BWR OWNERS' GROUP

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U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: A. C. Thadani
Office of Nuclear Reactor Regulation

Subject: **BWR OWNERS' GROUP ASSESSMENT OF THE SPENT FUEL POOL COOLING SYSTEM**

In response to your letter of October 30, 1993, attached is the subject document. This document provides a review of the regulatory guidance as it pertains to the design of the BWR spent fuel pool cooling system, in particular for the postulated loss of spent fuel pool cooling event scenario that was the subject of a 10 CFR 21 report. The assessment results in the following conclusions:

- Based on a review of the regulatory guidance, and the NRC's application of that guidance, the postulated event scenario is beyond the typical licensing basis of BWRs.
- Given the extremely low probability of the postulated event scenario, the licensing basis is adequate.
- Licensing basis events can be successfully mitigated, and public health and safety is not compromised.

Nevertheless, the BWROG is recommending that its member utilities each conduct a review against their current licensing basis of their procedures regarding operator actions to align backup spent fuel pool cooling and makeup systems, unless they have already either reviewed the procedures or demonstrated that they are adequate by applying them.

The comments/positions provided in this letter have been endorsed by a substantial number of the members of the BWROG, however, it should not be interpreted as a commitment by any

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individual member to a specific course of action. Each member must formally endorse the BWROG position for that position to become that member's position.

If you have any questions, please contact either W. A. (Bill) Zarbis (GE - BWROG Projects, 408-925-5070) or the undersigned.

Very truly yours,

L. A. England, Chairman
BWR Owners' Group

Attachment
WAZ/LAE/waz

cc: R. A. Pinelli, BWROG Vice Chairman
C. L. Tully, BWRO[illegible] Chairperson
BWROG Executive [illegible] Committee
BWROG Primary R[illegible]
S. J. Stark, GE
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BWR OWNERS' GROUP
ASSESSMENT OF THE
SPENT FUEL POOL COOLING SYSTEM

1.0 INTRODUCTION

1.1 BACKGROUND

On November 27, 1992, a 10 CFR Part 21 notification was filed to notify the NRC of potential concerns regarding the design of spent fuel pool cooling (SFPC) systems at a BWR site in the United States. The notification stated that a loss-of-coolant accident (LOCA) could create an inability to adequately cool the spent fuel pool (SFP), because of either the postulated failure of associated piping, a long-term loss-of-offsite power (LOOP) coincident with the LOCA, or any other accompanying condition. The radiological effects of the LOCA are postulated to prevent reactor operators from entering the reactor building and performing the steps necessary to restore SFPC using the backup system. Subsequent boiling of the SFP is postulated, and the reactor operators are also prevented by the radiological effects of the LOCA from performing the necessary steps to provide makeup water. The boiling is postulated to result in uncovery of the fuel in the SFP and also possible damage to safety-related equipment in the reactor building from the steam environment, thus resulting in an offsite release.

In a letter dated October 30, 1993, the NRC informed the BWR Owners' Group (BWROG) that they were evaluating this issue and were interested in the actions being taken by the BWROG to address the issue. The BWROG has prepared this document in response.

1.2 PURPOSE

The BWROG has reviewed the regulatory guidance related to this issue. This paper provides an assessment of the characteristics of the BWR design against the generic licensing basis.

1.3 APPLICABILITY

The postulated event scenario is not applicable to plants with a safety-grade SFPC system, because normal SFP cooling and makeup systems will not be lost, and therefore the alignment of backup systems in a LOCA environment will not be necessary.

2.0 SUMMARY AND CONCLUSIONS

A review of the licensing basis for the SFPC system and the makeup water system, and the design of these systems, results in the following conclusions:

- Based on a review of the regulatory guidance, and the NRC's application of that guidance, the postulated event scenario is beyond the typical licensing basis of BWRs. The regulatory guidance does not identify a particular accident or accidents for which a SFPC system must be designed. The typical licensing basis for the SFPC system of a BWR does not require that post-LOCA operation be considered in conjunction with a LOOP.

- Given the extremely low probability of the postulated event scenario, the licensing basis is adequate. The probability of a design basis LOCA coupled with an extended loss of SFP cooling is extremely low and is thus not a credible event. The calculated probability of the postulated scenario has been calculated for some plants and is on the order of 10^{-10} to 10^{-15}, depending on the assumptions applied.

- Licensing basis events can be successfully mitigated, and public health and safety is not compromised. The spent fuel pool is designed so that no single failure will cause the inability to maintain the fuel submerged in the water. Adequate makeup water is available from one or more of several sources should the normal makeup water system be lost, and most BWRs also have the capability for backup cooling in case of failure of the normal cooling system.

3.0 LICENSING BASIS EVALUATION

3.1 SUMMARY

Based on the following evaluation, the BWROG believes that the event scenario presented to the NRC in the Part 21 report is beyond the typical licensing basis of BWRs. Design and analysis of a LOCA coincident with the loss of normal spent fuel pool cooling and makeup are not required by the regulations. The SFPC system licensing basis varies from plant to plant, but is considered sufficient to ensure that licensing basis events are mitigated and public health and safety are protected.

3.2 SYSTEM DESIGN

The SFPC system is designed to remove decay heat from spent fuel assemblies, maintain the spent fuel pool water level, and remove dissolved or suspended radioactive materials from the SFP and thus minimize the potential release of radioactive materials contained in the SFP. The SFPC system, the SFP makeup water system, its source, and the fuel pool building and its ventilation and filtration system, may or may not be designed to Seismic Category I requirements depending on the vintage of the plant.

The event scenario postulated in the Part 21 report is not applicable to those plants with a safety-grade SFPC system.

3.3 REGULATORY GUIDANCE

The licensing basis will vary from plant to plant depending on the period of time in which the licensee submitted and the NRC reviewed the application to construct and license the plant. In this report, relevant regulatory guidance is reviewed, although it is recognized that not all of it will apply to every plant.

The pertinent regulatory guidance is discussed in Appendix A of this document.

3.4 COMPLIANCE WITH LICENSING BASIS

Again, it is recognized that the licensing basis will vary from plant to plant; however, the discussion below will apply in general to BWRs.

The scope of this document is the postulated event scenario initiating from either failure of SFPC system piping due to LOCA-induced hydrodynamic effects, a long-term LOOP coincident with the LOCA, or any other accompanying condition. The regulatory guidance summarized in Appendix A that is directly relevant to that scenario is discussed below.

In summary, the following discussion indicates that the postulated event scenario is outside the typical licensing basis for BWRs.

GDC 2

GDC 2 refers only to natural effects such as earthquakes. For plants licensed against the GDC, the fuel pool makeup water system is a Seismic Category I system, and thus GDC 2 is satisfied. For plants licensed prior to implementation of the GDC, adequate makeup water is available from one or more of several sources if the SFP boils.

GDC 44/GDC 61/GDC 63

The SFP is designed so that no single failure of equipment will cause the inability to maintain fuel submerged in water. A makeup water system and pool water level instrumentation are provided to replace evaporative and leakage losses. Adequate makeup water is available from one or more of several sources in case of failure of the normal makeup water system.

For some BWRs, the normal SFPC system is backed by diesel generators and thus would continue to be available during a LOOP event. For other BWRs, a LOOP event could cause normal SFP cooling to be unavailable for a period of time until power is restored. However, plant-specific probabilistic risk assessments have been performed that demonstrate there is a high probability (approaching 100%) of restoring power prior to the SFP reaching a boiling condition. In the unlikely event that the LOOP is of longer duration, sufficient makeup water is available to maintain water level should boiling occur.

Most BWRs also have the capability for backup cooling using the Residual Heat Removal (RHR) system in case of failure of the normal SFPC system. For these plants, the SFP is provided with a connection to the RHR system utilizing Seismic Category I piping. Thus the safety-related and emergency diesel generator-backed RHR system can be used to cool the SFP.

The regulatory guidance does not identify a particular accident or accidents for which a SFPC system must be designed. The typical licensing basis for the SFPC system of a BWR does not require that post-LOCA operation be considered in conjunction with a LOOP.

A review of how the guidance has been applied by the NRC indicates that the licensing basis for SFP cooling for the postulated event scenario initiating from failure of SFPC system piping due to LOCA-induced hydrodynamic effects or from a long-term LOOP coincident with the LOCA is not required by the regulations. The regulations governing LOCA or LOCA/LOOP events (10 CFR 50.46, 10 CFR 50 Appendices A, J and K, and 10 CFR 100.11) do not identify the assumptions and consequences that must be considered. The pertinent regulations and their application were determined during each plant's licensing process and establish that plant's licensing basis.

3.5 ADEQUACY OF LICENSING BASIS AND REGULATIONS

The BWROG believes that the licensing basis is sufficient with regard to the postulated scenario.

Not all BWRs are licensed against the GDC of 10 CFR 50 Appendix A, but in general the design of all BWRs is consistent with the intent of the GDC to provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. The bases for these criteria are conservative, "deterministic" analyses rather than "mechanistic" analyses. The historical licensing basis for BWRs thus is generally deterministic, while mechanistic analyses are used for realistic evaluations such as probabilistic risk assessments.

The GDC and other industry standards establish the basis for properly designed systems that respond to credible event scenarios. Concerns and issues within the scope of the licensing basis are addressed deterministically to assure an adequate level of safety in accordance with Title 10 of the CFR. Issues or concerns outside of the licensing basis are addressed mechanistically using a cost/benefit approach per 10 CFR 50.109.

ANSI/ANS 52.1-1983, "Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants", defines "credible events" as those having a frequency greater than 10^{-7} per reactor year. Events with a frequency of less than 10^{-6} per reactor year are considered not credible. The probability of a design basis LOCA coupled with an extended loss of SFP cooling is extremely low, well less than the 10^{-6} threshold, and is thus not a credible event. The calculated probability of the postulated scenario has been calculated for some plants and is on the order of 10^{-10} to 10^{-15}, depending on the assumptions applied. This probability is also below the 10^{-8} threshold at which the NRC requires reporting of core damage event sequences in Individual Plant Examinations.

Generic Issue (GI) 82, "Beyond Design Basis Accidents in Spent Fuel Pools," specifically considered the probability and consequences of a loss of spent fuel pool cooling resulting from a beyond design basis event, component failures, operator errors, and times for repair and/or alignment of systems. In addition, GI 82 considered the possibility of a long duration power loss as an unlikely LOCA initiator, relying on a 1988 study (NUREG/CR-5032, "Modeling Time to Recovery and Initiating Event Frequency for Loss of Off-site Power Incidents at Nuclear Power Plants") which reported that the longest power outage was approximately nine hours. The staff concluded that reducing the risk from spent fuel pools due to events beyond the safe shutdown earthquake would still leave a comparable risk due to core damage accidents, and that because of the large inherent safety margins in the design and construction of spent fuel pools, no new requirements were to be established.

In conclusion, based on the preceding discussion the BWROG believes that the current regulatory guidance is sufficient and correct, and that changes to the regulations will not increase the current margins of safety and therefore are not needed in response to this issue.

APPENDIX A:
REGULATORY GUIDANCE

INTRODUCTION

The information provided in this Appendix is based on the information contained in Section 9.1.3, "Spent Fuel Pool Cooling and Cleanup System," of the NRC Standard Review Plan (NUREG-0800). The exact wording of the General Design Criteria (GDC) is not repeated here.

The regulatory guidance presented in this Appendix includes: GDCs 2, 4, 5, 44, 45, 46, 61 and 63 of 10 CFR 50 Appendix A; 10 CFR 20; and Regulatory Guides (RGs) 1.13, 1.26, 1.29 and 1.52. Upon reading this information, it is apparent that much of it applies to aspects of the spent fuel pool cooling system that are not relevant to issues raised by the postulated event scenario. The information in that category is provided for completeness; however, only GDCs 2, 44, 61 and 63 are discussed in detail in Section 3.3 of this document.

It is also recognized that not all of the regulatory guidance in this Appendix is applicable to all BWRs, because each plant's licensing basis will vary depending on its vintage.

REGULATORY GUIDANCE

GDC 2

Structures housing the SFPC system and the system itself should be capable of withstanding the effects of natural phenomena such as earthquakes. Acceptance for meeting this criterion is based on conforming to pertinent positions in RG 1.13. NUREG-0800 provides additional discussion regarding GDC 2.

GDC 4

Structures housing the system and the system itself should be capable of withstanding the effects of external missiles.

GDC 5

Shared systems and components important to safety should be capable of performing required safety functions.

GDC 44

The SFPC system including the makeup water system should include:

1) The capability to transfer heat loads from safety-related structures, systems and components to a heat sink under both normal operating and accident conditions pursuant to 10 CFR 50 Appendix A.

2) Suitable redundancy of components so that safety functions can be performed assuming a single active failure of a component coincident with the loss of all offsite power.

3) The capability to isolate components, systems, or piping, if required, so that the system safety function will not be compromised.

GDC 45

The design of safety-related components and equipment should permit periodic inspection of safety-related components and equipment.

GDC 46

The design of safety-related systems or components should permit functional testing.

GDC 61

The system design for fuel storage and handling of radioactive materials should include the following:

1) The capability for periodic testing of components important to safety.

2) Provisions for containment.

3) Provisions for decay heat removal.

4) The capability to prevent reduction in fuel storage coolant inventory under accident conditions in accordance with the guidelines of position C.6 of RG 1.13.

5) The capability and capacity to remove corrosion products, radioactive materials and impurities from the pool water.

GDC 63

Monitoring systems are to be provided to detect conditions that could result in the loss of decay heat removal, to detect excessive radiation levels, and to initiate appropriate safety actions.

10 CFR Part 20

Radiation doses are to be kept as low as reasonably achievable.

RG 1.13

RG 1.13 provides an acceptable method for implementing GDC 61, and is also applicable to specific aspects of GDCs 2 and 4.

RG 1.26

RG 1.26 describes a quality classification system related to specified national standards that may be used to determine quality standards acceptable to the NRC.

RG 1.29

RG 1.29 describes a method acceptable to the NRC for identifying and classifying those features of nuclear power plants that should be designed to withstand the effects of a Safe Shutdown Earthquake.

RG 1.52

RG 1.52 presents methods acceptable to the NRC with regard to design, testing and maintenance criteria for post-accident engineered safety feature atmosphere cleanup systems designed to mitigate the consequences of postulated accidents.