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July 19, 1988

Re: Indian Point Station Unit No. 2
Docket No. 50-247

Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555

SUBJECT: NRC Bulletin No. 88-04: Potential Safety Related Pump Loss

This is in response to the subject NRC Bulletin.

On October 26, 1987, Westinghouse issued a generic customer notification letter which advised that Westinghouse NSSS designs employing redundant Residual Heat Removal (RHR) pumps were subject to potential pump loss concerns. This initial advisory was subsequently followed by the NRC Information Notice 87-59: "Potential RHR Pump Loss" and a second Westinghouse letter dated December 8, 1987 which amplified the initial Westinghouse notification. Two concerns were addressed and each is evaluated separately in this response. The first concern involves the potential for dead-heading one of two RHR pumps in a system design that provides a minimum flow recirculation (miniflow) line common to both pumps. The second concern involves the adequacy of the miniflow capacity even for single pump operation. Although these concerns resulted from review of a specific plant's RHR System, a review of all safety related centrifugal pump configurations was recommended. Our evaluation presented below encompasses the major safety related centrifugal pumps employed at Indian Point Unit No. 2 (IP-2).

I. PARALLEL PUMPS SHARING COMMON MINIFLOW RECIRCULATION LINE

The concern raised by Westinghouse was derived from a recent determination that, when two centrifugal pumps operate in parallel at minimum flow conditions using a common miniflow recirculation line, there is a tendency for a pump with slightly stronger performance characteristics to dead-head a weaker pump. Westinghouse stated that based upon an evaluation by the RHR pumps' manufacturer, damage, and ultimately pump failure, can be expected to occur following 10.4 minutes of dead-headed operation.

Westinghouse did note however, that certain systems with pressure reducing orifices installed on the individual pumps' miniflow lines prior to joining a common miniflow header are not affected by the

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strong pump/weak pump dead-heading phenomenon. The reason provided is that this orificed design reduces the pressure at the entrance to the common miniflow line low enough so that the weaker pump(s) will still be able to recirculate miniflow. At IP-2, the following pumps fall into this category and are thus not subject to potential dead-headed operation when operated in parallel on miniflow recirculation:

High Head Safety Injection Pumps 21, 22, and 23
Steam and Motor driven AFW Pumps 21, 22, and 23

The dead-heading concern, however, does apply to the RHR pumps at IP-2. These pumps do share a common miniflow line and pressure reducing orifices are not provided on the pumps' individual miniflow lines prior to joining the common header. There are certain postulated accident scenarios where the RHR pumps will be operating in parallel with RCS pressures at or above their shutoff head (i.e., on miniflow recirculation) for extended time periods and will thus be subjected to the potential for dead-heading. As reported in IP-2 LER 87-018, submitted to the NRC on January 4, 1988, the corrective action taken has been to revise the plant Emergency Operating Procedures to reflect the additional actions necessary to protect a potentially dead-headed RHR pump. The revised EOPs provide that if RCS pressure is greater than RHR shutoff head (with the operator verifying this condition by observing RCS pressure indications) and two RHR pumps are running, then one pump is to be tripped.

At IP-2, no other major safety related centrifugal pumps fall into the category of operating in parallel at minimum flow with common miniflow recirculation lines.

II. ADEQUACY OF INDIVIDUAL PUMP MINIMUM FLOW CAPACITY

Regarding the second concern, Westinghouse indicated that in the past, the required miniflow for centrifugal pumps was based solely on the need to limit pump fluid temperature rise, and that it is now generally recommended that minimum continuous flow for this type of pump should consider inlet flow breakdown when determining required miniflow. Westinghouse also indicated that Ingersoll-Rand, the manufacturer of the RHR pumps, has recommended a miniflow recirculation rate of 500 gpm for each pump to ensure safe continuous pump operation while on miniflow. The maximum measured miniflow rate for the RHR pumps at IP-2 is 390 gpm.

Con Edison had discussions with Ingersoll-Rand regarding the recommended RHR pump miniflow of 500 gpm. The information we obtained from the manufacturer clarified the issue in that the "500 gpm limit" applies to two pumps operating in parallel through a common miniflow line whereas the IP-2 minimum recirculation flow for a single running pump is 350 gpm. Therefore, single pump operation is within manufacturer recommendations and double pump operation is covered by the procedural actions described previously to ensure that differential performance between the two pumps cannot result in damage to the weaker redundant pump when both are running on miniflow.

Other safety related centrifugal pumps evaluated with regard to this concern are as follows:

1. High Head Safety Injection Pumps 21, 22, and 23
2. Recirculation Pumps 21 and 22
3. Containment Spray Pumps 21 and 22
4. Service Water Pumps 21, 22, 23, 24, 25, and 26
5. Component Cooling Water Pumps 21, 22, and 23
6. Auxiliary Component Cooling Pumps 21 and 22
7. Motor Driven Auxiliary Feedwater Pumps 21 and 23
8. Turbine Driven Auxiliary Feedwater Pump 22

1. High Head Safety Injection Pump 21, 22, and 23

Each of the High Head Safety Injection pumps is equipped with a minimum flow recirculation line that is designed to pass 25 to 30 gpm when the pump is operating. The Emergency Operating Procedures (EOPs) contain optimal plant recovery techniques that require the HHSI pumps to be running for periods of up to 4 hours at or near their shutoff head (1500psi). Under these conditions, the pumps will be protected by the 25 gpm miniflow. Because the 4 hour operating time at or near shutoff could be considered "continuous operation", the pump manufacturer, Pacific Pumps, was contacted to determine if the miniflows obtained would provide the necessary pump protection. Pacific determined that HHSI pump operation at 25 gpm is permissible up to 4 hours each month. Should damage occur at these flows it would be cumulative and Pacific has recommended an inspection after 5,000 hours of operation. Nominally, these pumps are tested on a quarterly basis under miniflow conditions. The time period of operation in test mode is less than thirty minutes. This is much less severe than the restrictions imposed by the manufacturer. The total cumulative time of operation to date is far below the 5,000 hour mark established by the pump manufacturer for pump inspection.

2. Recirculation Pumps 21 and 22

The Recirculation System is a manually actuated Emergency Core Cooling subsystem which is designed to provide core recirculation flow from the containment sump following the injection phase of a LOCA. Each of the two pumps is provided with a 3/4" minimum flow bypass line to protect the pump against blockage. A test line is also provided for periodic inservice tests. The only time these pumps experience low flow rates is during inservice testing (160gpm). Because the Recirculation pumps operate at low flow rates both infrequently and for short duration (approximately 30 minutes for testing at each refueling outage), the concerns raised in the Westinghouse letters, NRC Information Notice 87-59, and Bulletin 88-04, are not considered applicable.

3. Containment Spray Pumps 21 and 22

The Containment Spray System is designed to provide full flow to the spray headers upon auto or manual initiation signals. Additionally, when running, each pump recirculates approximately 112gpm back to it's suction via a 3 inch diameter line fitted with a spray additive eductor. A 3/4 inch diameter pump test line branches off from each pump's recirculation line and is used for periodic inservice testing. This line is kept closed during normal operation since dead-head protection is provided by the fact that the pumps align to the spray headers when actuated. The only time a pump will be subject to low flow rates is during the performance of inservice testing (112gpm recirculation and 45gpm test flow - 157gpm total). Considering both the infrequent operation of the Containment Spray pumps at low flow, and the short duration of such operation (approximately 30 minutes for quarterly test), the concerns raised in the Westinghouse letters, Information Notice 87-59, and Bulletin 88-04, are not considered applicable.

4. Service Water Pumps 21, 22, 23, 24, 25, and 26

The Service Water System is configured in such a way that any of the pumps, when started, develop full flow. Each pump discharge is also equipped with a 6 inch diameter test line to facilitate periodic inservice tests. When lined up in the test circuit, the pump flow rate is throttled to 1500gpm. This testing is performed quarterly for a duration of approximately 30 minutes. Therefore, for the same reasons cited above with respect to the Containment Spray and Recirculation pumps, the concerns raised in the Westinghouse letters, IN-87-59, and Bulletin 88-04, are not considered applicable.

5. Component Cooling Water Pumps 21, 22, and 23

The CCW pumps are not equipped with miniflow recirculation lines. Each pump develops full flow when started. During all plant and system operating modes including tests, the CCW system is lined up in such a way that the operating pump(s) maintain flow rates at or near design conditions. Therefore, the concerns raised in the Westinghouse letters, IN 87-59 and Bulletin 88-04 are not applicable.

6. Auxiliary Component Cooling Pumps 21 and 22

Like the main CCW pumps, the Auxiliary Component Cooling pumps are not equipped with minimum flow recirculation lines. The pumps are auto started during the injection phase of Safety Injection and provide cooling water flow (80gpm per pump) to the Recirculation pump motors. The pumps are tested under the same full flow conditions. Therefore, the concerns raised in the Westinghouse letters, IN 87-59, and Bulletin 88-04 are not applicable.

7. Motor Driven Auxiliary Feedwater Pumps 21 and 23

During operation of the motor driven AFW pumps, minimum flow is ensured by automatic control of the pumps' recirculation flow path. Flow switches for No. 21 and 23 pumps measure suction flow. These flow switches will operate such that when the pump feed decreases to 80 gpm, the recirculation flow control valve will automatically open and cause suction flow to increase from 80 to 160 gpm. The amount of recirculation flow has been established by a variable lock-in-place restriction orifice which is preset to pass 80 gpm when the feedwater regulating valves are closed. The circuitry includes an alarm in the Control Room which activates when the flow decreases to 80 gpm and reset after it has increased to 170 gpm. This alarm operates only when the pump is running and warns the operator that all automatic recirculation features may be defeated. This low flow operating mode meets current manufacturer recommendations.

The recirculation line is also the flow path used for periodic inservice testing. In test mode, recirculation flow is set manually at 80 gpm with the main flow path isolated. The duration of quarterly inservice testing is approximately 30 minutes. This low flow operating mode also meets current manufacturer recommendations.

A third low flow operating mode can be experienced by the motor driven Auxiliary Feed Water Pumps. If during the winter a prolonged shutdown of the turbine generator is experienced, a means is provided to heat the condensate storage tank using the M.D. Auxiliary Feedwater Pumps when the Auxiliary Feedwater System is not required to be operable. The recirculation lines back to the CST from the two pumps provide a source of both heat and flow in sufficient quantities to protect the tank from freezing. When using the pumps in this mode, the recirculation flow is adjusted to provide 125 gpm (31% rated flow) for each pump using high pressure drop valves. The flow to the tank is important in order to provide maximum BTU input to the tank with minimum hazard to the pumps. The flow rate required for safe extended pump operation during this mode is currently being evaluated. We expect to complete this evaluation and provide the results in a supplement to this response by August 31, 1988.

8. Turbine Driven Auxiliary Feedwater Pump 22

Along with the evaluation of the motor driven Auxiliary Feedwater pumps, we expect to complete an evaluation of the Turbine Driven Auxiliary Feedwater Pump No. 22 and provide the results in a supplement to this response by August 31, 1988.

Our response is provided pursuant to the provisions of Section 182a, Atomic Energy Act of 1954 as amended. If you or your staff should have any questions regarding this subject, please contact us.

Very truly yours,

Subscribed and sworn to
before me this 19th day
of July 1988

Notary Public

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