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50-369	William B. McGuire Nuclear Station, Unit 1, Duke Powe	05000369
50-370	William B. McGuire Nuclear Station, Unit 2, Duke Powe	05000370
50-413	Catawba Nuclear Station, Unit 1, Duke Power Co.	05000413
50-414	Catawba Nuclear Station, Unit 2, Duke Power Co.	05000414

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SUBJECT: Responds to NRC Bulletin 88-04 re potential safety-related pump loss,Action 4 rept status update for plants.

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DUKE POWER

December 5, 1989

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

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 Report Status Update
(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, and June 30, 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 and June 30th 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 November 30, 1989.

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Please find attached an updated interim response on the status of Duke's Bulletin 88-04 work for the McGuire, Catawba, and Oconee Nuclear stations. Note that this is not a final Bulletin Action No. 4 response as committed to in the June 30, 1989 submittal due to continued delays in getting needed information from a manufacturer (Ingersoll-Rand). All information requested from Ingersoll-Rand has now been received; however, the schedule for final resolution of some of these pumps must be delayed to allow for evaluation and resolution of minimum flow information received from Ingersoll-Rand as late as December 1, 1989. The individual status sheets for each pump (originally provided in the August 31, 1988 response) have been updated as follows:

- Pumps for which final disposition is now available are identified on the attached summary sheets. [Pumps for which final disposition was provided in our June 30, 1989 submittal are not repeated in this submittal.]

- The schedule for final resolution of the remaining pumps is provided (all final resolutions are to be submitted by January 15, 1990).

Note that the information provided for Catawba's ND pumps, KC pumps, and boric acid transfer pumps, McGuire's ND pumps, and Oconee's LPI and LPSW pumps identifies commitments necessary to resolve safety related pump issues. Note also that activities in addition to those identified to date may be required after the remaining pump information is evaluated.

As noted above, a final Bulletin Action No. 4 response will be submitted by January 15, 1990. That response will provide final resolution, or identify an appropriate schedule for long-term resolution if necessary, for those pumps still outstanding in this response. Note that no Bulletin Action No. 5 reports have been made to date since all long term resolutions have not yet been completed (or possibly even identified) for any station.

This response is being submitted three working days late in order that I could provide as complete a response as possible. I regret this delay and the necessity for another response extension, but it was due to matters not within Duke Power Company's control. This matter has previously been discussed with Mr. D. S. Hood of your staff.

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

Hal B. Tucker

PBN188/lcs

Attachment

xc: <u>(w/attachment)</u>
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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.

Continued operation of the LPI pumps is justified on the following basis:

- 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 mode of operation:

  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.

Status/Planned Action:

1. Received manufacturer's final recommendations on 11/22/89. The manufacturer recommended increasing recirculated minimum flow capacity from 16 gpm to 60 gpm.

2. Perform analysis to determine impact on delivered accident flow resulting from increasing LPI Pump recirculation orifice bore diameter by 12/31/89. Preliminary analysis indicates less than 1% decrease in delivered accident flow.

3. Submit final response on 1/15/90 including scope and schedule for any modifications and/or procedure changes.

Oconee Nuclear Station

	Pumps	Manufacturer
High Pressure Injection (HPI)	1A,1B,1C,2A,2B,2C 3A,3B,3C	Ingersoll-Rand

Configuration:

The three HPI pumps per unit have separate minimum flow lines that contain block orifices supplied by the pump manufacturer. The minimum flow lines merge downstream of the orifices into a common line that returns to the Letdown Storage Tank through the Seal Return Coolers.

Final Disposition:

- Flow is limited in each individual minimum flow line upstream of the common minimum flow return line. Therefore, pump interaction does not affect individual pump performance.
- The capacity of each minimum flow line is greater than the manufacturer's final recommendation.

Status/Planned Action:

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

Oconee Nuclear Station

	Pumps	Manufacturer
Reactor Building Spray (RBS)	1A,1B,2A,2B,3A,3B	Ingersoll-Rand

Configuration:

The two RBS pumps per unit do not have minimum flow recirculation lines. They are lined up to discharge through spray nozzles to containment atmosphere.

Final Disposition:

- The RBS pumps do not interact during multiple pump operation because the crossover pipe between discharge headers is isolated.
- The RBS pumps do not have minimum flow lines because they discharge through spray nozzles to containment atmosphere and therefore cannot be deadheaded. These pumps are operated above the manufacturer's final recommended minimum flow by procedure.

Status/Planned Action:

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

Oconee Nuclear Station

	Pumps	Manufacturer
Auxiliary Service Water (ASW)	1A	Ingersoll-Rand

Configuration:

The ASW pump has a separate minimum flow path that is manually opened before the pump is started.

Final Disposition:

- Single pump; no interaction potential.

- The manufacturer (IR) recommended minimum flow rates for Continuous operation, Short-Period operation, One-Time operation, and Start/Stop operation. These recommendations are based on the potential detrimental effects of extended periods of low flow operation and cumulative effects of such operation(s). A service life maintenance interval was formulated by the manufacturer based on these operations. The formulation was analyzed and applied to the ASW pump. The formula showed that even with 40 more years of present operation (IWP testing) and including the worst case scenario occurring once during 40 years, the pump will not exceed its service life. This is due to the fact that the design basis event for this pump is a One-Time low probability tornado event. Conservative analysis has shown that the ASW Pump is operated at a flow rate greater than the manufacturer's final minimum flow recommendation when tested.

Status/Planned Action:

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

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.

Continued operation of the LPSW pumps is justified on the following basis:

- Pump interaction is not expected to affect individual pump performance because pumps are not operated in the low flow range on the pump curve.
- The LPSW pumps do not have minimum flow lines because normal and emergency flow demand is greater than manufacturer's minimum flow recommendation except when multiple loads are isolated during maintenance. Guidance has been given to operators to divert flow during maintenance activities to maintain manufacturer's recommended minimum flow.

Status/Planned Action:

1. Received manufacturer's final minimum flow recommendations on 11/17/89.
2. Requested procedure change to ensure that the LPSW Pumps are operated above the manufacturer's final minimum flow recommendations during all possible scenarios on 11/22/89.
3. Evaluate procedure changes to ensure compliance with manufacturer's final recommendations.
4. Submit final response on 1/15/90 including date when procedure changes go into effect.

Oconee Nuclear Station

	Pumps	Manufacturer
SSF Auxiliary Service Water (SSFASW)	1	Bingham

Configuration:

The SSFASW pump has a minimum flow recirculation line with a block orifice between pump discharge and pump suction.

Final Disposition:

- Single pump; no interaction potential.
- The SSFASW pump minimum flow capacity meets the manufacturer's minimum flow requirements for both short and long term operation for all design basis scenarios.

Status/Planned Action:

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

Oconee Nuclear Station

	Pumps	Manufacturer
SSF HVAC Cooling Water (SSFHVAC)	1,2	Ingersoll-Rand

Configuration:

Either of the two SSFHVAC pumps is capable of providing cooling water flow to two condensers that have bypass lines. Pump interlocks prevent operation of SSFHVAC Pump 2 while SSFHVAC Pump 1 is operating. The ability to provide adequate cooling water flow with only one SSFHVAC pump is the result of a recent modification which replaced the two 1750 RPM SSFHVAC pump motors with two 3600 RPM motors. This modification was performed to allow the system to be operable for lake water temperatures up to 90 F. Three-way regulating valves open to bypass the condensers during periods of low demand.

Final Disposition:

- Due to pump interlocks and operating procedures, only one SSFHVAC pump may be operated at a time. Therefore, pump interaction will not occur.
- The SSFHVAC pumps supply condensers which are provided with bypass capacity greater than manufacturer's final recommended minimum flow. Plant operating procedures do not allow pump operation below manufacturer's recommendation.

Status/Planned Action:

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

Oconee Nuclear Station

	Pumps	Manufacturer
SSF Diesel Engine Cooling Water (SSFDECW)	1	Ingersoll-Rand

Configuration:

The SSFDECW pump does not have a minimum flow line. It is lined up to supply cooling water through two heat exchangers.

Final disposition:

- Single pump; no interaction potential.
- The SSFDECW pump does not have minimum flow protection because it is operated at best efficiency point during its only mode of operation.

Status/Planned 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.

Continued operation of the residual heat removal pumps is justified on the following basis:

- 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 used during refueling outages (mid-loop operation) to remove residual heat. These operations have been continued with relatively low flow rates and have shown no pump degradation.

- Although each pump has separate miniflow lines and valves, they are 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.

- Preliminary hydraulic calculations show acceptable flow rates during miniflow operation. Although these flow rates are 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 review of the performance curves for the pumps actually installed shows that the pumps will be operating sufficiently out on their curves such that the stronger pump will not prevent the weaker pump from running at acceptable minimum flow. A preliminary analysis shows that with application of IWP acceptance criteria, interaction does occur. However interaction will not occur given the present performance curves. Test Acceptance Criteria will be provided for the station to limit pump performance degradation to ensure the pumps will perform within acceptable miniflow limits. In the event that the pumps degrade and cannot perform within the acceptable range, a modification will be required to prevent interaction and allow adequate minimum flow. Although the pumps are justified for continuous operation with the pump performance as presently installed, a modification request will be issued to modify the miniflow lines to allow adequate miniflow in case future pump tests do not meet the Test Acceptance Criteria.

Status/Planned Action:

1. Received manufacturers final recommendations on 9/21/89.

2. Provide Test Acceptance Criteria to station to limit pump performance curve degradation by 1/15/90.

3. Provide request for modification to station by 1/15/90. (Schedule for implementation will be provided in final response).

4. Submit final response, or additional recommendations if necessary, by 1/15/90.

McGuire Nuclear Station

	Pumps	Manufacturer
Containment Spray (NS)	1A, 1B, 2A, 2B	Ingersoll-Rand

Configuration:

Two identical pumps per unit are installed in separate flow paths without any interaction.

Final Disposition:

- Flows exceed miniflow requirements during normal system operations. During quarterly IWP testing of each pump a throttle valve in the minimum flow line is adjusted to achieve recommended minimum flow.
- Interaction is not a problem, since pumps discharge on separate paths. During the tests, only one pump is operated, hence pump to pump interaction is not a problem.

Status/Planned Action:

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

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.

Continued operation of the boric acid transfer pumps is justified on the following basis:

- 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. Schedule of implementation will be provided with final response, 1-15-90.

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 for 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.
- 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.
- 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 "piggyback" mode for long term operation of ND pumps, the auxiliary spray header ensures flow conditions greater than 1000 gpm.

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 change requested 11-6-89.

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 the flow rate has increased to an adequate flow, the minimum flow valve closes to avoid pump runout.

Continued operation of the component cooling water pumps is justified on the following basis:

- 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. 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 provide adequate capacity to preclude pump interaction during two pump (per train) operation. Design Engineering is currently evaluating the option of increasing the low flow setpoint which opens the minimum flow path and opening an additional flow path to provide increased flow capacity. If this option is not viable, a modification will be required to prevent pump interaction during two pump (per train) operation.

- 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. ASME Section XI Subsection IWP performance test results (June 1984 - August 1989) give no indication of pump degradation.

Status/Planned Action:

1. Performed detailed calculations to identify pump flows resulting from appropriate valve alignments while imposing IWP acceptance criteria.

2. Requested clarification of short term minimum flow requirements from pump manufacturer.

3. Evaluate possible setpoint changes, procedure changes, or system modifications available to preclude unacceptable pump interaction.

4. Submit final response on 1/15/90 including scope and schedule for any modifications and/or procedure changes.