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SUBJECT: Forwards response to NRC Bulletin 88-004 re potential safety-related pump loss.

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July 8, 1988

U. S. Nuclear Regulatory Commission
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Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Initial Response to NRC Bulletin No. 88-04:
Potential Safety-Related Pump Loss

References: 1) NRC Information Notice No. 87-59: Potential RHR Pump Loss
2) NRC Bulletin No. 88-04: Potential Safety-Related Pump Loss

Recently, Westinghouse Electric Corporation notified all utilities operating Westinghouse pressurized water reactors of two concerns with the design of the miniflow recirculation configuration for residual heat removal (RHR) pumps that also function as low pressure safety injection pumps. The first concern involves pump-to-pump interaction of two centrifugal pumps operated in parallel on a common miniflow recirculation line. The stronger of the two pumps can cause the weaker pump to dead-head and eventually fail. The second concern involves the adequacy of miniflow recirculation capacity for single pump operation. Pump manufacturers are finding that pumps that are operated for long periods of time at low flows are exhibiting impeller degradation. The manufacturers believe that unstable flow conditions occurring at low flows for extended periods of time are causing the impeller damage. Manufacturers have discovered instances of pump damage at flow rates above the original manufacturer recommended minimum flow rate for miniflow recirculation.

The NRC issued NRC Information Notice No. 87-59 (reference 1) outlining the above concerns for RHR pump loss. The NRC subsequently issued Bulletin No. 88-04 (reference 2) requiring Licensees to investigate the potential for pump loss for all safety-related pumps.

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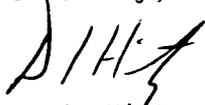
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Attached is WPSC's response to item 4 of NRC Bulletin No. 88-04 and includes the following requested information:

- 1) A summary of the problems and the systems affected.
- 2) The identification of 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.
- 3) WPSC's schedule for long-term resolution of this and/or other significant problems that are identified as a result of this bulletin.
- 4) Justification for continued operation, particularly with regard to General Design Criterion 35 of 10 CFR 50, Appendix A, "Emergency Core Cooling" and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling System for Light Water Nuclear Power Reactors."

If there are any questions concerning this response, please contact me or my staff.

Sincerely,



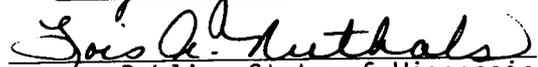
D. C. Hintz
Vice President - Nuclear Power

PIS/jms

Attach.

cc - Mr. Robert Nelson, US NRC
US NRC, Region III

Subscribed and Sworn to
Before Me This 8th Day
of July 1988


Notary Public, State of Wisconsin

My Commission Expires:
May 3, 1992

ATTACHMENT 1

WPSC Response to Item 4 of
NRC Bulletin 88-04

NRC Request: A. Summarize the problems and the systems affected.

WPSC Response: The following systems were reviewed for applicability to NRC Bulletin 88-04:

- 1) Residual Heat Removal (RHR)
- 2) Safety Injection (SI)
- 3) Containment Spray
- 4) Component Cooling
- 5) Service Water (SW)
- 6) Auxiliary Feed Water (AFW)

Each system was first reviewed to determine whether its miniflow configuration could allow for pump-to-pump interaction. The systems were then reviewed to determine if the minimum flow through each pump's recirculation line was adequate to prevent pump damage caused by long-term pump operation at low flows.

The following summarizes the results of WPSC's review.

Pump-to-Pump Interaction During Miniflow Operation

RHR

The RHR system is designed so that each RHR pump has its own separate miniflow recirculation path. Because the RHR pumps do not share a common miniflow line, pump-to-pump interaction is not a concern.

Containment Spray, AFW and SI

The containment spray, AFW, and SI systems have shared miniflow configurations; however, the miniflow design for these systems is such that pump-to-pump interaction is not a concern. Each pump has a flow restricting orifice in its miniflow line upstream from where the shared portion of the miniflow lines joins to form a common line. Westinghouse informed WPSC (Reference 1) that an orifice in an individual miniflow line desensitizes a parallel pump system to strong/weak pump miniflow concerns.

Service Water

The service water pumps do not have miniflow recirculation lines. Although the SW pumps are operated in parallel, the pumps are not operated at low flow rates where pump-to-pump interaction would become a concern.

Component Cooling

The component cooling pumps do not have miniflow recirculation lines. System design and normal operating practices are such that the pumps are always supplying the main component cooling loads; therefore, recirculation flow to the pumps is not required, and pump-to-pump interaction is not a concern.

Adequacy of Installed Miniflow Capacity

The engineering philosophy behind the design of miniflow recirculation configurations for centrifugal pumps has changed since the design of the safety-related pump systems at KNPP.

Originally, safe minimum pump flow was based entirely on maximum allowable fluid temperature rise. Pump manufacturers are now accounting for fluid entrance velocity, impeller recirculation, hydraulic instability and other flow phenomena when specifying safe minimum pump flows. Generally, the newer criteria apply to long-term continuous pump operation at low flows.

The miniflow recirculation lines for the safety related pumps at KNPP were designed to accommodate the safe minimum pump flows that the manufacturers based on maximum fluid temperature rise. The low flow concerns described above would exist only if (1) system design allows for a pump to be operated on full miniflow recirculation during normal plant operations or post accident; and (2) the actual time that a pump would be running on full miniflow recirculation is greater than that recommended by the manufacturer.

The following summarizes WPSC's preliminary review of the adequacy of installed miniflow recirculation lines on safety related pumps.

RHR Pumps

The miniflow recirculation design for each RHR pump allows for flow that is 7.5% of the best efficiency point (BEP) flow. The pump manufacturer, Byron Jackson, has stated that this minimum flow is acceptable for short term pump operation.

WPSC is presently working with Byron Jackson to determine if this flow is adequate for the durations of miniflow operation predicted for normal and post-accident operations. WPSC will provide the manufacturer with data on past pump operation and predicted post accident times for recirculation operation. Based on this information, Byron Jackson will perform an analysis to determine if the present minimum recirculation flow is acceptable.

Presently, the RHR pumps are run on full miniflow recirculation during quarterly inservice testing and during plant startups to cool the RHR heat exchangers. During inservice testing, the RHR pumps are usually run for 15-20 minutes on full miniflow recirculation, although the procedure allows for a 30 minute run time. No problems or pump degradation have been identified as a result of this testing.

When the RHR pumps are run on miniflow recirculation to cool the RHR heat exchangers during plant startup, the recirculation flow is cooled by the component cooling heat exchangers; therefore,

maximum fluid temperature rise is not a concern. Also, the time for the RHR heat exchangers to cooldown is about 10 to 15 minutes; therefore, pump degradation due to low flow continuous operation is also not a concern.

SI Pumps

The miniflow recirculation design for each SI pump allows for 9.4% of BEP flow. This meets the manufacturer's original minimum flow requirement, based on fluid temperature rise.

During normal plant operations, the SI pumps are run on full miniflow recirculation during quarterly inservice testing, SI leakage testing, and diesel generator automatic testing. The procedures for these tests limit the amount of time that the SI pumps can run in the miniflow mode to 30 minutes.

WPSC is presently developing possible scenarios for SI pump operation on miniflow recirculation during post-accident conditions. For almost all post-accident scenarios, the high shutoff head of the SI pumps (2200 lbs) is greater than the predicted reactor coolant system (RCS) pressure corresponding to the SI activation parameters, RCS pressure, main steam pressure, and containment pressure. Because SI flow to the RCS will occur for most of the post-accident scenarios, SI miniflow recirculation is not predicted to occur for long periods of time during post-accident conditions.

Because long-term continuous SI pump miniflow recirculation does not occur during normal plant operations and is not predicted to occur during post-accident conditions, WPSC believes that the concern for long-term low flow operation of safety-related pumps outlined in Bulletin 88-04 is not applicable to the SI pumps at KNPP. However, WPSC is working with the pump manufacturer Sulzer-Bingham Pumps to determine if the minimum recirculation flow is adequate for the durations of miniflow operation predicted for normal and post-accident conditions.

AFW Pumps

The miniflow recirculation design for each AFW pump is 16.7% of BEP flow. This meets the manufacturer's original minimum flow requirement, based on fluid temperature rise.

Discussions with the AFW pump manufacturer Dresser indicate that the original minimum design flow for the pumps has not changed; however, Dresser is recommending that a time restriction be placed on pump operation in the miniflow recirculation mode. Although Dresser has not made a final recommendation for the time restriction, they did indicate that it would be several hours each month.

Presently, there is no time restriction on operating the AFW pumps at KNPP in the miniflow recirculation mode. The pumps are normally operated on miniflow recirculation during quarterly inservice testing and during plant startups.

WPSC is waiting for the final operating criteria that will be recommended by Dresser and will incorporate those recommendations in plant procedures and operator training where appropriate.

SW Pumps

The SW pumps at KNPP are not designed with miniflow recirculation lines. During normal and post-accident operation, these pumps are loaded sufficiently so that recirculation flow is not necessary.

During quarterly inservice testing, each SW pump has its discharge isolated and a flow path is maintained through the pump's strainer backwash. During this testing, the SW pumps are typically run for 15 minutes in this reduced flow lineup, with the amount of flow maintained at approximately 15-30% of BEP flow.

Pump damage due to low flow conditions is not a concern for the SW pumps. The SW pumps will always be loaded sufficiently during normal and post-accident conditions. Also, adequate flow

is maintained during the short time that the pumps are inservice tested at low flow conditions.

Containment Spray Pumps

During normal plant operations, the containment spray pumps are only operated on full miniflow recirculation during quarterly inservice testing. Typically, inservice testing is completed within 15 minutes, although the procedure allows for the pumps to be run on miniflow recirculation for up to 30 minutes.

The miniflow recirculation flow developed for inservice testing is approximately 8% of BEP. This meets the original pump design criteria.

WPSC believes that pump damage due to low flow conditions is not a concern for the containment spray pumps. These pumps will be sufficiently loaded if required post-accident. Also, the amount of time the pumps are in the miniflow recirculation mode during inservice testing is not considered adequate to damage the pump. The minimum pump flow concerns outlined in Bulletin 88-04 deal with long-term damage to pumps due to continuous use at low flows.

Component Cooling Pumps

The component cooling pumps do not have miniflow recirculation lines. System design and normal operating practices are such that when a pump is operating, it is sufficiently loaded to component cooling loads. Pump damage due to low flow conditions is not a concern for the component cooling pumps.

NRC Request: B. Identify 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.

WPSC Response: At this time, WPSC is not planning any modifications to plant hardware or procedures as a result of NRC Bulletin 88-04.

WPSC's review of all safety-related pumps for possible pump-to-pump interaction is complete, and no problems were identified.

WPSC's review of safety-related pumps for the containment spray, service water and component cooling systems for adequacy of miniflow recirculation is complete, and no problems were identified.

The review of the RHR, SI and AFW systems for adequacy of miniflow recirculation is ongoing while WPSC waits for additional information from the pump manufacturers. Following completion of this review, WPSC will inform the NRC of any significant problems identified and will specify any modifications to plant hardware or procedures at that time.

NRC Request: C. Identify an appropriate schedule for long-term resolution of this and/or other significant problems that are identified as a result of Bulletin 88-04.

WPSC Response: WPSC's review of all safety-related pumps for possible pump-to-pump interaction is complete, and no problems were identified.

WPSC's review of safety-related pumps for the containment spray, service water and component cooling systems for adequacy of miniflow recirculation is complete, and no problems were identified.

The final review of the RHR, SI and AFW systems for adequacy of miniflow recirculation shall be completed and submitted to the NRC within 120 days from the date of this submittal. This updated response shall include all information required by Bulletin 88-04 applicable to the RHR, SI and AFW systems.

NRC Request: 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."

WPSC Response: WPSC's review of the adequacy of miniflow recirculation for the safety-related pumps in the RHR, SI and AFW systems is not complete. However, WPSC believes that the concerns brought out in NRC Bulletin 88-04 will not apply to these pumps for the following reasons:

- 1) The concerns of minimum pump flow that have been raised by pump manufacturers and the nuclear industry are clearly intended for pumps that operate for extended periods of time at low flows. The damage to the pump is limited to impeller degradation and is a gradual process; catastrophic pump failure is not a concern.

The SI, RHR and AFW pumps are not continuously operated at the low flows where flow instabilities can damage their impellers. These pumps are operated on miniflow recirculation only during short periods of time, mainly during inservice testing and plant startups.

Possible operation of these pumps on miniflow recirculation post-accident is not a safety concern because the time required before impeller degradation would occur is much greater than the time that the pumps would be left running in the recirculation mode.

- 2) Possible degradation of safety-related pumps is monitored as part of KNPP's inservice testing program. Each pump is tested quarterly to determine if any of its major operating parameters have changed from the previous test. Degradation of pump performance would be found during testing, the cause would be identified, and pump repairs would be initiated.

In conclusion, WPSC firmly believes that the RHR, SI and AFW pumps are capable of performing their safety-related functions and satisfy all criteria for safety-related equipment identified in 10 CFR 50.46 and 10 CFR 30, Appendix A, General Design Criterion 35.

References

- 1) Letter from R. J. Steve, Westinghouse to C. R. Steinhardt, WPSC, dated November 30, 1987.