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SUBJECT: Responds to IE Bulletin 88-004, "Potential Safety-Related Pump Loss."

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Iowa Electric Light and Power Company
July 7, 1988
NG-88-2219

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
Response to NRC Bulletin 88-04, "Potential Safety-Related Pump Loss"

Reference: D. Grace to T. Murley, "Response to NRC Bulletin 88-04: Potential Safety-Related Pump Loss, BWROG-8836, June 29, 1988"

File: A-101a

Dear Dr. Murley:

Bulletin 88-04 requires licensees to investigate and correct, two miniflow design concerns pertaining to safety-related pumps.

We have evaluated our piping configuration and determined that the potential for dead-heading due to pump-to-pump interactions is negligible. In addition, the minimum flow capacity for the RHR and Core Spray pumps is adequate for the full spectrum of loss-of-coolant accidents. One short-term corrective action has been taken in response to the bulletin. A precaution has been added to the system operating instructions to limit the minimum flow operation of these pumps. No long-term actions are needed.

The attachment to this letter provides the information requested by the bulletin. Our response utilizes information previously provided to you by the BWR Owner's Group in the referenced letter.

Should you have any additional questions on this matter, please contact this office.

IOWA ELECTRIC LIGHT AND POWER COMPANY

By [signature]
William C. Rothert
Manager, Nuclear Division

Subscribed and sworn to before me on this 8th day of July, 1988.

[signature]
Notary Public in and for the State of Iowa

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WCR/PLB/pjv+

Attachment: Iowa Electric Response to NRC Bulletin 88-04: Potential Safety-Related Pump Loss

cc: P. Bell
L. Liu
L. Root
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J. R. Hall (NRC-NRR)
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Commitment Control 880158

Iowa Electric's Responses to NRC Bulletin 88-04: "Potential Safety-Related Pump Loss"

Bulletin 88-04 requests a written response that (a) summarizes the problems and the systems affected, (b) identifies 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."

Response:

a) Problems and Affected Systems

At the Duane Arnold Energy Center (DAEC) the low pressure Emergency Core Cooling System pumps were identified as having the potential for pump-to-pump minimum flow interaction due to their piping configuration. The "A" side low pressure Emergency Core Cooling Systems share a common minimum flow line as do the "B" side systems. With this configuration, each minimum flow line serves two RHR pumps and a Core Spray pump. HPCI and RCIC also share these same minimum flow lines. HPCI and RCIC were not identified as having the potential for pump-to-pump interaction due to the fact that unlike low pressure systems, HPCI and RCIC are able to inject at high reactor pressures. Therefore, only the RHR and Core Spray pump are potentially affected.

Flow resistance calculations and data gathered from Special Test Procedure (SpTP) 152 - RHR and Core Spray Minimum Flow Data demonstrate that there is no potential for dead-heading a pump in the low pressure Emergency Core Cooling System. Flow resistance calculation were performed for the RHR and Core Spray systems when operating at minimum flow. Most of the pressure drop in the minimum flow lines was shown to be across the orifices in the individual minimum flow lines. These relatively large drops in pressure, coupled with large downstream common lines, effectively negate the effects of pump-to-pump interaction. The special test demonstrated that dead-heading of a pump did not occur, even when all three pumps on a common minimum flow line were run simultaneously.

Data gathered from SpTP-152 and calculations show minimum flow adequate to prevent damage to the RHR and Core Spray pumps. System resistance curves were developed and plotted against both the original pump curves and the curves generated from SpTP-152. Minimum flow values from these curves correspond well to design minimum flowrates. Also based on our 15 years of operating experience, we estimate that these pumps have accumulated approximately 25 hours of minimum flow operation per pump. To date, we have not seen any degradation in pump performance.

b) Short-Term and Long-Term Modifications

As a result of our review of the bulletin, a short term modification was identified. A precaution has been added to the operating instructions for RHR and Core Spray. It directs the operator to minimize pump operation at minimum flow and to limit minimum flow operation to less than one hour. The Emergency Operating Procedures currently allow these pumps to be secured if adequate core cooling has been confirmed. This situation would be encountered during a small break LOCA where the low pressure pumps start, but injection is delayed until the reactor is depressurized below the shut-off head of the low pressure pumps.

As our calculations and test data have demonstrated the adequacy of the minimum flow capacity and the lack of a dead-heading problem due to pump-to-pump interaction, no long term modifications are currently identified. Therefore, we believe that augmented diagnostic monitoring of the pumps is not warranted. The current surveillance testing in accordance with DAEC Technical Specifications and ASME Section XI In-Service Testing (IST) program are adequate to detect pump degradation. However, if such degradation is observed in the future, prompt corrective action will be taken.

c) Schedule for Long Term Resolution

This bulletin item is not applicable to the DAEC as no long-term corrective actions are needed.

d) Justification for Continued Operation

The NRC concerns stated in Bulletin 88-04 are as follows:

1. With two pumps operating in parallel in the minimum flow mode, one of the pumps may be dead-headed resulting in pump damage or failure.
2. Installed minimum pump flows may not be adequate to preclude pump damage or failure.

The first concern is not a problem at the DAEC as demonstrated by SpTP-152. Therefore, no justification for continued operation is needed. The second concern is addressed by the responses below.

1. All Class 1, 2, and 3 centrifugal pumps installed in BWRs required to perform a specific function in shutting down the reactor or in mitigating the consequences of an accident and that are provided with an emergency power source must undergo routine in-service inspection as required by ASME Boiler and Pressure Vessel Code Section XI, Article IWP-1000. These quarterly tests are in addition to the Technical Specification Surveillance Requirements intended to demonstrate compliance with the plant safety analyses. The Section XI tests are intended to detect changes in pump performance. Article IWP-1500 ("Detection of Change") states:

> "The hydraulic and mechanical condition of a pump, relative to a previous condition, can be determined by attempting to duplicate, by test, a set of basic reference parameters. Deviations detected are symptoms of changes and, depending upon the degree of deviation, indicate need for further tests or corrective action."

The in-service tests measure pump differential pressure, inlet pressure, flow rate, vibration amplitude, and bearing temperature. Alert ranges and required action ranges are strictly defined, and require increased frequency of testing or declaring the pump inoperative, respectively. Performance outside of the required action range would place the affected system in a Technical Specification Limiting Condition for Operation.

As discussed in item 2 below, the time during which pumps operate in the minimum flow mode is short enough that pump performance should not be susceptible to the concerns stated in the bulletin. However, if any degradation were to occur, the plant's In-Service Testing program would detect a change in performance. The tests themselves would not detect pump inadequate minimum flow (since these are intended to be full flow tests), but any deleterious effects of operating with inadequate flow would be detected in advance of significant pump performance degradation. Therefore, any changes in pump performance due to cumulative low flow effects from pump surveillance testing and normal system starts would be detected and corrected.

2. The potential for excessive wear on pumps attributable to minimum flow operation is negligible. Pump vendors suggest minimum flow guidelines for intermittent operation, which is defined as less than two hours of minimum flow operation in any 24-hour period. During a 40 year plant life, this would amount to approximately 30,000 hours of low flow operation. However, system operation in the minimum flow mode is limited to pump startup during startup testing, monthly surveillance testing, and system start on a LOCA signal. This equates to less than one percent of the 30,000 hour limit suggested by pump vendors. However, the vendor of the pumps in question has not yet been able to verify that current minimum flow rates are acceptable. But as detailed in item 3 below, field experience and our own plant history demonstrate that no pump damage from low flow operation has occurred. We will continue to pursue this issue with our pump vendor.

3. A review of the BWR operating experience by the BWR Owners' Group (see Ref. 1 of cover letter), demonstrates that short-term operation in the minimum flow mode has little or no impact on pump life. The pumps in question continued to function normally after such operations.

   There have been occurrences in the industry where inadvertently dead-headed pumps have been operated for a significant time. These pumps have continued to function normally with no apparent adverse performance effects.

4. Industry Probabilistic Risk Assessments have shown that pump wear attributable to minimum flow operation is not a significant contributor to total system unavailability. Other factors (such as loss of emergency power, loss of cooling, etc.) are more significant. BWR operating history indicates no occurrences of system unavailability due to pump excessive wear attributable to low flow operation.

5. For the RHR and Core Spray pumps, the only design basis events that would lead to operation in the minimum flow mode are events that result in an ECCS initiation signal while the reactor is at high pressure (above the pump shutoff head). These events are normally small break LOCAs and loss of drywell cooling isolation events. Of these, only certain small break LOCAs actually require ECCS injection from the RHR or Core Spray system after running at low flow.

   Once a LOCA is initiated, the maximum duration that a RHR or Core Spray pump may operate in the minimum flow mode for the spectrum of hypothetical LOCAs is less than 30 minutes. This is derived from postulated small break LOCAs, wherein reactor depressurization to below the shut-off head of these pumps is delayed. For large break LOCAs, where the full complement of ECC systems is more fully utilized, the reactor rapidly depressurizes through the pipe break. Based on our test data, the present minimum flow bypass line provides adequate protection for these pumps for compliance with ECCS requirements for the short durations postulated during both the small and large break LOCAs.

   For other scenarios, there is adequate time to secure the RHR and Core Spray pumps, and restart them as necessary, precluding extended operation in the minimum flow mode. In such scenarios, the operator would secure the RHR or Core Spray pumps when it is recognized that they are not immediately needed, in accordance with the Emergency Operating Procedures. The pumps would be restarted when vessel injection becomes necessary.

6. As discussed in item 5 above, only certain small break LOCAs actually require ECCS injection from RHR or Core Spray where the pumps may be operated in the minimum flow mode. However, because of the excess ECCS capacity that is available, limiting LOCA scenarios for most BWRs do not depend on operation of both pumps of a pair of parallel pumps to operate in order to satisfy 10CFR50.46 and 10CFR50 Appendix A, General Design Criteria 35 requirements. In fact, a realistic LOCA analysis would show that only one low pressure ECCS pump is typically necessary to satisfy these 10 CFR Part 50 core-cooling requirements during and following a LOCA.

Based on the above responses, we conclude the continued operation of the DAEC is justified.