UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INSERVICE TESTING PROGRAM REQUESTS FOR RELIEF

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

DOCKET NUMBERS 50-282 AND 50-306

1.0 INTRODUCTION

The Code of Federal Regulations, 10 CFR 50.55a, requires that inservice testing (IST) of certain ASME Code Class 1, 2, and 3 pumps and valves be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable addenda, except where alternatives have been authorized or relief has been requested by the licensee and granted by the Commission pursuant to Sections (a)(3)(i), (a)(3)(ii), or (f)(6)(i) of 10 CFR 50.55a. In proposing alternatives or requesting relief, the licensee must demonstrate that: (1) the proposed alternatives provide an acceptable level of quality and safety; (2) compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety; or (3) conformance is impractical for its facility. NRC guidance contained in Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," provides alternatives to the Code requirements determined acceptable to the staff.

Section 55a of 10 CFR Part 50 authorizes the Commission to approve alternatives and to grant relief from ASME Code requirements upon making the necessary findings. The NRC staff's findings with respect to authorizing alternatives and granting or not granting the relief requested as part of the licensee's IST program are contained in this safety evaluation (SE).

Furthermore, in rulemaking to 10 CFR 50.55a effective September 8, 1992 (see 57 Federal Register 34666), the 1989 Edition of ASME Section XI was incorporated in 10 CFR 50.55a(b). The 1989 Edition provides that the rules for IST of pumps and valves shall meet the requirements set forth in ASME Operations and Maintenance Standards Part 6 (OM-6), "Inservice Testing of Pumps in Light-Water Reactor Power Plants," and Part 10 (OM-10), "Inservice Testing of Valves in Light-Water Reactor Power Plants."

2.0 EVALUATION OF RELIEF REQUESTS

Because the IST program for Prairie Island Nuclear Generating Plant was developed using the 1989 Edition of the ASME Code, the relief requests have been reviewed against the requirements of OM-6 and OM-10. The third 10-year interval for the Prairie Island Nuclear Generating Plant began December 16, 1993, for Unit 1, and will begin December 21, 1994, for Unit 2. Relief requests submitted in Northern States Power Company's letter of December 22, 1993, are evaluated below. These relief requests were identified by the licensee upon reviewing the NRC's SE dated December 8, 1993, which was issued for the third 10-year interval program.

2.1 Relief Request 11

The licensee has requested relief for the diesel-driven cooling water pumps (12, 22) and the motor-driven cooling water pump (121) which remove heat from components that must function during accident conditions. Paragraph 4.6.2.2 of Part 6 (OM-6) specifies that, when determining differential pressure across a pump, a differential pressure gauge, a differential pressure transmitter that provides direct measurement of pressure difference, or the difference between the pressure at a point in the inlet pipe and the pressure at a point in the discharge pipe, may be used.

2.1.1 Licensee's Basis for Relief

The licensee states:

> The pumps have a submerged suction in the cooling water intake bay and inlet pressure indication is not available. The method is in accordance with a determination of differential pressure allowed by the Code. By including the calculation in implementing procedures, the test can determine the differential pressure in a manner that is consistent and repeatable from test to test. This method will yield the information needed for monitoring the hydraulic condition of the applicable pumps without the need to install suction (inlet) pressure gauges which is not practical.

2.1.2 Alternative Testing

The licensee proposes:

> Pump bay level will [be] used to calculate the suction (inlet) pressure and allow the determination of pump differential pressure. The calculation of bay level will be included in the surveillance procedure and supported by error analysis which shows the measurement of level and the calculational method yield an accuracy within ± 2%.

2.1.3 Evaluation

When inlet pressure gauges are not installed in the inlet of a vertical line shaft pump, it is impractical to directly measure inlet pressure for use in determining differential pressure for the pump. If the licensee uses a bay level to calculate the suction (inlet) pressure as described in Paragraph 4.6.2.2 of OM-6, the calculation must be included in the implementing procedure and the licensee must verify that the reading scale for measuring the level and the calculational method yield an accuracy within ± 2%. By including the calculation in implementing procedures, the licensee can determine the differential pressure in a manner that is consistent and repeatable from test to test. This method will yield the information needed for monitoring the hydraulic condition of the applicable pumps without the need to install suction (inlet) pressure gauges which would not be practical for the applicable pumps. Because the Code allows the alternative of using the difference between the pressure at a point in the inlet and the pressure at a point in the discharge pipe, the licensee may implement a calculational method without obtaining relief.

2.1.4 Conclusion

The alternative meets the guidance the NRC recommends for using bay level to meet the requirements of paragraph 4.6.2.2 of OM-6 (including the calculation in the implementing procedures and ensuring that the method meets the 2% accuracy requirements of the Code). Because the method is in accordance with the methods described in the Code, no further NRC approval is required. The implementation of the method is subject to NRC inspection.

2.2 Relief Request 12

The licensee has requested relief for the component cooling pumps (11, 12, 21, 22) which remove heat from components associated with removal of reactor core decay heat under accident conditions. Paragraph 5.2(b) of OM-6 requires that resistance of the system be varied until the flow rate equals the reference value prior to taking pressure readings.

2.2.1 Licensee's Basis for Relief

The licensee states:

> System design does not allow performance of hydraulic tests at specific reference points. Because of changing system loading conditions it is not practical to duplicate the exact reference point for each pump test. Some of the variable flows are the result of the cycling of flow control valves for system cooling demand. Examples of these variable loads are boric acid evaporator, spent fuel heat exchanger, letdown and excess letdown heat exchangers. Plotting pump curves for flow and differential pressure over the range of conditions expected during the systems' normal operation will allow evaluation of the pump in as-found system conditions. Implementing this process would allow conformation of proper pump performance during in-situ testing. The proposed alternatives will give indication of any pump degradation.

2.2.2 Alternative Testing

The licensee proposes:

> Pump flow, suction and discharge pressure are measured, then pump differential pressure plotted against flow to determine a "point" on the pump curve. This point is then compared to acceptance criteria based on Code allowable required action ranges for centrifugal pumps.
>
> The following elements are performed in preparing pump curves:
>
> (1) Pump curves are prepared or manufacturer's pump curves validated when the pumps are known to be operating acceptably.

(2) When measuring the reference points for plotting or validating the curve, instruments at least as accurate as the Code, OMa 1988 Part 6 Table 1, except as allowed by Request for Relief #2 [see NRC's Safety Evaluation dated December 8, 1993, for evaluation of Relief Request 2], will be used.

(3) Each curve will be constructed with a minimum of five points.

(4) The curve will be constructed using only those points beyond the "flat" portion (low flow rates) of the curves in a range which includes or is as close as practicable to design basis flow rates.

(5) Acceptance criteria for the pumps will be established such as to not conflict with the operability criteria for flow rate and differential pressure in the Technical Specifications or the USAR [Updated Safety Analysis Report].

(6) If vibration levels vary significantly over the range of pump conditions a method will be prepared to assign appropriate vibration acceptance criteria for regions of the pump curve.

(7) When the reference curve may have been affected by repair, replacement or routine service, a new reference curve will be plotted or the previous curve revalidated by conducting an inservice test.

2.2.3 Evaluation

When it is impractical to test pumps, such as the component cooling pumps, at a single reference point due to the normal service conditions of pumps with varying system demands, the staff has determined that the use of pump curves is an acceptable method for establishing a curve of "reference points" over a range of flow and differential pressure values. This method allows a licensee to test the pumps quarterly in the condition of pump operation that is required for continued plant operation. It would be an undue burden to remove an entire train of cooling water to facilitate pump testing at a single "reference point." While it may be practical to perform such testing by extending the frequency from quarterly to cold shutdown conditions, the more frequent testing using a reference curve gives more data points for monitoring for degrading conditions. Because the curves are established when the pumps are known to be operating in good condition, any degradation should be evident when comparing the test data to the curves.

2.2.4 Conclusion

Relief from the requirements of OM-6, Paragraph 5.2(b), is granted for the component cooling pumps (11, 12, 21, 22) pursuant to 10 CFR 50.55a(f)(6)(i) based on (1) the impracticality of performing testing at a single reference point each quarter, (2) the determination that testing using reference curves in the manner described in the relief request will provide an adequate method for monitoring the pumps for degradation and ensure operational readiness, and (3) in consideration of the burden on the licensee if the requirements were imposed.

2.3 Relief Request 13

The licensee has requested relief for the safety injection pumps (11, 12, 21, 22) which deliver cooling water to the reactor core in the event of a loss-of-coolant accident. Paragraph 4.6.5 of OM-6 specifies that, when measuring flow rate, use a rate or quantity meter installed in the pump test circuit.

2.3.1 Licensee's Basis for Relief

The licensee states:

> Installing flowmeters or flow orifices on bypass lines to meet code accuracies is not warranted due to the expense involved with no commensurate benefit. Estimated costs required to install 2% accuracy flowmeters is $25,000 per pump.
>
> (1) 11, 12 (21, 22) Safety Injection Pumps - Isolation of the minimum flow line during full flow testing removes all backup pump cooling should discharge flow be interrupted. Flow through this minimum flow line will be constant during full flow testing. Long-term increasing trends in the minimum flow line would conservatively be credited during full flow testing. Long-term decreasing trends are unlikely due to the non-corrosive property of the pipe and the lack of tendency for the boric acid to form deposits at the concentrations used. The position of mini-flow valves are independently verified to be in the correct position and are tagged and wired open for pump protection.
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> (2) Isolation of the minimum flow during full flow testing removes all backup pump cooling should discharge flow be interrupted.
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> The piping design and therefore system resistance of each bypass line will remain constant for each test. It can be shown that the pressure, flow and flow paths of the system during the pump testing, as controlled by the procedure, will assure negligible changes in the unmetered flow path. The pump metered flow and pressure readings taken during regular testing can be trended per code requirements and will give adequate indication should pump degradation occur. The installation of code accuracy metering instrumentation on these bypass lines would place an undue burden on the plant without a compensating increase in either quality or safety.

2.3.2 Alternate Testing

The licensee proposes:

> Each safety injection pump has a portion of its discharge flow which is unmetered. Specifically:

11, 12 Safety Injection Pumps - These pumps have a minimum flow line which is un-instrumented and remains open during pump operation to provide flow through the pump should other flow paths be interrupted. This flow will not be metered during the full flow test at refueling outages. This flow is constant and is factored into the pump acceptance curves. Normal unmetered flow is approximately 10% of reference flow.

21, 22 Safety Injection Pumps - Isolation of the minimum flow line during full flow testing removes all backup pump cooling should discharge flow be interrupted. These pumps have a minimum flow line which is un-instrumented and remains open during pump operation to provide flow through the pump should other flow paths be interrupted. This flow will not be metered during the full flow test at refueling outages. This flow is constant and is factored into the pump acceptance curves. Normal unmetered flow is approximately 10% of reference flow.

2.3.3 Evaluation

Position 9 in Attachment 1 of GL 89-04 states the NRC's position that flow rate measurement is important in monitoring the condition of pumps. For the safety injection pumps, the piping and instrumentation diagrams indicate that a manual valve is installed in the recirculation line that could be closed to block flow through the line. This would allow the entire flow to be measured in the discharge line. The design does not appear to be unique to Prairie Island, and therefore, no undue burden or special situation exists that warrants approval of the proposed alternative. The staff is not aware of similar relief requests submitted by other plants which indicate concerns that discharge flow interruptions would occur during pump testing. Controls could be established in the test procedure which would account for any situations that might require opening of the manual valve to reestablish recirculation flow. An unmetered flow of as much as 10% of the referenced flow could influence the test results in a nonconservative manner.

2.3.4 Conclusion

The proposed alternative is not authorized in accordance with 10 CFR 50.55a based on the reasons discussed above. If the licensee believes that additional justification is available that either describes a hardship unique to the plant or describes how the test and acceptance criteria can be performed in a manner that accounts for the potential nonconservative test conditions, a revised relief request could be submitted prior to further required tests. However, the staff suggests that the licensee establish test procedures that include controls to ensure that potential flow interruptions are eliminated or mitigated.

2.4 Relief Request 14

The licensee has requested relief for the auxiliary feedwater pumps (11, 12, 21, 22) which provide for removal of reactor core decay heat upon loss of normal feedwater. Paragraph 4.6.5 of OM-6 specifies that, when measuring flow rate, a rate or quantity meter installed in the pump test circuit is to be used.

2.4.1 Licensee's Basis for Relief

The licensee states:

Installing flowmeters or flow orifices on bypass lines to meet code accuracies is not warranted due to the expense involved with no commensurate benefit. Estimated costs required to install 2% accuracy flowmeters is $25,000 per pump. Isolation of the minimum flow line during full flow testing removes all backup pump cooling should discharge flow be interrupted. The unmetered flow is required for pump cooling and must be in service whenever the pump is in operation. Flow through this unmetered line will be constant during full flow testing. Long term increasing trends in the minimum flow line would conservatively be credited to pump degradation. Decreasing flow trends are unlikely since the condensate being pumped will not corrode or form deposits.

The piping design and therefore system resistance of each bypass line will remain constant for each test. It can be shown that the pressure, flow and flow paths of the system during the pump testing, as controlled by the procedure, will assure negligible changes in the unmetered flow path. The pump metered flow and pressure readings taken during regular testing can be trended per code requirements and will give adequate indication should pump degradation occur. The installation of code accuracy metering instrumentation on these bypass lines would place an undue burden on the plant without a compensating increase in either quality or safety.

2.4.2 Alternative Testing

The licensee proposes:

Each auxiliary feedwater pump has a portion of its discharge flow which is unmetered. Specifically, these pumps have an unmetered bypass line which feeds a lube oil cooler and cooling must be provided during pump operation. This flow will not be metered during the full flow test at refueling outages. This bypass flow will be held constant during the test and is approximately 10-15% of reference flow.

2.4.3 Evaluation

The piping and instrument diagrams indicate that the bypass lines cannot be isolated. Therefore, the design limits performance of the test in a manner that ensures measurement of the full pump flow with installed instrumentation. The recirculation cooling flow is as high as 10% to 15% of the reference flow rate. An example of a potential problem is that if the pump flow rate reference values are established when the recirculation flow is at 15%, a 5% degradation could occur in the recirculation line with no change in the measured flow rate. Therefore, the acceptance criteria must account for a potential decrease of at least 5% which will not be indicated on the measured flow rate. One option would be that the measured value could be assumed to be 5% less than the value indicated by the instrumentation.

A different approach would be to address any potential changes in the recirculation flow due to changes in the resistance of the lines. This may require periodic inspection of the coolers and cooling lines to ensure that there is no buildup. The period of the inspection could be established accounting for the non-corrosive property of the pipe, as discussed in the basis for relief. A third option might be to install flow instruments in the recirculation lines, while a fourth option might be to use temporary (ultrasonic) flow instrumentation in the suction lines or in the minimum flow lines to determine the total flow, if practical.

Long-term relief cannot be authorized based on the lack of information in the relief request explaining how the testing will account for potential masking of degrading flow rates. However, interim relief can be granted based on the impracticality of the design and the burden that could result if the Code requirements were immediately imposed, such as a plant shutdown because testing in accordance with the Code could not be performed. The current test method will identify significant degrading trends for an interim period, providing an adequate level of assurance of the operational readiness of the pumps.

2.4.4 Conclusion

Interim relief for 1 year is granted pursuant to 10 CFR 50.55a(f)(6)(i) based on the impracticality of the design of the auxiliary feedwater pumps and the pump recirculation cooling systems, consideration of the burden if Code requirements were imposed, and the alternative providing assurance of the operational readiness of the pumps for the interim period. In the interim period, the licensee should evaluate the performance of the test to account for potential masking of degradation or determine an alternative, such as inspection of piping, adding flow instruments, or using temporary instruments, that ensures the IST is adequate for long-term relief. The licensee should respond within 1 year to inform the staff of the actions taken and include a revised relief request, if necessary.

2.5 Relief Request 15

The licensee has requested relief for the diesel-driven cooling water pumps (12, 22) which remove heat from components that must function during accident conditions. Paragraph 4.6.5 of OM-6 specifies that, when measuring flow rate, a rate or quantity meter installed in the pump test circuit is to be used.

2.5.1 Licensee's Basis for Relief

The licensee states:

> Installing flowmeters or flow orifices on bypass lines to meet code accuracies is not warranted due to the expense involved with no commensurate benefit. Estimated costs required to install 2% accuracy flowmeters is $25,000 per pump. Isolation of flow to the diesel gear cooler and jacket cooler is not possible since this cooling is required during pump operation. The control valve that supplies the jacket cooler opens to the same position during each diesel test so there is assurance that resistance will not change. The remaining screenhouse unmetered

flows affect both pumps in the same manner. The chemical treatment and filtered water flows are small and are continually in service.

The piping design and therefore system resistance of each bypass line will remain constant for each test. It can be shown that the pressure, flow and flow paths of the system during the pump testing, as controlled by the procedure, will assure negligible changes in the unmetered flow path. The pump metered flow and pressure readings taken during regular testing can be trended per code requirements and will give adequate indication should pump degradation occur. The installation of code accuracy metering instrumentation on these bypass lines would place an undue burden on the plant without a compensating increase in either quality or safety.

2.5.2 Alternative Testing

The licensee proposes:

Each cooling water pump has a portion of its discharge flow which is unmetered. Specifically:

(1) The diesel driven pumps have an unmetered bypass line which feeds a jacket cooler and a gear oil cooler which must be available for engine cooling. This bypass flow will be held constant during the test and is estimated to be 1% of reference flow.

(2) Additional small unmetered loads exist in the screenhouse, e.g., supply to chemical treatment and filtered water and affect the diesel cooling water pumps. Flow to the chemical treatment is estimated at 1% and flow to filtered water at 1/2% of reference flow [total 1.5%]. These flows are normally inservice and are held constant during the tests.

2.5.3 Evaluation

These pumps are similar to the auxiliary feedwater pumps discussed in Section 2.4 above in that the recirculation cooling cannot be isolated; however, the cooling flow is a smaller percentage of the reference flow, and has less potential to mask degrading flow rates. The design limits performance of the test with the recirculation flow isolated. Imposition of the Code requirements to measure [total] flow would be a burden in that instrumentation would have to be installed or some other alternative would be necessary to preclude a plant shutdown because testing could not be performed in accordance with the Code. Therefore, long-term relief can be granted with the provision that the licensee determine if the acceptance criteria or measured values of flow rate require any adjustment to ensure that the test conservatively identifies degrading conditions.

2.5.4 Conclusion

Relief is granted to continue to use installed flow instrumentation and not measure the recirculation cooling flow pursuant to 10 CFR 50.55a(f)(6)(i) based on the impracticality of the design of the pumps and the pump cooling systems, consideration of the burden if Code requirements were imposed, and the alternative providing assurance of the operational readiness of the pumps. The granting of the relief is provisional on the licensee ensuring that the manner of testing is conservative. The licensee should include a description of the actions taken to address the provision and revise the relief request, if necessary, within 1 year.

2.6 Relief Request 16

The licensee has requested relief for the motor-driven cooling water pump (121) which removes heat from components that must function during accident conditions. Paragraph 4.6.5 of OM-6 specifies that, when measuring flow rate, a rate or quantity meter installed in the pump test circuit is to be used.

2.6.1 Licensee's Basis for Relief

The licensee states:

> Installing flowmeters or flow orifices on bypass lines to meet code accuracies is not warranted due to the expense involved with no commensurate benefit. Estimated costs required to install 2% accuracy flowmeters is $25,000 per pump. The unmetered screenhouse flows are small and are continually in service.
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> The piping design and therefore system resistance of each bypass line will remain constant for each test. It can be shown that the pressure, flow and flow paths of the system during the pump testing, as controlled by the procedure, will assure negligible changes in the unmetered flow path. The pump metered flow and pressure readings taken during regular testing can be trended per code requirements and will give adequate indication should pump degradation occur. The installation of code accuracy metering instrumentation on these bypass lines would place an undue burden on the plant without a compensating increase in either quality or safety.

2.6.2 Alternative Testing

The licensee proposes:

> 121 cooling water pump has a portion of its discharge flow which is unmetered. Specifically, small unmetered loads exist in the screenhouse, e.g., supply to chemical treatment and filtered water and affect the diesel cooling water pumps. Flow to the chemical treatment is estimated at 1% and flow to filtered water at 1/2 % of reference flow [total 1.5%]. These flows are normally inservice and are held constant during the tests.

2.6.3 Evaluation

These pumps are similar to the auxiliary feedwater pumps discussed in Section 2.4 above in that the recirculation cooling cannot be isolated; however, the cooling flow is a smaller percentage of the reference flow and has less potential to mask degrading flow rates as for the diesel cooling pumps discussed in Section 2.5

above. The design limits performance of the test with the recirculation flow isolated. Imposition of the Code requirements to measure [total] flow would be a burden in that instrumentation would have to be installed or some other alternative would be necessary to preclude a plant shutdown because testing could not be performed in accordance with the Code. Therefore, long-term relief can be granted with the provision that the licensee determine if the acceptance criteria or measured values of flow rate require any adjustment to ensure that the test conservatively identifies degrading conditions.

2.6.4 Conclusion

Relief is granted to continue to use installed flow instrumentation and not measure the recirculation cooling flow pursuant to 10 CFR 50.55a(f)(6)(i) based on the impracticality of the design of the pumps and the pump cooling systems, consideration of the burden if Code requirements were imposed, and the alternative providing assurance of the operational readiness of the pumps. The granting of the relief is provisional on the licensee ensuring that the manner of testing is conservative. The licensee should include a description of the actions taken to address the provision and revise the relief request, if necessary, within 1 year.

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