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SUBJECT: Submits GL 97-04, "Assurance of Sufficient Net Positive Suction Head for ECC & Containment Heat Removal Pumps."

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January 30, 1998

AEP:NRC:1280A

Docket Nos.: 50-315
50-316

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Gentlemen:

Donald C. Cook Nuclear Plant Units 1 and 2
LICENSE NOS. DPR-58 AND DPR-74
REQUESTED INFORMATION - GENERIC LETTER (GL) 97-04
ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR
EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS

On October 7, 1997, the Nuclear Regulatory Commission (NRC) issued GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps", indicating that adequate net positive suction head may not be available to the emergency core cooling system and containment spray pumps under all design basis accident scenarios.

The attachment to this letter contains our response to the information requested in GL 97-04.

Sincerely,

EEFitzpatrick

E. E. Fitzpatrick
Vice President

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 30th DAY OF JANUARY, 1998

Linda L. Boelcke
Notary Public

My Commission Expires 1-21-2001

LINDA L. BOELCKE
Notary Public, Berrien County, MI
My Commission Expires January 21, 2001

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/vlb

Attachment

c: J. A. Abramson
A. B. Beach
MDEQ - DW & RPD
NRC Resident Inspector
J. R. Sampson

120104

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PDR ADOCK 05000315
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ATTACHMENT TO AEP:NRC:1280A

REQUESTED INFORMATION - GENERIC LETTER (97-04),
ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD
FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS

Following is our response to the information requested in generic letter (GL) 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps", dated October 7, 1997.

GL 97-04 REQUEST NO. 1

"Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers."

OUR RESPONSE TO REQUEST NO. 1

The emergency core cooling system (ECCS) suction strainers at Cook Nuclear Plant consist of grating and screens at the inlet to the containment recirculation sump. The sump design includes two layers of coarse grating at the sump entrance that sandwich a single layer of 1/4" fine mesh screen. The net positive suction head (NPSH) calculation for the ECCS and containment spray (CTS) pumps assumes a head loss of 1 ft. across the containment recirculation sump at a flow of 15,600 gpm. This head loss represents losses from upstream of the outer layer of grating, through the sump, and into the pipes at the sump exit. The assumed head loss is based on empirical data from sump model testing, plus conservatism.

Our containment recirculation sump design was model tested during the late 1970s at Alden Research Laboratory to study vortexing and air entrainment. The results from the model testing were submitted to the NRC in our letter AEP:NRC:00112, dated December 20, 1978. A by-product from the model testing, which included testing for various "plate blockage" schemes at the sump entrance, was empirical head loss data across the entire sump at minimum water level, elevation 602'-10". Sump entry screen blockage of up to 50% was modeled. Loss coefficients were determined for various test schemes, and are represented by the equation:

$$C_L = \frac{h_L}{v^2 / 2g}$$

where:

C_L	=	dimensionless loss coefficient
h_L	=	the head loss in ft.
v	=	fluid velocity at the sump exit pipes
g	=	32.2 ft./sec.^{2}

Loss coefficient data from table 10 of the Alden Laboratory test report, when used with the above equation, indicated that the highest observed head loss across the sump was 0.77 ft. Maximum flow during sump model testing was 15,400 gpm, 7,700 gpm per sump outlet pipe, which compares well to a maximum expected flow of 15,600 gpm per current calculations. This difference in flow was considered insignificant in determining head loss across the sump inlet and through the sump. The as-modeled sump design included a single coarse grating and a single fine mesh screen. Alden Laboratory also provided head loss data for losses across the grating and screen. Because the current sump entrance includes two layers of coarse grating, one upstream and one downstream of the fine mesh screen, the head loss across the grating and screen was counted twice to conservatively account for the second grating.

Based on the head loss through the sump of 0.77 ft. in the as-modeled configuration, and a head loss of 0.052 ft. across the second grating, the current NPSH calculation conservatively assumes a 1 ft. head loss across the sump. Although the sump head loss data above includes losses from upstream of the sump entrance to inside the pipes at the sump exit, entrance losses at the sump exit pipes were also calculated separately and included in the NPSH calculations for conservatism.

GL 97-04 REQUEST NO. 2

"Identify the required NPSH and the available NPSH."

OUR RESPONSE TO REQUEST NO. 2

The net positive suction head required (NPSHR) and net positive suction head available (NPSHA) for the residual heat removal (RHR) and CTS pumps, which take suction directly from the containment recirculation sump, are as follows:

Pump	NPSHR	NPSHA
RHR	20 ft. abs	29 ft. abs
CTS	9 ft. abs	31 ft. abs

As a point of information, the NPSHR and NPSHA for the safety injection (SI) and centrifugal charging (CC) pumps, which take suction from the RHR pumps when the ECCS is in the recirculation mode of operation, are:

Pump	NPSHR	NPSHA
SI	13 ft. abs	122 ft. abs
CC	17 ft. abs	48 ft. abs

The NPSHR, tabulated above, was obtained from the individual ECCS pump performance curves at the expected ECCS pump flow. Available NPSH, tabulated above, was calculated using the general methodology detailed below. As indicated in our response to question No. 1, a head loss of 1 ft. across the sump screen was assumed in the NPSH calculation at 15,600 gpm.

The basic equation for calculating NPSH is:

$$NPSH = h_a - h_{vpa} + h_{st} - h_{fs}$$

where:

h_a = absolute pressure, in feet of the liquid being pumped, on the surface of the recirculation sump level,

h_{vpa} = head, in feet, corresponding to the vapor pressure of the recirculation sump liquid at the temperature being pumped,

h_{st} = static height, in feet, that the recirculation sump liquid level is above or below the pump suction centerline or impeller eye, and

h_{fs} = all friction losses, in feet, including entrance losses and friction losses through pipe, valves, and fittings, etc.

Additional details on each of the above terms are provided below.

h_a - Absolute pressure on the surface of the recirculation sump level.

This term is the containment pressure assumed in the analysis. Because no credit is taken for containment overpressure, atmospheric pressure is used as the liquid's absolute pressure.

h_{vpa} - Head corresponding to the vapor pressure of the recirculation sump liquid at the temperature being pumped.

This term is a function of the temperature of the fluid. The maximum expected recirculation sump temperature of 190° F. is used. This conservatively bounds both units.

h_{st} - Static height that the recirculation sump liquid level is above or below the pump suction centerline or impeller eye.

This term is the minimum static height of fluid above the pump centerline. A minimum sump water level corresponding to elevation 602'-10" was used, which was confirmed via sump model testing to be a level that precludes air entrainment and vortexing. Sump inventory calculations confirm that this level will be sustained for postulated accidents.

h_{fs} - All friction losses including entrance losses and friction losses through pipe, valves and fittings.

This term involves suction line losses associated with the ECCS pump being evaluated. The head losses considered in this term are friction losses based on pipe roughness, pipe length, velocity head losses, head loss associated with sump screen, entrance losses, and number or type of valves and fittings in the suction piping.

GL 97-04 REQUEST NO. 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."

OUR RESPONSE TO REQUEST NO. 3

The current design basis NPSH analysis differs from the most recent analysis submitted to the NRC in the manner in which the RHR system was analyzed.

The most recent NPSH analysis submitted to the NRC was provided in response to FSAR chapter 6.3, question 212.29 (unit 2, appendix Q; amendment 78, October 1977). Question 212.29 consisted of three parts, one of which was specific to the NPSH analyses for the ECCS pumps. This question requested detailed descriptions of the NPSH calculations for the ECCS pumps during postulated post loss-of-coolant accident conditions, including pertinent elevations, limiting pump and valve alignment that would provide the smallest NPSH margin, pump NPSH requirements, justification of the sump water temperature, suction line hydraulic losses, and resultant

NPSH margin in accordance with regulatory guide 1.1. As part of the response to this question, a copy of the NPSH calculation was included as an attachment. A review of that attachment indicates that the NPSH was calculated based on the following.

1. Water temperature, 190° F.

2. Containment pressure, one atmosphere (absolute).

3. Pumps operating at maximum flow rate as determined by system resistance calculations assuming reactor coolant system pressure equal to 0 psig and all affected valves considered wide open.

4. The single failure that will result in the lowest NPSH margin is the failure of one RHR pump to operate. In this instance, the remaining RHR pump will operate at a runout condition.

5. No reactor coolant water nor ice bed melt down is used to establish active containment sump water inventory. The NPSHA calculations utilize only that portion of the refueling water storage tank (RWST) inventory that has been pumped into the containment prior to the switchover of the first ECCS train switch-over from RWST to the active containment sump.

6. RHR pump discharge crosstie valves, IMO-314 and IMO-324, are open allowing RHR flow from one pump to flow through both RHR heat exchangers.

7. Containment recirculation sump design includes coarse grating at the sump entrance and fine grating, perforated plate, in the sump back chamber just upstream of the sump outlet pipes.

The current design basis NPSH calculation is based on the following.

1. Water temperature, 190°F.

2. Containment pressure, one atmosphere (absolute).

3. Pumps operating as determined by system resistance calculations assuming reactor coolant system pressure equal to 0 psig, and ECCS SI and CC valves set as required by technical specifications.

4. The single failure applied is the failure of one RHR pump to operate. In this instance, the remaining RHR pump will supply two SI pumps and two CC pumps through a single RHR heat exchanger (see 6 below).

5. Reactor coolant water and ice bed melt down is used to establish active containment sump water inventory. This change was determined to be an unreviewed safety question. A license amendment has been issued in response to our submittal AEP:NRC:0900K, dated October 8, 1997.

6. RHR pump discharge crosstie valves are closed as required by our procedure OHP 4023.ES-1.3, "Transfer to Cold Leg Recirculation". The RHR pump discharge crosstie valves are normally closed to preclude dead-heading of a weaker RHR pump.

7. Containment recirculation sump design as modified to incorporate recommendations from sump model testing by Alden Research Laboratory. Modified sump design includes two layers of grating that sandwich a single layer of fine mesh screen, at the sump entrance. Fine grating and perforated plate in the sump back chamber were removed.

Therefore, the current design basis NPSH analysis differs from the most recent analysis submitted to the NRC as indicated by the differences between items 3, 4, 5, 6, and 7 above.

GL 97-04 REQUEST NO. 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."

OUR RESPONSE TO REQUEST NO. 4

Credit was not taken for the containment pressure in determining the NPSH available to the ECCS pumps. The containment pressure used in determining the NPSH available is one atmosphere, absolute. No overpressure or minimum overpressure was used in determining the available NPSH.

GL 97-04 REQUEST NO. 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."

OUR RESPONSE TO REQUEST NO. 5

Credit is not taken for containment overpressure pressure in determining the NPSH available to the ECCS pumps. The containment pressure used in determining the NPSH available is one atmosphere.