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SUBJECT: Responds to NRC Bulletin 88-04 re potential loss of safety related pumps.

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Reference: Letter from Charles E. Rossi, NRC, to all holders of operating licenses or construction permits for nuclear power reactors dated May 5, 1988. Subject: NRC Bulletin No. 88-04, Potential Safety-Related Pump Loss.

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Response to NRC Bulletin No. 88-04
File: 88-A-056-026, 88-055-026

By the referenced letter, the NRC has issued NRC Bulletin No. 88-04. This bulletin discusses the potential loss of safety related pumps due to deficiencies in the minimum flow recirculation design for the pumps. The NRC has requested that all power reactor licensees provide answers to several questions concerning their minimum flow recirculation designs. The ANPP responses to these NRC questions are provided in the attachment to this letter.

If you have any questions on this matter, please contact Mr. A. C. Rogers at (602) 371-4041.

Very truly yours,

E. E. Van Brunt, Jr.
Executive Vice President
Project Director

EEVB/BJA/dlm
Attachment

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ATTACHMENT

ANPP RESPONSES TO NRC BULLETIN NO. 88-04

1. NRC QUESTION

Promptly determine whether or not its facility has any safety-related system with a pump and piping configuration that does not preclude pump-to-pump interaction during miniflow operation and could therefore result in dead-heading of one or more pumps.

ANPP RESPONSE

ANPP has conducted a review of the safety-related pump and piping configurations at PVNGS. Our review indicates that the configuration of the following systems does not preclude pump-to-pump interactions:

1) Safety Injection System

2) Auxiliary Feedwater and Condensate Transfer Systems

The results of our review of the piping systems are presented in the response to question #2. A brief description of these systems is provided in the following paragraphs.

The safety injection system has two separate trains. Each train has a High Pressure Safety Injection (HPSI) pump, a Low Pressure Safety Injection (LPSI) pump, and a Containment Spray (CS) pump. A simplified schematic of the safety injection system is shown in Figure 1. As shown in the figure, all of the safety injection pumps take suction from the Refueling Water Tank (RWT). Each pump has an orificed minimum flow recirculation line. The flow orifice is located directly downstream of the pump. The flow orifice is followed by an automatic isolation valve. The isolation valve automatically closes when the system enters the recirculation mode of operation. The three minimum flow recirculation lines, associated with the three pumps of a single train, are joined into a common return header downstream of the automatic isolation valves. Another automatic isolation valve is provided on the common return header before the return header joins with the other train's return header. The recirculation flow then returns to the RWT. As an additional note, the recirculation piping increases in diameter as the individual pump recirculation lines combine into common headers. The recirculation lines begin as 2 inch diameter lines immediately downstream of the pumps. When the recirculation lines of three safety injection pumps join together, the common recirculation line increases to 4 inches in diameter. Finally, the common return header to the RWT is a 6 inch line.

Figure 2 shows the condensate transfer pumps and the auxiliary feedwater pumps. There are two safety grade pumps in the condensate transfer system and in the auxiliary feedwater system. All of the pumps receive suction from the Condensate Storage Tank (CST). Each pump is equipped with an orificed minimum flow recirculation line that returns to the CST. A common return header is shared by the A-train condensate

transfer pump and the A-train auxiliary feedwater pump. A similar arrangement also exists for the B-train pumps. The recirculation lines for the auxiliary feedwater pumps are 6 inch diameter lines for most of the recirculation flowpath. The recirculation lines for the condensate transfer pumps are 1 inch diameter lines that expand to 3 inch lines prior to connecting with the auxiliary feedwater pump recirculation lines.

FIGURE 1 : SAFETY INJECTION SYSTEM

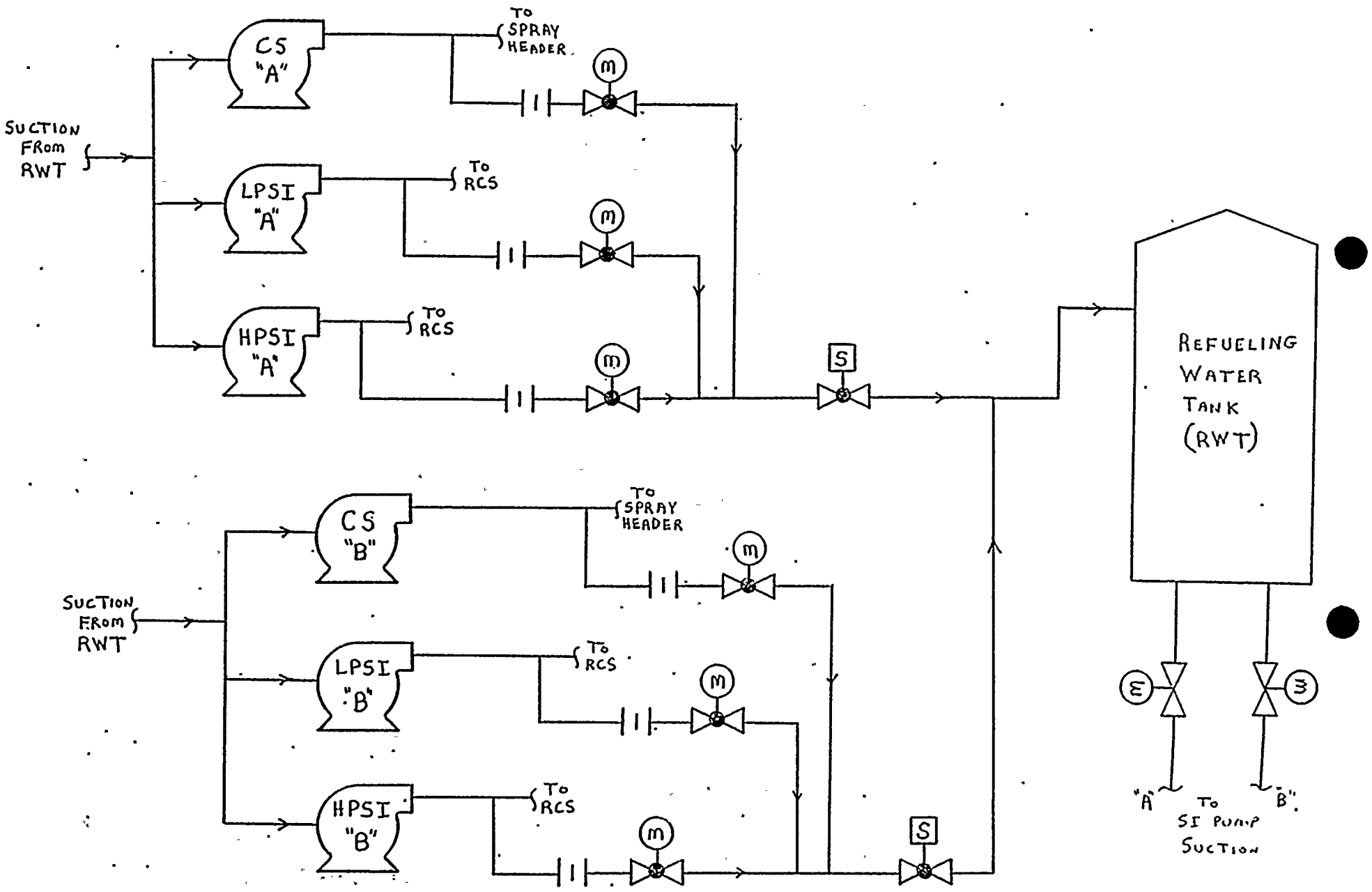
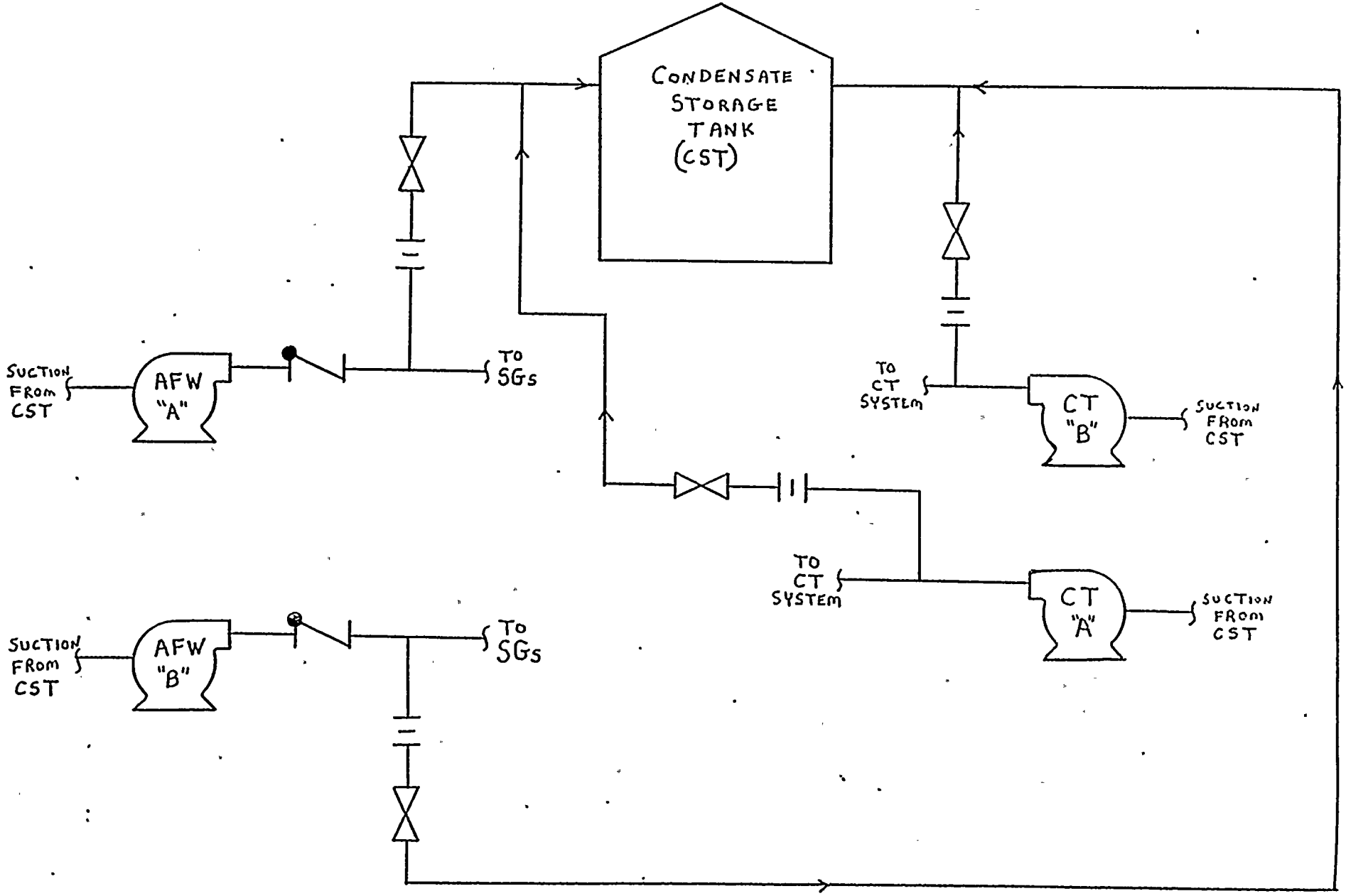


FIGURE 2: AUXILIARY FEEDWATER AND CONDENSATE TRANSFER



2. NRC QUESTION

If the situation described in Item 1 exists, evaluate the system for flow division taking into consideration (a) the actual line and component resistances for the as-built configuration of the identified system; (b) the head versus flow characteristics of the installed pumps, including actual test data for "strong" and "weak" pump flows; (c) the effect of test instrument error and reading error; and (d) the worst case allowances for deviation of pump test parameters as allowed by the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Paragraph IWP-3100.

ANPP RESPONSE

For the safety injection system, ANPP has performed a calculation to evaluate the system for flow division. The calculation verified that the weakest pump (i.e., the lowest head pump) is capable of delivering its design recirculation flow when all six safety injection pumps are operating on minimum flow recirculation. The lowest head pumps in the safety injection system are the LPSI pumps. Furthermore, the Train B LPSI pump was selected for analysis since it has longer recirculation piping lengths than the Train A pump. Other significant features of the calculation are listed below:

1) Line and component resistances were calculated for the piping system based on startup test data and the as-built piping configuration.

2) The suction source (i.e., the RWT) was assumed to be at the minimum possible water level.

3) The highest recorded recirculation flow rates from Unit 1 startup testing were used. This maximizes the pressure drop in the recirculation lines.

4) For the weakest pump, the pump was assumed to be degraded to the required action level as per the ASME Section XI test requirements.

5) The effects of instrument error were accounted for. This further reduced the discharge head assumed in the analysis.

The calculation proved that the LPSI pump discharge head is more than sufficient to overcome the recirculation piping head losses. The design feature that significantly minimizes the potential for pump-to-pump interactions in the safety injection system is the dedicated orifices for each pump. Therefore, the potential problem of adverse pump-to-pump interactions during minimum flow recirculation operation is not a concern for the safety injection system.

A similar calculation was performed for the common recirculation lines of the condensate transfer and auxiliary feedwater pumps. For the analysis, the weakest pump was selected. In this case, the condensate transfer pumps were selected as the weakest pumps since they have a

design head of 61 feet as opposed to a design head of 3280 feet for the auxiliary feedwater pumps. Some of the key features of the calculation are listed below:

1) The suction source (i.e., the CST) was assumed to be at its empty level setpoint.

2) Line and component resistances were calculated based on the as-built piping system configuration.

3) The associated auxiliary feedwater pump was assumed to be operating with a recirculation flow rate of 260 gpm. The as-built recirculation flow rates for the auxiliary feedwater pumps in the three PVNGS units range from 240 to 260 gpm. For this calculation, the maximum value of 260 gpm was used. This results in conservatively high pressure drops.

4) The condensate transfer pump was assumed to be degraded to the required action level per the ASME Section XI test requirements.

5) Instrument error was assumed to further reduce the assumed pump performance.

The results of the calculation show that the condensate transfer pumps are capable of maintaining a recirculation flow rate of 26.3 gpm under these worst case conditions. Note that this flow rate is slightly less than the current design recirculation flow rate of 30 gpm. ANPP does not believe that this reduced recirculation flow rate impacts pump operation. The reduced flow rate is approximately 20% of the pump's output. Additionally, the reduced flow rate exceeds the vendor's original recommended minimum recirculation flow rate of 10%. The pump vendor has also been asked to evaluate the condensate transfer pumps and to provide the minimum acceptable recirculation flow rates based on the NRC's identified concerns (refer to question 3). Once the vendor input is received, the worst case recirculation flow rate of 26.3 gpm will be compared with the vendor's recommendation.

3. NRC QUESTION

Evaluate the adequacy of the minimum flow bypass lines for safety-related centrifugal pumps with respect to damage resulting from operation and testing in the minimum flow mode. This evaluation should include consideration of the effects of cumulative operating hours in the minimum flow mode over the lifetime of the plant and during the postulated accident scenario involving the largest time spent in this mode. The evaluation should be based on best current estimates of potential pump damage from operation of the specific pump models involved, derived from pertinent test data and field experience on pump damage. The evaluation should also include verification from the pump suppliers that current miniflow rates (or any proposed modifications to miniflow systems) are sufficient to ensure that there will be no pump damage from low flow operation. If the test data do not justify the existing capacity of the bypass lines (e.g., if the data do not come from flows comparable to the current capacity) or if the pump supplier does not verify the adequacy of the current miniflow capacity, the licensee should provide a plan to obtain additional test data and/or modify the miniflow capacity as needed.

ANPP RESPONSE

ANPP has conducted a review of the safety related piping systems at PVNGS. The purpose of the review was to identify the centrifugal pumps that were equipped with minimum flow recirculation lines. Table 1 summarizes the results of our review. Each safety-related centrifugal pump, that is equipped with a minimum flow recirculation line, is listed along with the design flow, current recirculation flow, and pump manufacturer.

For the identified pumps, we have requested the respective pump vendors to evaluate the current minimum recirculation flow rates for acceptability. Responses from these vendors have not yet been received but are expected by August 1, 1988. Following receipt of the vendor input and our evaluation of the vendor input, we will provide a formal response to this question. We expect that this response can be provided to the NRC Staff by August 31, 1988.

ANPP has also conducted a review of the existing recirculation flow rates against the original pump vendor specifications. Our review indicates that in all cases, the current recirculation flow rates comply with the existing requirements of the pump vendors.

TABLE 1: CENTRIFUGAL PUMPS WITH MINIMUM FLOW RECIRCULATION LINES

PUMP TAG NUMBERS	DESCRIPTION	DESIGN FLOW (GPM)*	DESIGN HEAD (FEET)	MINIMUM FLOW RECIRCULATION (GPM)	MANUFACTURER	MODEL NO.
AFA(B)-P01	Turbine-Driven Auxiliary Feedwater Pump (A-Train) and Motor-Driven Auxiliary Feedwater Pump (B Train).	1010	3280	240	Bingham-Willamette	4x6x10-1/2 B MSD 8 Stage
CTA(B)-P01	Condensate Transfer Pumps. Two Pumps (A and B Trains).	130	61	30	Ingersoll-Rand	2x10AN
SIA(B)-P01	Low Pressure Safety Injection Pumps. Two Pumps (A and B Trains).	4300	335	100	Ingersoll-Rand	8x20 WDF
SIA(B)-P02	High Pressure Safety Injection Pumps. Two Pumps (A and B Trains).	815	2850	85	Ingersoll-Rand	4x11 CA-8
SIA(B)-P03	Containment Spray Pumps. Two Pumps (A and B Trains).	3890	505	150	Ingersoll-Rand	8x23 WDF

*Design flow includes the design minimum flow.

4. NRC QUESTION

Within 60 days of receipt of this bulletin, provide a written response that (a) summarizes the problems and the systems affected, (b) identifies the short-term and long-term modifications to plant operating procedures or hardware that have been or are being implemented to ensure safe plant operations, (c) identifies an appropriate schedule for long-term resolution of this and/or other significant problems that are identified as a result of this bulletin, and (d) provide justification for continued operation particularly with regard to General Design Criterion 35 of Appendix A to Title 10 of the Code of Federal Regulations (10 CFR 50), "Emergency Core Cooling" and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling System for Light Water Nuclear Power Reactors".

ANPP RESPONSE

(a) The affected systems have been identified in the responses to questions 1 and 3. At this time, no problems have been identified with the recirculation system piping configurations or recirculation flow rates.

(b) No modifications to plant operating procedures or hardware are necessary at this time. However, the results of the pump vendor reviews have not been received. If the pump vendor reviews indicate the need for any procedural or hardware modifications, ANPP will provide a description of the modifications and a schedule to the NRC.

(c) A schedule for communicating the results of the pump vendor reviews is provided in the response to question 3. No other actions requiring a schedule have been identified at this time.

(d) At this time, no deficiencies have been identified which would require a justification for continued operation. For the safety related centrifugal pumps with minimum flow recirculation lines, the analysis to date indicates that the worst case recirculation flow rates meet or exceed the pump vendor's recommended recirculation flow rates. If any deficiencies are identified based on further information from the pump vendors, a justification for continued operation will be provided to address the deficiencies.

5. NRC QUESTION

Within 30 days of completion of the long-term resolution actions, provide a written response describing the actions taken.

ANPP RESPONSE

At this time, no long-term corrective actions have been identified. The only outstanding action, to complete our review of this matter, is to obtain input from the pump vendors on the existing minimum flow recirculation values. The results of this effort will be communicated to the NRC as described in the response to question #3.

If any long-term corrective actions are identified during this last portion of our review, the written response describing the actions taken will be provided within 30 days after completion of the actions.

6. NRC QUESTION

An evaluation of your actions in response to this bulletin should be documented and maintained at the plant site for a minimum of two (2) years. That evaluation should, as a minimum, address the piping system configuration in accordance with Item 1 above, each of the four factors discussed in Item 2, pertinent test data and field experience on minimum flow operation, and verification of the adequacy of current miniflow capacity by the pump manufacturer.

ANPP RESPONSE

In response to Item 2, ANPP has performed two separate engineering calculations. The first calculation, for the condensate transfer pumps, is calculation number 13-MC-CT-303. For the safety injection pumps, calculation number 13-MC-SI-307 was performed. Both of these calculations will be maintained by ANPP for a minimum of 2 years. The additional information provided by the pump vendors will also be maintained by ANPP for a minimum of 2 years.