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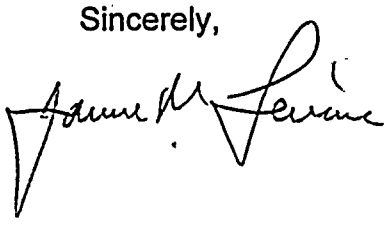
Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50 - 528/529/530
Response to NRC Generic Letter 97-04

This letter provides Arizona Public Service Company's (APS), 90 day response to NRC Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps ".

The attached response addresses items 1-5 of the Requested Information Section of the Generic Letter. In addition to the response, APS is working with the Combustion Engineering Owners Group (CEOG) and other industry groups in addressing the issues associated with the referenced Generic Letter.

Should you have any questions or concerns please contact Scott A. Bauer at (602) 393-5978.

Sincerely,



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Attachment

cc: E. W. Merschoff
K. E. Perkins
J. W. Clifford
J. H. Moorman

A001

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, J. M. Levine, represent that I am Senior Vice President - Nuclear, Arizona Public Service Company (APS), that the foregoing document has been signed by me on behalf of APS with full authority to do so, and that to the best of my knowledge and belief, the statements made therein are true and correct.

J. M. Levine

Sworn To Before Me This 30th Day Of December, 1997.

Dora E. Meador
Notary Public

My Commission Expires

April 6, 1999

OFFICIAL SEAL
NORA E. MEADOR
Notary Public - State of Arizona
MARICOPA COUNTY
My Comm. Expires April 6, 1999

ATTACHMENT

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

The following is provided in response to NRC Generic Letter 97-04, Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps, dated October 7, 1997 for Palo Verde Nuclear Generating Station.

SYSTEMS OVERVIEW

Palo Verde is a three unit Combustion Engineering System 80 pressurized water reactor facility with an Emergency Core Cooling System (ECCS) and a Containment Spray System (CSS) which function to provide cooling flow to the core and to reduce containment pressure, respectively, following certain design basis accidents. The ECCS is comprised of two independent trains each with one high pressure safety injection (HPSI) system and one low pressure safety injection (LPSI) system. The train related HPSI, LPSI and CSS pump suctions are aligned in parallel to the respective train containment sump following depletion of the borated water inventory in the Refueling Water Tank. These are the only pumps which take suction from the recirculation sump during accident conditions. Figure 1 illustrates the Palo Verde configuration.

GENERIC LETTER 97-04 RESPONSES

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

   The response to this question will conservatively encompass the total methodology used to quantify the available net positive suction head (NPSHA) to the ECCS pumps and the CSS Pumps, inclusive of the specific methodology for the calculation of the loss associated with the ECCS sump screens. The general methodology used at Palo Verde to calculate the NPSHA for the ECCS and CSS pumps is as follows:

   The basic equation for calculating NPSH is:

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

   where:

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

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

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

h_{fs} = 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 above atmospheric pressure that is taken credit for in the analysis. Palo Verde, however, does not credit containment overpressure and conservatively assumes that the sump fluid is saturated at the containment pressure at all times. Hence, h_a is assumed equal to the vapor pressure of the sump fluid at the pump suction, h_{vpa}.

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

As noted for the absolute pressure term, h_a, the Palo Verde NPSHA analyses assume that the sump fluid is at saturated conditions. Since containment overpressure is not credited and therefore h_a is equal to h_{vpa}, the sump fluid temperature is irrelevant and the available head reduces to the difference between the static water head and the suction losses defined below.

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

This term is the minimum static height of fluid above the ECCS and CSS pump datum. The minimum water height in containment following a LOCA, for conditions which will result in transfer of the ECCS and CSS pump suction to the recirculation sump, has been calculated assuming minimum transfer volume from the RWT and other water sources.

h_{fs} - all suction line losses including entrance losses and friction losses

Palo Verde has calculated the total suction line losses for the ECCS and CSS pumps using standard industry methodology. In

general, the calculated line losses are the sum of the losses for the total piping runs and the losses for the valves, fittings and components. Additional loss is applied for entrance and exit effects due to the sump screen. Loss due to the accumulation of fibrous debris is also included in accordance with NRC Regulatory Guide 1.82, Revision 1, Sumps for Emergency Core Cooling and Containment Spray Systems.

Piping losses are based on friction factors for clean stainless steel piping. No consideration of aging or increased pipe roughness is included due to the relative cleanliness of the water and minimum system operation time.

Maximum (conservative) head loss is predicated on bounding system operation which maximizes the suction flow rate for each of the pumps and for the common suction flow paths. For Palo Verde, the suction piping head loss is calculated assuming concurrent operation of the train related ECCS and CSS pumps at their respective vendor specified run-out flow rates during the limiting mode of operation. No credit for variable ECCS or CSS flow rate, as a function of containment pressure, is assumed.

The limiting mode of operation considered in the evaluation of NPSHA is recirculation following injection for a large break or certain small break LOCAs. No other design basis accidents, such as the Main Steam Line Break event, result in sufficient depletion of the Refueling Water Tank which would initiate the transfer of the ECCS and CSS pump suction to the recirculation sump. No other mode of operation requires a suction flow path from the recirculation sump for which NPSH must be evaluated.

The Palo Verde recirculation sump screen design is described in the PVNGS UFSAR, Section 6.2.2.2. The screen is composed of an outer trash rack, a medium coarse screen, and a fine inner screen. Head loss for the clean composite screen is calculated by summing the losses across the rack and each screen. The calculated losses are predicated on maximum flow conditions corresponding to concurrent operation of the train related ECCS and CSS pumps at design runout flow rate. The resultant head losses are based on published empirical correlations and have been determined to be negligible. This conclusion is supported by initial sump design testing by the Architect - Engineer.

The head loss across the sump screen associated with fibrous debris accumulation has been incorporated in accordance with

NRC Regulatory Guide 1.82, Revision 1. The head loss correlation published in NUREG-0897, Containment Emeergency Sump Performance, has been applied to quantify the loss conservatively assuming equal debris loading on the available flow area of the sump screen. The available flow area considers the fraction of screen area blocked by failed coatings. The total quantities of fibrous debris and failed coatings are conservatively assumed in these calculations.

2. **Identify the required NPSH and the available NPSH.**

The required ECCS and CSS pump NPSH is based on vendor specified requirements for the pumps at runout conditions. These requirements are conservatively imposed for all operating conditions and flow rates up to and including runout. The following represent the bounding conditions (i.e. minimum margin) for available NPSH and are compared to the vendor specified required NPSH.

PUMP	NPSH – REQUIRED (ft)	NPSH - AVAILABLE (ft)	MARGIN (ft)
CS	22	25.8	3.8
LPSI	20	26.1	6.1
HPSI	25	28.8	3.8

Note that the Combustion Engineering System 80 ECCS design includes termination of the LPSI pump injection upon switchover to recirculation and suction from the recirculation sump. However, the available NPSH for the LPSI pump has been evaluated to ensure that the adequate suction head is available to support operation should operators elect to override the ESF logic and realign the pump to provide additional core flow. This mode of operation, however, is not credited in the Palo Verde UFSAR Chapter 15 analyses. Note also that the available NPSH for the HPSI and CSS pumps conservatively assume concurrent operation of the LPSI pump during recirculation.

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 most recent NPSH analysis reviewed and approved by the NRC is that documented in the Palo Verde SER (NUREG-0857), Section 6.2.2 and Section 6.3.1. The calculations which supported the original SER, however, have been revised. Revision to the calculations was made in order to incorporate recirculation sump screen blockage as required by Regulatory Guide 1.82, Supplement 1 and were revised using the methodology of NUREG-0897. None of the general

calculational methodology of the original calculation, which was reviewed and approved by the NRC, was affected.

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.**

   No containment overpressure is credited in the calculation of available NPSH for Palo Verde as described in the response to Question 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.**

   Not applicable.

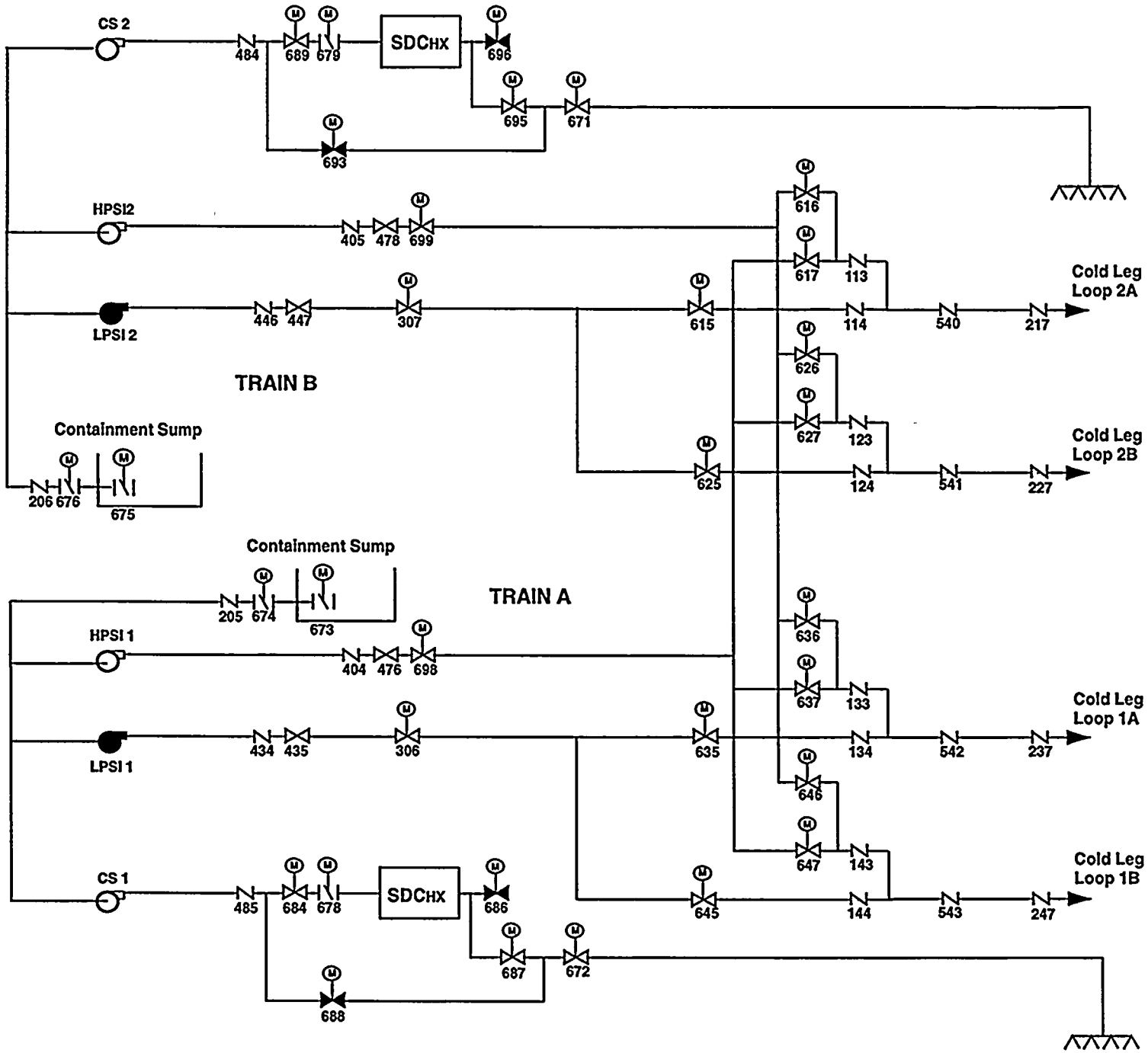

FIGURE 1 - ECCS AND CSS CONFIGURATION DURING RECIRCULATION MODE