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DUKE POWER

January 15, 1990

U. S. Nuclear Regulatory Commission
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Subject: McGuire Nuclear Station
Catawba Nuclear Station
Oconee Nuclear Station
Docket Nos. 50-369, -370; 50-413, -414; and 50-269, -270, -287
NRC Bulletin No. 88-04
Potential Safety-Related Pump Loss
Action 4 Final Report
(TACS 69934, 69935, 69898, 69899, 69944, 69945, and 69946)

Gentlemen:

NRC Bulletin No. 88-04 concerning potential safety related pump loss was issued May 5, 1988. This bulletin requested investigation and correction, as applicable, of two miniflow design concerns. One of the bulletin's requested actions (Action No. 4) was the submittal of a report within 60 days of receipt of the bulletin that (a) summarizes the problems and the systems affected, (b) identified 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) provides 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." Another report describing the actions taken is to be submitted within 30 days of completion of the long-term resolution actions in accordance with Bulletin Action No. 5.

By letters dated July 11, August 31, December 1, 1988, April 21, June 30, and December 5, 1989, I submitted partial responses to NRC Bulletin 88-04 for the McGuire, Catawba, and Oconee Nuclear Stations. The August 31, 1988 interim response on the status of Duke's Bulletin 88-04 work provided a statement justifying continued operation for each pump based on information available at that time, and also a list of activities (and associated schedules where possible) that remained to be completed before a final Bulletin Action No. 4 response could be made for a station(s). Further status updates were provided by the December 1st, April 21st, June 30th, and December 5th letters (including a justification of Duke's extended schedule for responding to the Bulletin, and final resolutions for pumps where possible), with a final Bulletin Action No. 4 response to be submitted by January 15, 1990.

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Accordingly, this submitted constitutes the Final Bulletin Action No. 4 Report for the McGuire, Catawba, and Oconee Nuclear Stations. Please find attached updated individual status sheets (originally provided in the August 31, 1988 response) providing the final disposition for all remaining pumps. [Pumps for which final disposition was provided in our previous submittals are not repeated in this submittal]. The attached summary sheets provide the supporting information for this final disposition and identify commitments necessary to resolve outstanding safety related pump issues.

Note that long term resolutions (with appropriate schedules) have been identified for McGuire's ND pumps, Catawba's NV (BAT), ND, and KC Pumps, and Oconee's LPI pumps. All long term resolution actions are scheduling to be completed on McGuire by the end of the second refueling outage after the 1990 outages for both units, on Catawba by October 31, 1990, and on Oconee by September 1, 1990. In accordance with Bulletin Action No. 5, a written response describing the actions taken will be submitted within 30 days of completion of these long term resolution actions (per station).

As required by Bulletin Action No. 6, an evaluation of our actions in response to this bulletin will be documented and maintained at the plant site for a minimum of two years.

I declare under penalty of perjury that the statements set forth herein are true and correct to the best of my knowledge. Should there be any questions concerning this matter or if further information is desired, please advise.

Very truly yours,

Hal B. Tucker

PBN193/lcs

Attachment

xc: (w/attachment)
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Oconee Nuclear Station

	Pumps	Manufacturer
Low Pressure Injection (LPI)	1A,1B,2A,2B,3A,3B	Ingersoll-Rand

Configuration:

Each LPI pump has a separate minimum flow recirculation line with an orifice between pump discharge and pump suction.

Final Disposition:

- The LPI pumps do not interact during multiple pump operation because each pump is provided with a separate minimum flow recirculation line and the crossover pipe between discharge headers is isolated.

- The LPI pumps are normally operated above the manufacturer's recommended minimum flow. The pumps are required to operate below the recommended flow only during the following modes of operation:

  I. The LPI pumps are started automatically by Engineered Safeguards (ES) signal on very low Reactor Coolant System (RCS) pressure or high Reactor Building pressure. Each pump has a minimum flow recirculation loop to protect the pumps if RCS pressure is above pump shut off head when pumps receive ES signal. The capacity of the minimum flow recirculation loop is sufficient to prevent cavitation due to pump heat for more than 30 minutes. Plant operators are required to secure the pumps if a flow demand is not established within 30 minutes. Three LPI pumps have each been tested for 28 minutes in the minimum flow recirculation mode. There is no evidence to indicate that this limited mode of operation would be detrimental to pump performance. However as an additonal margin of thermal protection the mimimum flow in the recirculation loop orifice bore will be increased to assure the flowrate satisfies Ingersoll- Rand (I-R) requirement for 30 minute operation. Analysis has shown that the increased recirculation loop flow does not significantly impact emergency injection flow.

  II. For certain small break LOCA's where the RCS pressure remains above LPI shut off pressure, the BWST will deplete and the LPI will be aligned in series with the HPI pumps to provide recirculation until the RCS is depressurized. In this case the LPI flowrates are expected to be within the manufacturers requirement for 3 hours. This case would exist only during the transition period before long term core cooling is provided by LPI and flowrates would satisfy the manufacturer's long term requirement. A procedure change will be made to alert the Operators and Station Response personnel of the LPI minimum flow concerns. An option available to the operator to increase LPI flow into the manufacturers long term minimum flow requirement is to turn on the (RBS) Reactor Building Spray system. Other non-safety related options are available to the operator. The option exercised will be based on the existing plant condition.

III. LPI pumps are also used to lower the level in the reactor vessel during mid-loop operation. The LPI pumps are typically operated in this mode at approximately 400 gpm for a duration of less than 3 hours. This is below the I-R recomendation of 500 to 800 gpm for less than 3 hours (short period operation). Because lower flows are desirable from system controlability aspect, a higher flowrate will not be specified. Instead, to ensure continued pump operability the procedure will be changed to require IWP testing of the LPI pump whenever it is operated outside the manufacturers recommendation.

Status/Planned Action:

1. Manufacturer's recommended minimum flow review complete.

2. Minimum recirculation loop orifice bore will be increased to meet manufacturer's recommended minimum flow requirement for 30 minute operation. This will be completed by 9/1/90 for all LPI pumps.

3. Change emergency procedure (EP/1,2&3/A/1800/01) to alert Operators and Station Response personel of the LPI minimum flow concerns for continous operation during the piggy back mode of operation. This will be completed by 6/30/90.

4. Change operating procedure (OP/1,2&3/A/1102/15) to require IWP testing of any LPI pump following low flow operation below manufacturers recommendation for 3 hour operation. This will be completed by 6/30/90.

Oconee Nuclear Station

	Pumps	Manufacturer
Low Pressure Service Water	1A,1B,1C,3A,3B	Ingersoll-Rand

Configuration:

Three LPSW pumps provide cooling water to units 1 & 2 and two LPSW pumps provide cooling water to unit 3. These pumps do not have minimum flow lines.

Final Disposition:

- Ingersoll-Rand has identified a minimum flowrate for continous operation. Based upon previous system performance, and in accordance with good operating practices, the pumps are maintained above their minimum flowrate by selectively opening flowpaths.
- The pumps are routinely inspected at least once every 12 hours. If cavitation is noted, immediate corrective action is taken via opening of the crossover lines or other additional flowpaths. If such action does not adequately increase the flow demand, the affected pump is secured. Depending upon need, crossovers may then be opened.
- Inspection of the LPSW internals following 10 years of routine station operation identified an increase in clearances but less than 1% degradation in pump discharge head.
- Quarterly testing of pumps under the IWP program has shown acceptable levels of vibration and temperature rise.

Status/Planed Action:

Review is complete; no further action or response is necessary.

McGuire Nuclear Station

	Pumps	Manufacturer
Residual Heat Removal (ND)	1A, 1B, 2A, 2B	Ingersoll-Rand

Configuration:

Each pump has a separate minimum flow line which provides a path from the pump discharge downstream of the respective heat exchanger to the pump suction. A valve automatically opens on low flow to provide an adequate miniflow. The purpose of the mini-flow portion of the ND system is to provide a flow path for the pumps during Design Basis Accident auto start while remaining in recirculation mode for a significant amount of time until RCS pressure decreases to the point that the ND pumps can inject. Also the mini-flow lines provide a flow path during pump test while all other portions of the system are isolated.

Final Disposition:

- Testing of pumps quarterly (IWP program) shows that available miniflow meets manufacturer's requirements for single pump operation. The tests show acceptable level of vibration and temperature rise. Also, the pumps are operated during refueling outages above the vendor recommended amount for continuous operation. These operations have shown no pump degradation.

- Although each pump has separate miniflow lines and valves, they ar e cross connected to meet LOCA break criteria stated in FSAR Section 6.3. Due to this cross connect, the single failure of a miniflow valve will result in both pumps flowing through one miniflow valve. Two pump operation with single valve failure can only occur during Reactor Trip or Safety Injection. Duke's Emergency Procedure EP/1/A/5000/1 requires that operators immediately verify that miniflow valves are open. If one fails to open, the valve shall be manually opened from the control room or opened using the handwheel. A request to revise the EP has been issued to require operators to manually open the failed valve within a time frame consistent with the pump manufacturer's miniflow time recommendations.

  An immediate change to the EP is not necessary since the pump performance curves are so close to each other that dead-heading of the weaker pump will not occur plus weaker pump flow during Design Basis Accident with single failure of one miniflow valve is considered acceptable for the duration that the valve remains closed. The purpose of revising the EP is to increase the reliability of the ND System. At the present, there is no urgency to implement the changes. This EP change is intended to be a short term resolution.

- Final hydraulic calculations show acceptable flow rates during miniflow operation. Although these flow rates are slightly below manufacturers recommendations, for continuous operation, the manufacturer concedes the miniflow rates provided are only suggested flow rates at which vibration monitoring should be performed and do not necessarily correlate to pump damage or bearing failure. During all normal operating modes when pumps are running at system miniflow conditions, continuous vibration monitoring is performed and evaluated. This monitoring program has shown no pump or bearing degradation.

- A Test Acceptance Criteria (TAC) has been issued to limit pump degradation to an acceptable value to prevent unacceptable low flow or dead-heading. History of past performance shows it is not expected that the pumps will degrade to the TAC limits. However, to improve the reliability of the ND System, the EP will be revised as stated above and a modification request to change the miniflow lines has been issued. The TAC is intended to be a short term resolution until the modification has been implemented.

Status/Planned Action:

1. Implement Emergency Procedure revisions by 10/31/90.

2. A modification to change the miniflow line will be implemented by the end of the second refueling outage after the 1990 outages for both units.

Catawba Nuclear Station

	Pumps	Manufacturer
Boric Acid Transfer (NV)	1A, 1B, 2A, 2B	Crane-Chempump

Configuration:

Each pair of pumps has a common miniflow line and orifice. Normally, the pumps are aligned in the recirculation path of the Boric Acid Tank (BAT). Minimum flow from these pumps flows back to the BAT. A single pump is used to help maintain thermal and chemical equilibrium of tank contents.

Final Disposition:

- Miniflow requirements provided by the manufacturer are met for one or both pumps running per unit by flow rates several times higher than miniflow requirements.

- Normally one Boric Acid Transfer Pump is run continuously to preclude thermal stratification and maintain chemical uniformity in the tank. A second pump is maintained in "auto" and starts on demand from the Reactor Makeup Control System to provide emergency makeup to the Volume Control Tank (VCT) (this is a non-ECCS function). Presently both pumps are setup to start (or stay on) upon receipt of a Safety Injection signal (SI) or upon entering Blackout. During the emergency makeup mode a flow path to the VCT is open such that minimum flow requirements are met. Currently actual pump curves are nearly identical, consequently interaction is not a problem, however compliance with IWP acceptance criteria forces the possibility of interaction such that only one pump can be run until such time when an operator aligns the pumps to the charging pumps suction following an SI or Blackout.

Status/Planned Action:

1. A Station Problem Report was written 9-21-89 to initiate a change to delete auto-start of pumps on SI and Blackout.

2. The requested change will be implemented by 10-31-90.

Catawba Nuclear Station

	Pumps	Manufacturer
Residual Heat Removal (ND)	1A, 1B, 2A, 2B	Ingersoll-Rand

Configuration:

Each pump has a separate minimum flow line which provides a path from the pump discharge, downstream of the respective heat exchanger, to the pump suction. A valve automatically opens on low flow to provide an adequate miniflow path.

Final Disposition:

- Testing of pumps quarterly (IWP program) shows that available miniflow meets manufacturer's requirements of 300--500 gpm for short term (approximately 3 hours) single pump operation. The tests show acceptable levels of vibration and temperature rise.

- Manufacturer's evaluation of the range of operating flows and times verified that the current start/stop and short period minimum flows are sufficient to prevent abnormal pump wear, as long as an adequate test and inspection program is followed.

- Current pump maintenance intervals have been judged to be adequate. Due to various motor problems, the pump ends on several ND pumps have been inspected in the past few years. At no time has unusual wear or cavitation been observed. Also, no wear rings or impellers have ever required replacement. At present, there is no formal periodic schedule to disassemble and inspect the pump end, and none is deemed necessary due to performance test results, motor electrical and bearing lube oil analysis programs, and the pump vibrational analysis program.

  In response to a Westinghouse issue concerning premature motor bearing wear due to high thrust loads at pump flow rates less than 3000 gpm, ND pump motors will be scheduled for periodic removal for inspection and refurbishment. When implemented, this disassembly of the vertical pump/motor combination will provide an additional opportunity for visual inspection of pump internals. In addition, the normal flow rate for the ND pumps is being increased from 3000 to the 3300 to 3500 gpm range to reduce thrust loading and thus extend the motor service life.

- Flow modeling utilizing the ND miniflow computer model has determined that there are no adverse interactions between parallel ND pump flow paths.

This is due to the independent miniflow paths and control valve logic in combination with separate suction line check valves. The maximum differential for strong pump-weak pump offset per ASME Section XI Subsection IWP were considered in this analysis, as well as the effects of single pump and valve failures. Adequate minimum flow is predicted for all appropriate scenarios.

- Station Emergency Procedures currently direct the operator to assess total LOCA flow demand and secure pumps not needed for that demand. However this procedure does not state the time frame considered appropriate for ND pump operation at flows less than 1000 gpm. Therefore, this procedure will be revised to state that ND pumps operating below 1000 gpm and not necessary for accident response should be secured within approximately three hours to preclude damage to these pumps.

  During cold leg recirculation, ND flow may be directed to the Safety Injection (NI) and Safety Injection/Charging (NV) pumps, into the ND auxiliary spray header, or directly to the Reactor Coolant (NC) System. If, when the ND auxiliary spray header is isolated, total ND flow does not exceed 1000 gpm, a step will be added to emergency procedures that will prevent realignment from the auxiliary spray header until a minimum of 1000 gpm total ND pump flow is ensured.

Status/Planned Action:

1. Received manufacturers final recommendations on 9-21-89. The manufacturer recommended 300-500 gpm for 3 hours and minimum 1000 gpm for continuous operation.

2. Emergency procedure changes have been identified and will be implemented by 10-31-90.

Catawba Nuclear Station

	Pumps	Manufacturer
Component Cooling Water (KC)	1A1, 1A2, 1B1, 1B2, 2A1, 2A2, 2B1, 2B2	Goulds

Configuration:

Each pair of component cooling pumps share a common minimum flow line which has a valve that automatically opens upon low flow to provide total minimum flow for both pumps when supplemented by minimum normal operating system demands. When the flow rate has increased to an adequate flow, the minimum flow valve closes to avoid pump runout.

Final Disposition:

- The minimum flow path is needed for faulted, normal operation (non-Engineered Safeguards) only. During unfaulted normal operation and all modes of Engineered Safeguards (safety injection, high containment pressure, high-high containment pressure) there are sufficient flow paths open to exceed the pump minimum flow requirements determined by the manufacturer, considering worst case head differences allowable under ASME Section XI Subsection IWP. Automatic action will open the minimum flow path upon the detection of low flow and control room alarms/indications will keep operators informed of system status.

- High flow setpoints provide adequate protection against pump runout for both one pump and two pump (per train) operation.

- The low flow setpoint provides adequate capacity for one pump operation, but does not currently provide adequate capacity to preclude pump interaction during two pump (per train) operation. Duke calculations indicate that this setpoint can be revised to accommodate the worst case head differences allowable under ASME Section XI Subsection IWP, when supplemented by minimum normal operating system demands.

- The scenario in which both KC pumps in a train are not assured of meeting manufacturer's minimum flow requirements involves the IWP acceptance criteria and the failure of a safety related valve to open, hence it is a single failure already evaluated per FSAR Table 9.2.2-4.

Should pump interaction on the associated train cause dead heading and subsequent pump damage, a separate, redundant train of Component Cooling is available to provide necessary cooling. In addition, the pump manufacturer concedes that the minimum flow rate provided is their recommendation to enhance life of the pumps and does not necessarily correlate to pump damage. Short periods of operation of up to 15 minutes with lower flow rates can be tolerated before any degradation would occur. ASME Section XI Subsection IWP performance test results (June 1984 - August 1989) give no indication of pump degradation.

Status/Planned Action:

1. Received manufacturers final clarification of earlier recommendation on 1-9-90. The manufacturer recommended 1100 gpm for continuous operation with short periods of operation of up to 15 minutes with lower flow rates before any degradation would occur.

2. Minimum flow line setpoint changes will be sent to the station and minimum flow test will be performed to verify the new setpoint by 10-31-90.