July 24, 2003

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
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PALISADES NUCLEAR PLANT
DOCKET 50-255
LICENSE No. DPR-20
RESOLUTION OF GENERIC LETTER 96-06 TWO-PHASE FLOW ISSUES
(TAC NO.M96844)

By letter dated April 24, 2002, the Nuclear Regulatory Commission (NRC) forwarded to the Nuclear Management Company, LLC (NMC) their acceptance of Electric Power Research Institute (EPRI) report TR-113594, "Resolution of Generic Letter [GL] 96-06 Waterhammer Issues," Volumes 1 and 2. The letter contained a request for NMC to complete actions to address GL 96-06 for the Palisades Nuclear Plant and submit the information referred to in Section 3.3 of the attached NRC safety evaluation by July 30, 2002. The requested information addressed waterhammer and two-phase flow issues. By letter dated February 28, 2003, NMC provided the response to the waterhammer issue and requested an extension to July 30, 2003, to provide the response to the two-phase flow issue. The attachment to this letter provides the response to the two-phase flow issue.

This letter contains no new commitments and no revisions to existing commitments.

FOR

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Attachment

A072

ATTACHMENT 1

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

July 24, 2003

RESOLUTION OF GENERIC LETTER 96-06 TWO-PHASE FLOW ISSUES

5 Pages Follow

RESOLUTION OF GENERIC LETTER (GL) 96-06 TWO-PHASE ISSUES

REQUESTED ACTIONS TO ADDRESS GL 96-06

PALISADES NUCLEAR PLANT

DOCKET NUMBER 50-255

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Requested Item

- *The additional information that was requested in RAIs that were issued by the NRC staff with respect to the GL 96-06 two-phase flow issue (as applicable).*

Response

Consumers Energy (the previous licensee for Palisades) received a request for additional information (RAI) from the NRC staff by letter dated June 18, 1998. The following information is provided to address this RAI.

Introduction

Two-phase flow is a concern in and downstream of the Palisades Nuclear Plant containment air coolers (CACs) under the design basis events of loss of coolant accident (LOCA) and main steam line break (MSLB). In order to address NRC requests for additional information relative to two-phase flow associated GL 96-06, a detailed engineering analysis was performed. The purpose of the analysis was to determine if two-phase flow existed in or downstream of the CACs during any accident scenario when the LOCA and MSLB containment response analysis took credit for them. The analysis was not an evaluation of the phenomenon of two-phase flow, but rather an analysis to determine if two-phase flow exists with the design basis accident scenarios.

The intent of the analysis was to assess the potential for local boiling after the service water flow is reinitiated.

The LOCA containment response analysis assumes a coincident loss of offsite power (LOOP). There would be a loss of service water flow with the potential for a resultant voiding during the brief period before the emergency diesel generators start. Full operability of the CACs in the LOCA environment is assumed to exist after 45 seconds into the event.

Unlike the LOCA, the MSLB containment response analysis does not assume a concurrent LOOP. A LOOP with diesel-powered engineered safeguards equipment available has been determined to be less limiting than the single failure associated with the failure of engineered safeguards to start. The worst-case single failures are those associated with relay failures to actuate where multiple engineered safeguards components do not start. In particular, the containment high pressure and safety injection relays of either channel have been evaluated.

Even though offsite power is available for the MSLB and there is not a loss of service water flow, the CACs were analyzed to determine if the flow is sufficient to preclude local boiling. The CAC and service water conditions assumed in the MSLB containment response analysis were reviewed. Full operability of the CACs is assumed no later than 21 seconds into the event.

A broad spectrum of critical service water loads was employed in the system analysis. The loads included the instrument air compressor after-coolers, component cooling water heat exchangers, emergency diesel generators, control room ventilation condensers, and the engineered safeguards room air coolers.

The analysis approach was as follows:

- Obtain steam pressure and containment temperature profiles from the containment response analyses.
- Determine the containment saturation temperature from the profiles at the time of interest.
- Determine the CAC service water outlet temperature associated with the saturation temperature of interest via the output of the CAC performance analysis.
- Determine the saturation temperatures at critical points on the service water outlets of the CACs at the time of interest from the pressures determined from the flow calculations.
- Compare the service water saturation temperatures determined above at the critical points at the time of interest with the service water outlet temperatures that resulted from the CAC performance analysis.

The conclusion from the bounding analysis is that, during the period that the containment air coolers are credited in the LOCA and MSLB containment response analyses, there is no boiling in the CAC tubes nor in the piping downstream of the CACs. Therefore, detailed two-phase flow (computer) analysis was not conducted.

Requested Items from June 18, 1998 RAI:

Item 2. For two-phase flow analyses, provide the following information:

a. *Identify any computer codes that were used in the two-phase flow analyses and describe the methods used to benchmark the codes for the specific loading conditions involved (see Standard Review Plan Section 3.9.1).*

b. *Requested item (b) pertained to waterhammer analysis and was superceded by the NRC letter dated April 24, 2002.*

c. *Provide a detailed description of the "worst-case" scenarios for two-phase flow, taking into consideration the complete range of event possibilities, system configurations, and parameters. Additional examples of two-phase flow considerations that must be addressed include:*

- *The effects of void fraction on flow balance and heat transfer;*
- *The consequences of formation, transport, and accumulation;*
- *Cavitation, resonance, and fatigue effects; and*
- *Erosion considerations*

Licensees may find NUREG/CR-6031, "Cavitation Guide for Control Valves," helpful in addressing some aspects of the two-phase flow analyses. (Note: It is important for licenses to realize that in addition to heat transfer considerations, two-phase flow also involves structural and system integrity concerns that must be addressed.)

d. *Confirm that the analyses included a complete failure modes and effects analysis (FMEA) for all components (including electrical and pneumatic failures) that could impact performance of the cooling water system and confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.*

e. *Explain and justify all uses of "engineering judgment." For example, the 120-day response states that the design of the CACs makes it unlikely to have any steam.*

Responses to Requested Items from June 18, 1998 RAI:

Item 2

a. As discussed above, the analysis performed concluded two-phase flow conditions do not occur after service water flow is reestablished and the CACs are credited in the safety analysis. Therefore, the use of computer codes is not applicable.

b. Requested item (b) pertained to waterhammer analysis and was superceded by the NRC letter dated April 24, 2002.

c. Two-phase flow analysis was unnecessary for the period where the CACs are credited in the containment response analysis. It has been noted, especially for the LOCA/LOOP considerations, that some voiding could exist very early in the transient before full service water flow is restored and the CACs are credited. This condition has been determined to be in the initial seconds prior to achieving full service water flow, and therefore, precludes significant effects associated with heat transfer, cavitation, resonance, fatigue, and erosion considerations.

d. A rigorous FMEA is not necessary for two-phase flow conditions given the conclusion stated previously that these conditions would not exist during the period where the CACs are credited in the containment response analysis. The requested item, as it pertains to waterhammer conditions, was superceded by the NRC letter dated April 24, 2002.

e. The "engineering judgment " referenced in the previous submittal was made without the benefit of detailed heat transfer analyses. The analysis conducted that indicates no two-phase flow during the period the CACs are credited confirms the "engineering judgment " of the previous submittal.

Requested Item

- *A brief summary of the results and conclusions that were reached with respect to the two-phase flow issues, including problems that were identified along with corrective actions that were taken. If corrective actions are planned but have not been completed, confirm that the affected systems remain operable and provide the schedule for completing any remaining corrective actions.*

Response

In summary, the conclusion from the analysis described above is that during the period when the CACs are credited in the LOCA and MSLB containment response analyses, there is no boiling in the CAC tubes nor in the piping downstream of the CACs. Therefore, no corrective actions are necessary.