged up the Vent Stack. Hence, the exhaust flow from Fuel Handling Building would not impact needed safety related equipment. Moreover, on loss of all Spent Fuel Pool Cooling, station procedure (AOP-6.4) requires an immediate Fuel Handling Building isolation. Hence, the Fuel Handling Building atmosphere would not communicate with those areas in other buildings containing safety related equipment.

During an outage the concrete block wall between the Fuel Handling Building and the Containment access is removed. With this wall removed the potential exists for air flow from the Fuel Handling Building to the Auxiliary Building Pipe Tunnels. If this block wall is removed, and there is a loss of SFP cooling, administrative actions (per AOP-6.4) require placing the Fuel Building ventilation and Pipe Tunnels in the charcoal mode. Since the normal air flow in the Auxiliary Building is into the pipe chases and pipe tunnels and then exhausted to the vent stack, any air flow from the Fuel Handling Building would not communicate with those areas of the Auxiliary Building containing safety related equipment. Within the pipe tunnels the adverse environmental effects of air flow from the Fuel Handling Building would be bounded by the post-LOCA environment due to various pipes being fission product pathways.

The spent fuel pool is served by two (2) trains of spent fuel pool cooling. Only one train of this cooling system is required to cool the spent fuel pool. Procedures are in place to cope with loss of spent fuel pool cooling or loss of spent fuel pool water level (AOP - 6.2 and AOP - 6.4). Moreover, the design basis fuel pool analyses show that, in the case of complete loss of fuel pool cooling after various core offload scenarios (UFSAR Section 9.1.3.1.1), sufficient time is available to add inventory to the SFP or to restore cooling capability before bulk pool boiling occurs.

G. Issue 7 - Absence of Onsite Power Supply for Systems Capable of SFP Cooling

This issue is concerned with a sustained loss of offsite power at plants without an onsite power supply for SFP cooling that may lead to inadequate decay heat removal.

Zion Response:

As identified by the NRC, this issue is applicable to Zion Station. The existing power supply for each of the SFP Cooling Pumps is from the station's non-essential power distribution system with one pump supplied from Unit 1 and the other pump supplied from Unit 2. Either train of SFP cooling can be used, but for a total, sustained loss of all offsite power no power is available to the SFP cooling pumps. See the Section II discussion for additional details.

H. Issue 9 - Limited SFP Decay Heat Removal Capability

This issue concerns plants that have less heat removal capability and shorter recovery times than similar plants following full core discharge into the spent fuel pool.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station is currently analyzed for various core offload scenarios, which are part of the current licensing bases (UFSAR Section 9.1.3.1.1). The Spent Fuel Pool Cooling System consists of two (2) trains of Spent Fuel Pool Cooling. Each train is capable of handling the normal heat load in the pool. The most conservative case that was considered involves a full core offload of one unit followed by a transfer of 117 fuel assemblies back to the core. This sequence is then repeated for the other

unit. That study determined that either train of Spent Fuel Pool Cooling could maintain a pool temperature of approximately 177 °F. There are also administrative controls and procedures in place that ensure that the heat removal capability of the spent fuel pool is maintained (AOP - 6.4).

I. Issue 9 - Infrequently Used Backup SFP Cooling System

This issue is concerned with the reliance on infrequently operated backup cooling systems due to the absence of onsite power supply for the primary SFP cooling system or low relative capacity of the primary cooling system.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station has two trains of spent fuel pool cooling. Either train is capable of maintaining the required cooling in the spent fuel pool, and both trains are used on a regular basis. Also, by procedure, both of these trains can be connected to essential service busses if offsite power is lost, and additional emergency measures for preventing SFP boiling and maintaining SFP level are provided (AOP - 6.4). Because of the redundancy and reliability of the Spent Fuel Pool Cooling System, there is no backup to the SFP cooling system.

J. Issue 10 - Limited Instrumentation for Loss of Cooling Events

This issue is related to instrumentation of limited capability to alert operators to a sustained loss of SFP cooling.

Zion Response:

ComEd concurs with the NRC that this issue is not applicable to Zion Station. Zion Station has instrumentation which continuously monitors the spent fuel pool water temperature and gives local indication as well as control room indication when the normal temperature range is exceeded. In addition, the Zion Operations Department performs rounds to monitor the local SFP level indicators twice per shift (four times a day) per procedure PTO, Appendix X (U-1). The operators are given specific procedural guidance for maintaining SFP level, including specific criteria for reporting to Operating Management. Therefore, the available instrumentation provides adequate operator indication to identify a sustained loss of spent fuel cooling.

ATTACHMENT F

Zion Evaluation of SFP Storage Safety Issues

II. Discussion of Identified Issues

A. Issue 5 - Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

1. Introduction:

As previously discussed, the Spent Fuel Pool Liner and Transfer Canal Liner are provided with continuous drains that detect any leakage at the liner welds (such as a through wall crack of a liner seam). Continuous leak channels are provided at the liner weld seams for leak detection. These channels from the SFP liner and Transfer Canal liner are interconnected, and any leakage through the liner is channeled to one of six (6) 1½" drain lines. These six (6) drain lines then empty into the 6" drain header to the Auxiliary Building Equipment Drain Tank (ABEDT). Each 1½" drain line is equipped with a sight glass. By identifying the drain line which has flow, the part of the SFP or Transfer Canal Liner with the leakage can be determined. Neither the individual drain lines nor the 6" drain header are equipped with isolation valves that would stop leakage across the SFP or Transfer Canal Liner. Hence, this issue is applicable to Zion Station.

2. Discussion:

In general, the issue of water leakage through the liner of the SFP or the Transfer Canal is significant in that the water inventory in the SFP and the Transfer Canal may not be maintained. This leakage could, if large enough, exceed the makeup capability to the SFP and continuous leakage could cause an overload and eventual overflow of the drainage collection equipment with increased dose rates in the collection tank area, flooding, and potential shutdown of the units due to the loss of equipment needed for operation.

For Zion Station liner leakage would not have an adverse effect on the safety of the station. Should SFP or Transfer Canal Liner leakage occur, procedures (AOP - 6.2 and SOI-75D) are provided for maintaining the water level in the SFP and/or the Transfer Canal. Any leakage would be drained to the ABEDT and processed as liquid radwaste. Experience to date shows that a 12 gpm leak from the Transfer Canal can be processed along with the other normal drainage to the ABEDT. However, for leakage above this value, the process train may not be able to handle the volume of water, and the ABEDT would eventually fill and overflow. This would cause a gradual flooding of the Auxiliary Building Basement.

3. Potential Modification:

Consideration has been given to a modification to provide a means to isolate the SFP or Transfer Canal leakage. To mitigate this problem, the addition of an isolation valve on each of the six (6) drain lines could be used to stop the leakage flow to the ABEDT. Each valve would be a manual valve located just upstream of its respective sight glass in the pipe tunnel room adjacent to the ABEDT Room on the 542' Elevation of the Aux. Bldg. Additional supports may be required for the addition of the valves at this point in the piping run and in the drain piping upstream of the valves. Installation of these valves would require temporary shielding due to the radiation fields in the area, but this location is the best overall from an ALARA and operational standpoint.

The total cost for the addition of these six (6) valves and the associated supports at the valves is estimated to be between $90,000 - $130,000. This estimate includes the direct costs (design, procurement, ALARA costs, and installation). The potential total installed cost for the additional supports upstream of the new valves in order to have the lines be seismically supported, is estimated to be between $270,000 - $370,000 depending on number and type of supports

required. This estimate for these seismic supports includes the costs associated with the occupational exposure that would be received in installing these supports.

4. Safety Significance of Modification:

An uncontrolled leak through the SFP Liner or the Transfer Canal Liner would not be safety significant. It would only be an operational concern. As identified above there are administrative controls in place to make up water to and maintain the SFP and/or Transfer Canal water level should a crack in a liner weld occur. There are three (3) sources of the water that can be used to provide make up water to the SFP. These include both Refueling Water Storage Tanks (RWST), the Demin. Water System, and the Fire Water System. The Water Purification Pump is capable of transferring 100 gpm from either RWST. The Demin. Water System can deliver 100 gpm, and there are two (2) hose stations in the Fuel Handling Building, each capable of delivering 100 gpm from the Fire Water System. In addition, the flows from the fire hoses could be increased by removal of the nozzles, and there are two (2) additional hose stations in the Fuel Handling Building that could be utilized for SFP water inventory replenishment, if necessary.

An estimate of the maximum leakage flow through any one drain line is approximately 68 gpm. For the very conservative condition of maximum estimated leakage from all six (6) drain lines, the make up sources could maintain SFP water level. The procedures (AOP-6.2 and SOI-75D) both direct boron addition to the SFP, if needed, to maintain required boron concentrations.

The flow of the leakage to the ABEDT would have a negative impact on the operations and habitability in the basement (542' Elevation) of the Auxiliary Building, but no safety-related equipment would be adversely affected, because emergency compensatory measures could be taken before the flooding could affect any safety-related equipment. The leakage to the basement of the Auxiliary Building would not create a radiological hazard beyond the Auxiliary Building. The offsite radiological impact from this leakage is bounded by the results of calculation 22N-0-0280-0003. In this calculation continued boiling of the SFP water results in all of the dissolved halogens coming out of solution with no filtering and modeled as a ground level release. The site boundary and low population zone gamma doses were then calculated resulting in doses that were less than 1% of the LOCA doses.

The proposed modification would contain the leakage, stop the decrease in the water inventory in the SFP or the Transfer Canal, and prevent the adverse conditions in the basement of the Auxiliary Building. However, this modification would not increase the station's ability to safely shutdown, and it would not reduce any offsite doses significantly.

The installation of these valves would have no impact on the overall safety of the station. No credit for these valves is taken to mitigate the consequences of any design basis accident.

5. Other Protective Measures :

Should leakage across the SFP Liner or the Transfer Canal Liner occur, there are various measures in place to mitigate the consequences of the leakage. If a leak were to occur, the leak would be detected by the loss of water inventory in the SFP and/or Transfer Canal. An alarm in the Control Room would identify the low level in the SFP. The water inventory in the SFP and Transfer Canal would be restored and controlled as described in Procedures AOP - 6.2 and SOI - 75D. The approximate location of the leak could be determined by observing at the sight glasses on the drain lines and observing which of the drain lines show flow to the ABEDT. The increased level in the ABEDT coupled with the decrease in the SFP level would identify that leakage in the liner is occurring, and, for small leakage (~ 15 gpm or less), the radwaste process stream could handle the increase in flow to the ABEDT.

6. Summary and Conclusions:

In general, the issue of leakage across the liner of either the SFP or the Transfer Canal could cause loss of water inventory, increased radiation dose rates in the Fuel Building and the Auxiliary Building, and the potential for an eventual spent fuel uncovery. For Zion Station, administrative controls do exist to maintain the water level in the SFP and/or the Transfer Canal (AOP - 6.2 and SOI - 75D). The worst case impact of major leakage at Zion Station would be flooding and dose rate increase in the basement of the Auxiliary Building and the spread of radioactive materials in the area. These impacts would pose operational problems, but there would be little or no impact on offsite doses. Hence, there would be no change to the overall safety of the station. The modification to install the isolation valves on the drains would not significantly improve the overall safety of the station, and their installation could be quite significant both in terms of occupational exposure and total installed cost.

B. Issue 7. Absence of Onsite Power Supply for Systems Capable of SFP Cooling

1. Introduction:

As previously discussed, the existing power supply for each of the SFP Cooling Pumps is from the station's non-essential power distribution system with one pump supplied from Unit 1 and the other pump supplied from Unit 2. Either train of SFP cooling can be used, but, for a total sustained loss of all offsite power, no power is available to the SFP cooling pumps.

2. Discussion:

In general, the issue of the loss of SFP cooling due to loss of offsite power is significant in that without cooling or backup systems to replenish coolant inventory, eventually the spent fuel could be uncovered. Because of the identified backups for replenishing the SFP water inventory, uncovering the spent fuel is not considered a realistic consequence of loss of SFP cooling. However, the elevated temperatures could adversely affect Fuel Building atmosphere (i.e., the iodine in solution comes out of the water) and the clean-up portion of the SFP cooling system. Moreover, long term boiling could adversely affect the SFP concrete.

For Zion Station a loss of SFP cooling due to loss of offsite power would not have an adverse effect on the safety of the station. Should a sustained loss of offsite power occur, procedures (AOP - 6.4 and AOP - 6.2) are provided that identify alternate cooling methods and direct temporary connections for the SFP Cooling Water Pumps to the Essential Power Distribution System. These procedures would also isolate the Fuel Handling Building and redirect HVAC flows (Fuel Building and, if necessary, Pipe Tunnels) through charcoal banks to remove released halogens. The result at Zion Station would be potential adverse affects to the SFP demineralizer equipment and pool concrete and an increase in the Fuel Handling Building airborne radioactivity concentrations.

The frequency of a dual-unit loss of offsite power (DLOOP) in the Zion PRA is 1.4 x 10-2/yr. Using the methodology of NUREG-1032, the probability of not recovering offsite power at 4 hr., 10 hr., and 16 hr., is 7.0 x 10-2, 3.0 x 10-2, and 1.5 x 10-2 , respectively. While the probability of not recovering offsite power is greatest at 4 hr., the fraction of the year during which the water in the fuel pool could be "boiled away" this quickly is small. Therefore, a reasonable estimate for the offsite power non-recovery probability is the value at 16 hr., or 1.5 x 10-2. Because many hours are available, and because the actions to refill the spent fuel pit with fire protection water are well proceduralized, a conservative value for the operator action failure probability is 10-2.

Taking no credit for temporary alternative electrical connections, the frequency of long-term loss of spent fuel pit cooling would be the product of these numbers:

(1.4 x 10-2 /yr.) x (1.5 x 10-2) x (10-2) = 2.1 x 10-6 /yr.

Even without "staged" equipment for the alternative power feed, a conservatively low estimate of the failure to provide the alternative power feed is 0.1. Taking credit for this power feed would reduce the long-term loss of cooling frequency to 2.1 x 10-7 /yr. Since the current (Zion Update) core damage frequency is 7.5 x 10-6 /yr., such scenarios are already less than 3% of the core damage frequency.

3. Potential Modification:

Consideration was given to modifying the physical configuration of the Station to change the power sources for the SFP cooling pumps to the essential power distribution system. This modification would entail routing new power cables from Essential 480 VAC Busses to the pumps, routing new control cables from these switchgear compartments to the local control panels, and replacing the switchgear breaker. This modification would eliminate the issue. The total cost for the described modification is estimated to range from approximately $700,000 to $1,300,000 depending upon the extent of the cable routing and changes to the essential power distribution system due to the additional loads on the system. This total installed cost includes all engineering, procurement, installation, and occupational exposure costs.

4. Safety Significance of Modification:

For a loss of SFP cooling due to a site wide (dual unit) extended Loss of Offsite Power (DLOOP) the modification to have the SFP Cooling Water Pumps powered from the Essential Power Distribution System would not have a major impact on the capability to continue cooling the spent fuel. At present, there would be a considerable time lag between loss of power to these pumps and restarting the pumps with the temporary cabling that connects these pumps to essential power. The most conservative case that was considered, postulated a time to boil of approximately 4 hours. Previous analysis concluded that sufficient time exists between the loss of power to the pumps and the establishment of SFP water inventory replenishment or the completion of temporary connections to the SFP Cooling Water Pumps. The present situation may result in some minor SFP water boiling, but total loss of water inventory would not result. Hence, the consequences of potential boiling of the water in the SFP on the health and safety of the public would be minor, and the impact of this modification would not significantly reduce these consequences.

For this postulated scenario with some boiling of the SFP water the proposed modification would not increase the level of safety for the station. The modification to the SFP Cooling Water Pumps would not be used to mitigate the consequences of any design basis accidents, and it would not significantly reduce any offsite doses or effluent discharges. Moreover, the modification would be very costly and it would increase the loads on the Essential Power System.

The proposed hardware modification would still require operator action to re-start cooling pumps, but that operator action would be much simpler than the requirement to hook up temporary cabling. Therefore, the factor of 0.1 used above would be replaced with a value of 10-2 or 10-3. This would reduce the estimated frequency of loss of spent fuel pit cooling due to loss of offsite power to between 2.1 x 10-8 /yr. and 2.1 x 10-9 /yr. However, the chance of fuel damage due to the proposed scenario is already so small that this improvement would not significantly change the risk profile of Zion Station.

5. Other Protective Measures:

At present, there are various administrative controls to cope with a loss of SFP cooling. Procedures exist that describe measures to prevent the SFP from boiling and maintain the SFP water level for shielding. These procedures provide instructions for installing a temporary power feed to the SFP cooling water pumps from any available power source. These procedures also describe methods for dealing with loss of Component Cooling Water Flow to the SFP Heat Exchangers. The specific procedures that direct these actions include AOP-6.2, AOP-6.4, and SOI-75D.

These procedures will be modified to more specifically identify the work necessary to provide the temporary power to the SFP Cooling Water Pumps. Included in these procedure modifications will be direction as to the spare power sources to use for the DLOOP condition, identification of temporary cable routes, and any installation details and diagrams needed to establish the temporary connections. Also, dedicated and staged cabling and other required equipment will be provided for implementation of these procedure revisions.. Based upon PRA analysis this planning and "staging" of equipment could reduce the current probability of failure to align alternative power by a factor of 10. The result would approach the estimated benefit of the hardware modification.

Finally, a revision to procedure AOP-6.4 to account for a removed block wall between the Fuel Handling Building and the respective Containment will be initiated.

6. Summary and Conclusions:

The issue of loss of SFP cooling could cause boiling of the water in the SFP, loss of water inventory, increased radiation dose rates in the Fuel Handling Building, and the potential for eventual uncovering of spent fuel. Administrative controls exist to provide makeup water to the SFP to prevent fuel uncovery and maintain the SFP water level (AOP - 6.2 , AOP - 6.4, and SOI - 75D). Hence, uncovering of spent fuel is not a concern. The major impact from elevated SFP water temperatures would be a release of the halogens (contained in the SFP water) and loss to the cleanup portions of the SFP cooling system. Also, long term boiling of the SFP water could impact the SFP concrete. There would be very little or no impact on offsite doses or a significant increase in effluent releases. Hence, there is very little or no adverse change in the overall safety of the station. The modification to change power supplies for the SFP Cooling Water Pumps would not contribute to any significant increase in the station safety. A significant benefit can be gained by providing additional clarification in the procedures and by staging the materials needed to make the temporary connections. Zion Station will perform these procedure revisions and will stage the necessary materials.