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U.S. Nuclear Regulatory Commission
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PALISADES NUCLEAR PLANT
DOCKET 50-255
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GENERIC LETTER (GL) 97-04, "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS" – UPDATED RESPONSE (TAC NO. MA0021)

On January 5, 1998, Consumers Energy provided the 90-day response to Generic Letter (GL) 97-04, "Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps." On July 2, 1998 the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) related to the 90-day response to GL 97-04. On August 3, 1998, Consumers Energy responded to the RAI, and further provided corrections to errors found in the original response to GL 97-04.

NMC is providing an update to both the original GL 97-04 response and the RAI response. Attachment 1 is the update to the original GL 97-04 response. Attachment 2 is the update to the original RAI response. This update is due to revisions made in the emergency core cooling system (ECCS) NPSH calculations of record. The calculation revisions were made in response to a commitment associated with a previous NRC Engineering and Technical Support inspection conducted at Palisades in 1998 (Inspection Report IR 98-012).

The updated response to GL 97-04 and to the RAI is attached. Both documents show revision bars where actual changes to the original documents took place. Due to recent plant modifications, the number of limiting engineered safeguard system (ESS) recirculation mode lineups has been reduced. In the original GL 97-04 response, eight limiting ESS recirculation modes were analyzed. The attached, updated response includes four limiting ESS recirculation modes.

The original RAI response provided corrections to errors found in the original GL 97-04 response. This was provided as attachment 2 in the original RAI response. Due to this update, this attachment 2 is superceded.

A076

SUMMARY OF COMMITMENTS

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

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Attachments

ATTACHMENT 1

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

NOVEMBER 26, 2002

UPDATED RESPONSE TO GENERIC LETTER (GL) 97-04
"ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS"

6 Pages Follow

UPDATED RESPONSE TO GENERIC LETTER 97-04 "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS"

INTRODUCTION

In Generic Letter (GL) 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," the Nuclear Regulatory Commission (NRC) requested that licensees provide the information outlined below for their facilities. Specifically, the licensees were requested to review the current design-basis analyses used to determine available net positive suction head (NPSH) for emergency core cooling system (ECCS) and containment spray system (CSS) pumps that meet one of the following criteria:

1. pumps that take suction from the containment sump following a design-basis loss-of-coolant accident (LOCA) or secondary line break, or

2. pumps that are supplied by pumps which take suction directly from the containment sump (piggybacking).

For Palisades, the high pressure safety injection (HPSI) and containment spray (CS) pumps fit the criteria for review.

NRC REQUESTED INFORMATION

(1) Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.

NUCLEAR MANAGEMENT COMPANY, LLC (NMC) RESPONSE

(1) The head loss for the containment sump screens (i.e. suction strainers) is calculated by the computer program used to evaluate recirculation mode flow rates at Palisades. The program uses the Darcy-Weisbach equation for head loss:

$$h_L = Kv^2/2g$$

where K is the total resistance coefficient for each pipeline in the system. The K value for the pipeline containing the sump screens includes the K value for the sump screens. The fluid velocity (v) is calculated from the predicted flow rates.

The K value for the sump screens is calculated using an equation from the "*Applied Fluid Dynamics Handbook*" by Robert D. Blevins. The sump screen K value is calculated assuming 50% of the total screen area is blocked by debris. The resistance coefficient of each sump screen, which is adjusted to account for the difference in flow area between the screen and the suction pipeline, has a value of 0.17 in the current analysis of record.

The determination of screen head loss is part of the overall calculation of ECCS and CS NPSH margins. This calculation uses the following equation to determine the available NPSH ($NPSH_A$) for each ECCS and CS pump following the initiation of recirculation following a large break loss-of-coolant accident (LBLOCA):

$$NPSH_A = h_A + h_{ST} - h_{vp} - h_f$$

Where:
- h_A = absolute pressure on containment water surface
- h_{ST} = static head of water above pump suction elevation
- h_{vp} = vapor pressure of water at the pump suction inlets
- h_f = frictional head loss in suction piping, sump screens, etc.

The current analysis assumes, in accordance with Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps" and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants", that the pressure on the water inside containment equals the vapor pressure of the water at the pump suction, (i.e. these two terms cancel each other). Thus, available NPSH is assumed to be the static head minus the friction losses in the suction piping.

A computer program is used to evaluate a model of the ECCS and CS systems in various recirculation mode configurations. The pressure predicted by the model at the pump suction nodes is converted to feet of water and taken to represent the available NPSH for pumps in each configuration.

Factors incorporated into the model and the analysis include the following:

a) The containment water level, which determines h_{ST}, is conservatively assumed to be less than the predicted minimum water level following a LBLOCA.

b) The friction losses between the containment sump and the pump suction inlets account for pipe roughness, the nominal piping lengths, the losses created by the various valves and fittings in the system, and the effect of fluid velocity through the piping. The fluid velocity is determined from the predicted flow rates generated by the computer model.

c) The current ECCS and CS pump NPSH analysis evaluates the LBLOCA scenario. This is the only final safety analysis report (FSAR) accident that is evaluated for the recirculation mode of ECCS operation. Secondary side pipe breaks and smaller LOCAs are not analyzed for ECCS and CS pump NPSH.

NRC REQUESTED INFORMATION

(2) Identify the required NPSH and the available NPSH for each pump.

NMC RESPONSE

(2) Due to Palisades ECCS configuration, assumed single failures, and operational lineups, several recirculation mode lineups are analyzed for ECCS pump and CS pump NPSH. The first distinction between lineups involves the assumed single failure. NMC evaluates two single failures: failure of left channel safety injection and failure of right channel safety injection. The left channel failure scenario leaves one HPSI pump, one low pressure safety injection (LPSI) pump and one CS pump available for mitigating an accident. The right channel failure scenario leaves one HPSI pump, one LPSI pump and two CS pumps available for mitigating an accident.

The second distinction between lineups involves the various operational configurations of the system following the initiation of recirculation. The cases evaluated include:

a) recirculation mode with subcooling (or piggyback operation) in service

b) recirculation mode with subcooling and hot leg injection in service

In each evaluated case, the operating pumps are predicted to have sufficient NPSH available ($NPSH_A$) to meet the NPSH requirements ($NPSH_R$) of the operating pumps.

Case 1: Left Channel Failure of Safety Injection

Operation of CS pump P-54A, HPSI pump P-66A, one spray header, subcooling in service, HPSI injection into primary coolant system (PCS) cold legs

Pump	Flow Rate, gpm	$NPSH_A$, ft	$NPSH_R$, ft
CS pump P-54A	2125	17.53	17.25
HPSI pump P-66A	764.40	320.20	24.78

This lineup is established at the initiation of recirculation with the combination of an operator action prior to receipt of a recirculation actuation signal (manual closure of containment spray header isolation valve CV-3001) and the automatic initiation of subcooling for HPSI pump P-66A by the recirculation actuation signal.

Case 2: Left Channel Failure of Safety Injection

Operation of CS pump P-54A, HPSI pump P-66A, one spray header, subcooling in service, HPSI injection into PCS cold legs and a hot leg

Pump	Flow Rate, gpm	$NPSH_A$, ft	$NPSH_R$, ft
CS pump P-54A	2046	17.64	16.46
HPSI pump P-66A	625.10	344.52	17.32

This lineup is established five and a half to six and a half hours after the LOCA when the operators manually initiate simultaneous hot leg/cold leg injection.

Case 3: Right Channel Failure of Safety Injection

Operation of CS pumps P-54B and P-54C, HPSI pump P-66B, two spray headers, subcooling in service, HPSI injection into PCS cold legs

Pump	Flow Rate, gpm	$NPSH_A$, ft	$NPSH_R$, ft
CS pump P-54B	1913	17.58	14.69
CS pump P-54C	1855	17.56	14.65
HPSI pump P-66B	771	349.09	26.86

This lineup is established at the initiation of recirculation by the automatic initiation of subcooling for HPSI pump P-66B by the recirculation actuation signal.

Case 4: Right Channel Failure of Safety Injection

Operation of CS pumps P-54B and P-54C, HPSI pump P-66B, two spray headers, subcooling in service, HPSI injection into PCS cold legs and a hot leg

Pump	Flow Rate, gpm	$NPSH_A$, ft	$NPSH_R$, ft
CS pump P-54B	1874	17.64	14.43
CS pump P-54C	1817	17.61	14.44
HPSI pump P-66B	641.50	363.78	19.00

This lineup is established five and a half to six and a half hours after the LOCA when the operators manually initiate simultaneous hot leg/cold leg injection.

NRC REQUESTED INFORMATION

(3) *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

NMC RESPONSE

(3) The current NPSH calculation was completed in December 2001. NMC determined that NRC approval was not required, in accordance with 10 CFR 50.59. Therefore, the current analysis has not been submitted to the NRC.

The current NPSH calculation is different than the calculation that formed the basis for Palisades' prior GL 97-04 submittals. The current calculation includes updates to the hydraulic model (as a result of recent system and component testing) and the effects of recent plant modifications and procedure changes. The current analysis predicts sufficient $NPSH_A$ for all allowable system lineups.

UPDATED RESPONSE TO GENERIC LETTER 97-04
"ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS"

NRC REQUESTED INFORMATION

(4) Specify whether containment overpressure (i.e. containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.

NMC RESPONSE

(4) Containment overpressure is not credited in the current NPSH analysis. The methodology used in the current analysis assumes the containment pressure is equal to the vapor pressure of the pumped fluid. See NMC's response to Item 1 for more details.

NRC REQUESTED INFORMATION

(5) When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.

NMC RESPONSE

(5) Based on the response to Item 4, a response is not required for this item.

ATTACHMENT 2

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

NOVEMBER 26, 2002

UPDATED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
GENERIC LETTER (GL) 97-04

2 Pages Follow

UPDATED RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING GL 97-04

NUCLEAR REGULATORY COMMISSION (NRC) REQUESTED INFORMATION

(1) In response to question 1, it is stated that "the containment water level, which determines h_{ST}, is conservatively assumed to be less than the predicted minimum water level following a large break LOCA." What is the predicted minimum water level, e.g., the containment floor or an amount above the containment floor?

NUCLEAR MANAGEMENT COMPANY, LLC (NMC) RESPONSE

(1) The predicted minimum water level is the amount above the containment floor. The minimum predicted level is at elevation 593.5 feet (i.e. 3.5 feet above the containment floor). The minimum water level assumed in the net positive suction head (NPSH) calculation is 593 feet (i.e. 3-feet above the containment floor).

NRC REQUESTED INFORMATION

(2) What is the maximum sump temperature assumed in the NPSH analyses? Is subcooling credited?

CONSUMERS ENERGY RESPONSE

(2) The NPSH analysis assumes a sump water temperature of 211.9°F. Subcooling of the sump water is not credited.

NRC REQUESTED INFORMATION

(3) In response to question 2, eight cases are evaluated. In Case 1, "Left Channel Failure of Safety Injection," the NPSH available is less than the NPSH required for a small amount of time. Why isn't this the design case for Palisades?

NMC RESPONSE

(3) The engineered safeguards system (ESS) NPSH analysis that formed the basis for NMC's original GL 97-04 response used the term "design case" to refer to those ESS lineups that persist for long periods of time following a design basis accident. Case 1 in the initial response to GL 97-04 is a short-term transient state (~10 minutes) that occurs prior to establishing the long-term system lineup. For this reason, it was not termed a design case. NMC's initial response to GL 97-04 was based on this terminology.

The current analysis, and this revised response to GL 97-04, does not use this terminology.

NRC REQUESTED INFORMATION

(4) In response to question 3, it is stated that the current NPSH analyses were completed in November 1996 under 10 CFR 50.59. Discuss the changes made to the analyses between the current NPSH analyses and the previous NPSH analyses.

NMC RESPONSE

(4) The current NPSH analysis, completed in December 2001, is a revision to the November 1996 analysis. The revised analysis incorporates a modified 50% containment sump screen loss coefficient, a new containment sump check valve head loss characteristic, updated ECCS and containment spray (CS) pump performance curves, updated high pressure safety injection (HPSI) and low pressure safety injection (LPSI) system benchmarking, and other minor model corrections and updates. The current analysis supersedes the recirculation mode evaluation portion of the November 1996 analysis.