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December 19, 1997

U.S. Nuclear Regulatory Commission
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Gentlemen: ULNRC-3704

DOCKET NUMBER 50-483
CALLAWAY PLANT
RESPONSE TO GENERIC LETTER 97-04

Reference: Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," dated October 7, 1997

Attached is Union Electric Company's response to Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps."

The above reference requested information necessary to confirm the adequacy of the net positive suction head (NPSH) available for emergency core cooling. Union Electric has evaluated the reference and reviewed plant information to address the requests made in the generic letter, see Attachment. Based on these reviews Union Electric has reasonable assurance that there is sufficient NPSH for the emergency core cooling and containment heat removal pumps at Callaway Plant.

Should you have any questions, please contact us.

Very truly yours,

Alan C. Passwater
Manager Licensing & Fuels

JMC/
Attachment

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STATE OF MISSOURI)
) S S
CITY OF ST. LOUIS)

Alan C. Passwater, of lawful age, being first duly sworn upon oath says that he is Manager, Licensing and Fuels (Nuclear) for Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Alan C. Passwater
Alan C. Passwater
Manager, Licensing and Fuels
Nuclear

SUBSCRIBED and sworn to before me this 19th day of December, 1997.

Patricia L. Reynolds

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NOTARY PUBLIC
STATE OF MISSOURI

PATRICIA L. REYNOLDS
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RESPONSE TO GENERIC LETTER 97-04 "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS

Scope

The scope of the subject Generic Letter as it applies to Callaway Plant includes the Emergency Core Cooling System (ECCS) pumps and the Containment Spray Pumps (CSPs). The ECCS pumps include the high head Centrifugal Charging Pumps (CCPs), intermediate head Safety Injection Pumps (SIPs), and low head Residual Heat Removal Pumps (RHRPs).

The ECCS provides emergency core cooling water to the Reactor Coolant System (RCS) following the receipt of a Safety Injection Signal (SIS). The ECCS operates in two separate and distinct modes of operation, injection and recirculation. During the injection mode, the ECCS pumps draw suction from the Refueling Water Storage Tank (RWST) and inject into the RCS through each of the four cold legs. When the volume of water is depleted to the point that the RWST lo-lo-1 signal is obtained, the RHR pumps automatically swap and draw suction from the containment sump. Following manual realignment, the CCPs and SIPs draw suction from the RHR pump discharge. The CCPs and SIPs inject to the RCS in the recirculation mode of operation in this 'piggyback' condition until the accident is brought under control and the pumps are secured.

CSPs start upon receipt of a containment spray actuation signal (CSAS), which occurs on high containment pressure (Hi-3 setpoint). Upon receipt of the CSAS, both containment spray pumps automatically start and the borated water from the RWST flows into the containment spray headers. Upon receipt of a lo-lo-2 RWST level signal, suction of the CS pumps is manually switched from the RWST to the containment sumps for the recirculation phase.

Requested Information

Following are the five areas of information requested by Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps." Based on the reviews completed to develop this response, Union Electric Company has reasonable assurance that there is sufficient NPSH for the emergency core cooling and containment heat removal pumps.

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

The general methodology used at Callaway Plant to calculate the head loss associated with the ECCS suction strainer/containment recirculation sump is as follows:

The basic equation for calculating NPSH is:

$$NPSH = h_a - h_{vap} + h_{st} - h_f$$

Where:

h_a = absolute pressure on the surface of the liquid supply level.

h_{vap} = head corresponding to the vapor pressure of the liquid at the temperature being pumped.

The calculations for available NPSH at Callaway Plant during the recirculation mode do not take credit for containment overpressure. The calculations assume that the vapor pressure of the liquid in the sump is equal to the containment pressure. This ensures that the actual available NPSH is always greater than the calculated NPSH.

h_{st} = static height that the liquid supply level is above or below the pump centerline or impeller eye.

h_f = suction line losses including entrance losses and friction losses.

Additional detail on each of the terms is provided below.

h_a - absolute pressure on the surface of the liquid supply level

This term is the containment pressure term used in the analysis. As discussed in the response to Question 4, no credit for containment pressure is assumed in the NPSH analysis for Callaway Plant.

h_{vap} - head corresponding to the vapor pressure of the liquid at the temperature being pumped

This term requires that the temperature of the pumped fluid be determined. The temperature used in the limiting NPSH calculation is based on the post-LOCA maximum fluid temperature predicted. See the response to Question 4 for a discussion on utilized maximum vapor pressure.

h_{st} - static height that the liquid supply level is above or below the pump centerline or impeller eye

This term is simply the minimum static height of fluid above the pump centerline or the impeller eye. The accident analysis is used as a basis for the height of water on the containment floor and in the sump during the pump operating sequence.

h_f - all suction line losses including losses associated with sump screens and suction pipe entrance

This term involves suction line losses associated with the pump being evaluated. The following parameters are considered when calculating h_f:

A. Suction line frictional losses. The important factors in calculating line frictional losses are:
- Length of piping
- Number and type of fittings and valves in the suction piping
- Fluid velocity
- Pipe roughness

B. Entrance loss to the suction piping
C. Head loss associated with the containment recirculation sump screens
D. The suction line frictional losses are determined based on expected system flow rates

At Callaway Plant, h_f was originally calculated based on adding the suction line frictional losses and suction piping entrance losses. A conservative Entrance Loss Coefficient (K) of 0.46 was used to calculate the piping entrance loss. Then the performance of the emergency containment sumps were verified with a 1:2.98 scale hydraulic model. The hydraulic model test determined that in one Containment Spray and Residual Heat Removal suction line with 50 percent sump screen blockage, the entrance loss coefficient was about 0.35. The loss coefficient included cumulative losses through the gratings, screens with 50 percent blockage, inlets, and vortex breakers. The test results concluded that additional net positive suction head was available to the RHRPs and CSPs than was considered in the plant design based on the use of the conservative entrance loss coefficient.

2. Identify the required NPSH and the available NPSH

The table below identifies the required and available NPSH for each of the four pumps within the scope of the Generic Letter. The values listed are obtained from the current Callaway Plant FSAR (Table 6.2.2-7 and 6.3-1) and are based on the most limiting margin considering both injection and recirculation mode.

	Required NPSH (ft)	Available NPSH (ft)
Residual Heat Removal Pump @ 4,800 gpm	21.0' note 1	21.9' note 1
Containment Spray Pump @ 3,950 gpm	16.5' note 1	23.2' note 1
Safety Injection Pump @ 691 gpm	17.0' note 2	45.9' note 3
Centrifugal Charging Pump @ 567 gpm	33.8' note 2	49.0' note 3

Note 1: The limiting margin for available NPSH for the RHRPs and CSPs occurs during the recirculation phase at the point of suction swapover to the containment recirculation sumps when the sump water elevation is at it's minimum level.
Note 2: The limiting NPSH required values listed for the SIPs and CCPs occur during the recirculation phase when flow rates are assumed to be boosted to a value slightly higher than injection flow rates.
Note 3: The limiting NPSH available values listed for the SIPs and CCPs occur during the injection phase at the point of swapover from the injection mode and are based on the minimum elevation head in the RWST. During the recirculation mode, the available suction pressure for these pumps increases significantly based on the head supplied from the RHR pump discharge. Based on conservative data the NPSH available to the CCPs and SIPs during recirculation would be more than 130 feet.

This data shows that for each case adequate NPSH margin is available for safe pump operation.

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.

The values given in the above table are the current design basis NPSH analyses and are the same as the most recent analyses that were reviewed and approved by the NRC with the following clarification:

As a result of this Generic Letter and a review by Union Electric's FSAR Task Team of industry findings and audits of other plants, minor calculation adjustments to the required and available NPSH values are currently being evaluated. However, Union Electric has determined that there are no adverse impacts on ECCS or containment spray system or component operability as a result of these adjustments. Adequate margin was included in the original line-loss assumptions which still ensure adequate margin between required and available NPSH will be maintained. This is being tracked under UE corrective action document SOS-97-1438.

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.

This item is not applicable to Callaway Plant because containment overpressure was not credited in the calculation of available NPSH as discussed in the above response to item 1.

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.

This item is not applicable to Callaway Plant because containment overpressure was not used.