Public Service
Electric and Gas
Company

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United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

NRC BULLETIN 88-04
REQUEST FOR ADDITIONAL INFORMATION
SALEM GENERATING STATION
UNIT NO. 1
FACILITY OPERATING LICENSE NO. DPR-70
DOCKET NO. 50-272

By letter dated October 8, 1993, the NRC requested that Public Service Electric and Gas Company (PSE&G) submit additional information to our August 2, 1993 letter, regarding Bulletin 88-04 (Potential Safety-Related Pump Loss.)

The additional information that the staff is seeking was discussed during a telephone conversation, on October 1, 1993, between the NRC Salem Project Manager, NRC staff reviewers, and members of my staff.

Attachment 1 to this letter provides the written responses to the NRC's questions as discussed on October 1, 1993.

Should you have any questions regarding this transmittal, please do not hesitated to contact us.

Sincerely,

JJHagan

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Attachment (1)

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Mr. C. S. Marschall (S09)
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The following is PSE&G's response to the NRC's questions as transmitted to us on October 8, 1993.

NRC QUESTION

1. In the August 2, 1993 letter, the acceptance criteria is listed as 300 gpm per pump with the RHR pumps operating in parallel. This would provide adequate flow for 3 hours of pump operation. Please provide the basis for the 300 gpm limit and the 3-hour limit.

PSE&G RESPONSE

The minimum flow requirements have been established by the manufacturer (Ingersoll-Rand). These flows are based on a thermal analysis for heat up rates during recirculation. The maximum allowed recirculation water temperature is defined as the temperature at which cavitation will occur on the inlet to the impeller at the minimum suction pressure. The time to reach this temperature is a function of the recirculation flow rate through the pump. The minimum required flow to support a continuous 3 hour run on fixed recirculation (with respect to the detrimental effects of cavitation, vibration, wear, bearing and shaft failure) is 300 gpm.

The lower the flow rate, the less heat is removed from the pump assembly and the sooner cavitation will begin at the impeller. Accordingly, any recirculation flows below 300 gpm will reduce the continuous allowable run time of the pump. The minimum flow allowed by Ingersol-Rand is 100 gpm for up to 1/2 hour.

Salem Station has selected the 300 gpm limit to support 3 hours of continuous operation, based on a conservative estimate that the Emergency Operating Procedure (EOP) step to stop an RHR pump (if both pumps were running) will be executed within the 3 hour limit. Ensuring that recirculation flows remain above 300 gpm will allow both RHR pumps to remain on recirculation, for at least 3 hours after an auto start, without compromising the redundancy design requirements. Therefore, strong pump/weak pump interaction will not result in failure of a running RHR pump before an operator can take action.

NRC QUESTION

2. In the August 2, 1993 letter, the statement that "The Technical Specification surveillance program in accordance with 4.0.5-P testing will be used to monitor for strong-weak pump interaction." is included. However, the 4.0.5-P program does not require operating the pump in parallel. Please provide a summary of the 4.0.5-P program and the enhancement to be added for testing the RHR pumps at Salem 1. Include how trending will be done, when corrective action will be taken, and any administrative controls that will be added.

PSE&G RESPONSE

The RHR pump performance testing is in accordance with ASME and Technical Specification 4.0.5-P requirements. The surveillance is performed in accordance with the 4.0.5-P frequency for 11 RHR pump (45 days), using procedure S1.OP-ST.RHR-0001(Q). The ASME required test measures and trends pump differential pressure given a fixed recirculation flow of 500 gpm.

The procedure [S1.OP-ST.RHR-0001(Q)] has been modified to include an additional test for strong pump/weak pump interaction by placing both pumps in service after the required performance test for 11 RHR pump is completed.

This test mimics the actual configuration identified in Bulletin 88-04 as having the potential to result in loss of recirculation flow for one RHR pump. The actual test will record the change in recirculation flows after both pumps are placed in service. The strong pump/weak pump interaction will affect the recirculation flows for each pump; one pump's flow will increase as the weaker pump's recirculation flow decreases.

The procedure includes acceptance criteria to ensure that recirculation flows are maintained above the minimum 300 gpm requirements for each pump. This recirculation flow will be trended along with the pump performance. Corrective actions will be taken if recirculation flow drops below the 300 gpm or trends indicate a flow reduction that will impact the allowable flow. Once the surveillance is completed and recirculation flows are verified, the pumps are not expected to degrade until their next surveillance because they will be in a stand-by mode, out of service.

See question four for additional information.

NRC QUESTION

3. Identify the accident scenarios where the strong-weak pump interactions may be a concern. Does the proposed testing simulate the conditions that would be expected during the identified accident scenarios? In the emergency operating procedures (EOP) for the identified accident scenarios, how are the operators alerted to the possibility of a strong-weak pump interaction taking place?

PSE&G RESPONSE

RHR pumps can be deadheaded under certain conditions/scenarios. Specifically, whenever the RHR pumps are automatically started and the Reactor Coolant System (RCS) pressure remains above the RHR shutoff head (i.e. small break loss of coolant accidents, or spurious actuation of the safety injection signal at normal operating pressure and temperature (NOP/NOT)). NOP/NOT conditions normally exist from shortly after entering Mode 3 through power operations.

This condition (RCS pressure > than RHR discharge pressure) would require the mechanically generated pump heat to be removed by the recirculation flow. A loss of an RHR pump is postulated to occur if one pump has a higher developed head that results in the loss of recirculation flow for the weaker pump. At Salem 1 the potential for deadheading an RHR pump is prevented by ensuring that recirculation flow is high enough to support 3 hours of continuous pump service while in parallel operations.

The test procedures as discussed in question two mimics the accident scenario by placing the pumps in parallel operation under shut off head conditions.

The potential for loss of an RHR pump due to strong-weak pump interaction is eliminated at Salem Station due to the verification that recirculation flow is above the manufacturer's minimum flow. The recirculation flow is automatically controlled by flow elements that detect discharge flow from each pump. If the discharge flow is lower than 500 gpm, the recirculation valve is opened and each pump is supplied with a separate recirculation flow path. Recirculation flow is verified to be above the minimum required to support 3 hours of continuous service without compromising either pump. The surveillance assures that a loss of a pump cannot occur due to strong/weak pump interaction.

During refueling operations the RHR pumps are used for decay heat removal, and the RCS pressure is well below the pump's shutoff head. In this mode of operation when the system pressure is reduced to below the pump discharge pressure, the flow is directed to the system as well as through the recirculation flow path up to a maximum of 1000 gpm at which point the recirculation flow will be automatically isolated.

Salem Station has selected the 300 gpm limit based on a conservative estimate that the EOP step to stop an RHR pump (if both pumps were running) will be executed within the 3 hour limit. Once in the EOP, operators are directed to verify Emergency Core Cooling System (EECS) flow through the cold leg injection path. If the the accident scenario is one where the RCS pressure is above the RHR pump shut off head no flow will be indicated through this flow path, and the operator will be directed to secure the running RHR pumps.

During annual licensed operator simulator requalification training different shift crews were given small break LOCA and Steam Line Break scenarios. During these training exercises different shifts secured the RHR pumps within 20 to 40 minutes of accident initiation, which is well within the 300 gpm - 3 hour limit.

NRC QUESTION

4. In a letter dated August 31, 1990, PSE&G proposed to use differential pressure between the RHR pumps to determine if deadheading was occurring and had prepared a change to the EOP to close a cross-connect valve if deadheading occurred. Is this previous commitment a part of the latest proposal for testing of the RHR pumps?

PSE&G RESPONSE

The August 2, 1993 submittal supersedes all previous commitments made on this subject, and does not propose any EOP changes.

As stated in our submittal, if during testing a pump is determined to be inoperable, PSE&G will take appropriate corrective actions, as needed and/or deemed acceptable, to return the pump to operable status. These corrective action may include repair and/or replacement of the inoperable pump within the allowable Technical Specification action statement time.

The original proposal was based on comparing pump developed head to determine if the strong-weak pump interaction could occur during recirculation and parallel operation. If the differential between the 2 RHR pump performance was greater than the allowable, a previously approved EOP change would have been implemented to close the cross-connect valves (RH19s) and eliminate the strong/weak pump interaction.

The allowable differential pressure, used in the original approach, was based on an analytical method which calculated the system resistance between pumps. This value was used to determine the maximum differential head that could cause one pump to deadhead the other pump by creating a higher downstream pressure than the weaker pump's developed head. This calculation used the system resistance from handbooks to determine the pressure drop from one pump's discharge nozzle to the other by summating the total piping and valve pressure drops at the recirculation flow rates. The deadhead potential was calculated to be a concern if the differential head exceeded 7 to 8 psid. This pressure would result in a higher downstream pressure in the weaker pump discharge path that could reduce the total flow to below minimum values to support recirculation.

The present approach for testing of RHR pumps eliminates the uncertainty in the analysis associated with calculating system resistance (as discussed above) and instead measures the actual strong-weak pump interaction, by recording recirculation flows during parallel operation. The existing parallel pump performance is trended and preventive actions can be taken prior to reaching degradation which could result in the loss of recirculation flow for one pump. The present testing approach eliminates the need for the previously committed EOP change.