UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report of Operations Inspection

IE Inspection Report No. 050-263/77-03

Licensee: Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Monticello Nuclear Generating Plant
Monticello, MN

License No. DPR-22
Category: C

Type of Licensee: BWR CE 1670 MWt

Type of Inspection: Special

Dates of Inspection: February 25 and March 17 and 18, 1977

Principal Inspector: J. S. Creswell — 5/20/1977 date signed

Accompanying Inspector: G. A. Phillip — 5-20-77 date signed

Other Accompanying Personnel: W. S. Little

Reviewed By: W. S. Little, Chief
Nuclear Support Section — 5/20/77 date signed

SUMMARY OF FINDINGS

Inspection Summary

Inspections were conducted on February 25 and March 17 and 18, 1977, (77-03): regarding the reactor scram associated with a short period which occurred February 23, 1977, at the Monticello Nuclear Station. The inspections were held in the corporate offices of Northern States Power Company located at Minneapolis, Minnesota, and at the Monticello Nuclear Plant. A management conference was held April 12 at the corporate offices. Two items of noncompliance were identified associated with the failure to follow technical specification procedure requirements.

Enforcement Items

Infractions

A. Technical Specification 6.5.A.1 requires that normal startup, operation, and shutdown of the reactor be conducted in accordance with detailed written procedures.

1. Procedure C.1, Startup, in Part B, Step 3, and referenced Part A, Section 2, Step 4.c, requires that the licensee "observe the period meter and govern control rod withdrawal to avoid a reactor period shorter than 30 seconds."

   Contrary to the above, on February 23, 1977, during a reactor startup, control rods were withdrawn on two separate occasions when there were indications that withdrawing the rods would produce periods less than 30 seconds. Both actions resulted in periods less than 30 seconds. Preceeding these rod withdrawals was a rod withdrawal which resulted in an indicated period of 10 seconds. The subsequent rod withdrawals were either made with the same rod over the same notch positions, or on a symmetric control rod where response should have been similar. (Paragraph 2, Report Details)

2. Procedure C.1 states in Part D, Section 1 that certain requirements must be observed prior to startup after a scram. One of these requirements is found in Section 3.a and states, "The cause of the scram must be determined and the condition which caused the scram must be corrected."

Contrary to the above, following a scram which occurred at approximately 5:00 p.m. a startup was initiated in that control rod withdrawal began at approximately 7:15 p.m. on February 23, 1977, without the condition which caused the scram being corrected. (Paragraphs 2 and 3.f, Report Details)

B. Technical Specification 6.5.A.3 states, "Detailed written procedures, including the applicable check-off and instructions shall be prepared and followed covering . . . actions to be taken to correct abnormal reactivity changes including follow-up actions required after protective system actions have been initiated."

Contrary to the above, a detailed written procedure covering actions to be taken to correct abnormal reactivity changes had not been prepared. (Paragraph 3.j., Report Details)

Licensee Action on Previously Identified Enforcement Items

None inspected.

Other Significant Findings

A. Systems and Components

None.

B. Facility Items (Plans and Procedures)

None.

C. Managerial Items

None.

D. Deviations

None identified.

E. Status of Previously Reported Unresolved Items

None.

Management Interviews and Conference

Two exit interviews and a corporate management conference were held with licensee representatives to discuss the results of the inspection.

A. February 25, 1977 Exit Interview (Corporate Office, Minneapolis, Minnesota)

1. Attendees

Northern States Power Company

G. Nelis, General Superintendent of Nuclear Power Plants
D. Nevinski, Nuclear Engineer
R. Anderson, Superintendent of Core Analysis
M. Voth, Nuclear Safety and Technical Services Engineer

Nuclear Regulatory Commission

J. Creswell, Reactor Inspector

2. Topics Discussed

a. The inspector noted that before the short period scram had occurred, that a symmetric rod had been pulled and that a period in the range of 7-10 seconds was observed. He asked the licensee why he had not stopped further rod withdrawals until the cause of the short period had been determined. The licensee stated that they wanted to determine if the effect was a local phenomenon.

b. The inspector asked the licensee what criteria had been developed after the short period (approximately 1 second) incident to prevent recurrence of short periods. The licensee stated that all necessary plant personnel had been advised of the problem and that the reactor coolant temperature was lowered approximately 100°F so that criticality would be achieved earlier in the rod withdrawal sequence. The inspector asked if they had

analyzed rod worths based on the lower temperature condition such that they know they did not have high worth notches. The licensee related that the lower temperature condition had not been analyzed, but that based on their judgement it was safe to restart. (Paragraphs 2 and 4, Report Details)

B. March 18, 1977 Exit Interview (Monticello Nuclear Plant)

1. Attendees

Northern States Power Company

G. Neils, General Superintendent of Nuclear Power Plants
L. Eliason, Monticello Plant Manager
M. Clarity, Superintendent Plant Engineering and Radiation Protection
D. Nevinski, Nuclear Engineer

Nuclear Regulatory Commission

W. Little, Chief, Nuclear Support Section
J. Creswell, Reactor Inspector
G. Phillip, Special Investigator

2. Topics Discussed

The inspector reviewed the results of the inspection with the licensee. Areas discussed were operator and management actions associated with the short period trip incident.

The first area of concern was explained to be licensee judgement in continuing rod withdrawals when the operators were experiencing unexpected reactor behavior including a period of approximately 10 seconds. It was noted that the actions taken were contrary to the applicable operating procedure which requires that periods less than 30 seconds be avoided. The licensee was told that not following the procedure constituted an item of noncompliance. (Paragraphs 2 and 3, Report Details)

The second area of concern discussed related to not taking corrective actions prior to restart after the scram. (Paragraphs 2 and 3, Report Details)

C. April 12, 1977 Management Conference

1. Attendees

Northern States Power Company

L. Wachter, Vice President, Power Production and System Operation
D. Gilberts, General Manager of Power Production
G. Neils, General Superintendent of Nuclear Power Plants
L. Eliason, Monticello Plant Manager
M. Clarity, Superintendent Plant Engineering and Radiation Protection
D. Nevinski, Nuclear Engineer

Nuclear Regulatory Commission

J. Keppler, Region III Director
G. Fiorelli, Chief, Reactor Operations and Nuclear Support Branch
W. Little, Chief, Nuclear Support Section
R. Warnick, Chief, Reactor Projects Section 2
J. Creswell, Reactor Inspector

2. Topics Discussed

On April 12, 1977, members of the Region III staff met with Northern States Power (NSP) personnel at the NSP corporate office. The purpose of the meeting was to discuss the short period trip abnormal occurrence which took place on February 25, 1977, at the Monticello Nuclear Plant.

The inspectors related the facts associated with the event as they understood them and asked for licensee comments in those areas in which they disagreed.

Discussion of the event focused on the causes which involved:

a. Staff communications and understanding of the reactor condition.

b. Management rationale leading to the attempted reactor startup and decision for reactor startup following the scram.

A sequence of events was presented by the inspectors and each item of the sequence and apparent item of noncompliance were discussed in detail. After the presentation the licensee stated that after the fact some of the judgements made by the operators and other plant personnel were not prudent.

Some of the corrective actions discussed by NSP were:

a. More detailed analysis of rod worths will be performed before rod sequences are implemented in order to provide operating personnel with information about high worth notches.

b. Operating procedures will be revised to more thoroughly define operator actions to be taken in the event of abnormal reactivity additions which result in short periods.

REPORT DETAILS

1. Persons Contacted

L. Wachter, Vice President, Power Production and System Operation
D. Gilberts, General Manager of Power Production
G. Neils, General Superintendent of Nuclear Power Plants
L. Eliason, Monticello Plant Manager
M. Clarity, Superintendent Plant Engineering and Radiation Protection
D. Nevinski, Nuclear Engineer
R. Anderson, Superintendent of Core Analysis
M. Voth, Nuclear Safety and Technical Services Engineer
L. Seversen, Shift Supervisor
W. Boehme, Lead Plant Equipment and Reactor Operator
R. Rohland, Plant Equipment and Reactor Operator
D. Wagner, Nuclear Engineer

2. Event Sequence

On February 23, 1977, the Monticello Nuclear Plant attempted a reactor startup following a scram from an electrical malfunction. During the subsequent startup attempts, three short reactor periods (approximately 10 seconds and less) occurred during control rod withdrawals. The last short period resulted in a high flux reactor scram.

The inspectors questioned plant and corporate office personnel concerning those events which led up to the fast periods, the reactor scram, and subsequent evaluation which took place prior to the reactor restart. Logbooks, recorder charts, the scram report and the Operation Committee Minutes were also reviewed. From this information the inspectors put together the following sequence of events:

Sequence of Events

February 23, 1977,

7:00 a.m.	Reactor scram (electrical problem).
8:00 a.m.	Nuclear Engineer communicated with corporate office physicist regarding nuclear core conditions.
12:00 p.m.	Critical rod predictions provided by Nuclear Engineer.

12:45 p.m.	Preparations for restart completed.
1:30 p.m.	Commenced control rod withdrawal.
3:17 p.m.	Reached predicted core reactivity of 0.99 k; however, no measurable multiplication observed at this time. At this point, procedure C.1 is reviewed and it states that control rod withdrawal "should" be changed from continuous to notch.
4:00 p.m.	Shift Supervisor authorized return to continuous control rod withdrawal because of no observable multiplication.
4:35 p.m.	Reached predicted critical configuration. Still no discernable multiplication. Based on discussions with corporate core physicist regarding new calculations on negative reactivity override, nuclear engineer predicted new critical rod positions. The nuclear engineer di' not believe the new prediction.
5:01 p.m.	Step 15 was in progress. Control Rod 06-27 was withdrawn from positon 0 (to be withdrawn continuously to position 10). A 10 second period was observed as the rod traveled between position 6 to 8. At this point, operator reinserted the rod to position 4 to terminate period. At this point in time, an SRO, RO, and nuclear engineer were at the control board. Operating procedures did not cover abnormal reactivity change conditions. SRO made decision to withdraw rod 06-27 notchwise.
5:03 p.m.	Withdrew Rod 06-27 from position 4 to position 6. No response observed.
5:04 p.m.	Withdrew Rod 06-27 from position 6 to position 8 with resultant 10 second period. This constitutes non-compliance with Technical Specification 6.5.A.1 and referenced Procedure C.1 which requires steps to be taken to avoid periods of less than 30 seconds. Rod was inserted to position 6 to terminate period.

Based on discussions between RC, SRO, and nuclear engineer, a decision was reached to pull a symmetric control rod to determine if the observed short periods were a localized effect.

5:06 p.m. Commenced notch withdrawal of control rod 46-27.

5:12 p.m. In withdrawing rod 46-27 from position 4 to 6, an approximate 600 second period was achieved. (600 second value obtained from subsequent analysis of the SRM chart)

5:15 p.m. Rod 46-27 was withdrawn from position 6 to 8. A fast period (∿ 1 sec) was experienced and the reactor scrammed on high flux on the IRM's. (Repeat of the item of noncompliance.)

5:15 p.m. - 7:00 p.m. Plant management and corporate office informed of events. The corporate physicist informed the plant that the two control rods involved had been recognized as being maximum worth rods and that new calculations would be initiated to determine the maximum worth of control rods as it relates to the rod drop accident. No hold was put on startup by management pending completion of these calculations. An entry was made in the Safety Review Followup Record, "No corrective action necessary prior to restart."

7:00 p.m. All prestartup checklists had been completed. It should be noted that procedures require the cause of the scram to be determined and the condition which caused the scram to be corrected.

7:02 p.m. Permission given for restart although new calculations of control rod worths had not been provided to plant.

7:15 p.m. Commenced pulling control rods.

9:30 p.m. Entry in Operator's Daily Log describing the plants position relative to the cause of the scram and the correction of the condition which caused the scram. (Identified as a late entry in the log.)

10:50 p.m. Achieved criticality.

3. Event Discussion

The following information was gathered by the inspectors and is considered pertinent:

a. A trainee was at the reactor console during the approach to critical. He was under the direction of the licensed reactor operator, and the inspectors could find no evidence that his presence had any noticable effect on the incident.

b. During the time immediately prior to the first fast period and up to the reactor scram, the Lead Plant Equipment and Reactor Operator (senior operators license) and a Nuclear Engineer (unlicensed) were cognizant of the reactor behavior and the licensed reactor operator's actions. The Shift Supervisor and the Superintendent, Plant Engineering and Radiation Protection were in the control room but were not aware of the reactor behavior and operator actions until the reactor scram.

c. Prior to 4:35 p.m. the Nuclear Engineer received a call from the corporate office notifying him that their calculations revealed that a negative reactivity of greater than 0.075 Δk due to the effects of Xenon, moderator temperature, burnup, etc., would have to be overcome in going critical. The curves used by the nuclear engineer to estimate the critical rod configuration had not been calculated for this great a value and he had to extrapolate the curve to obtain a critical rod prediction. Because of this the nuclear engineer questioned the accuracy of the prediction.

d. Those cognizant of the two fast periods immediately prior to the scram were surprised, but at that time no one thought that the proper action was to stop and evaluate the situation until after the scram occurred.

e. After the reactor trip at 5:15 p.m. some of the plant staff questioned whether the Technical Specification 3.3(a) LCO had been exceeded. This states that "the maximum calculated reactivity that could be added by dropout of any increment of any one control blade will not make the core more than 1.3% Δk supercritical." Calculations were initiated (Section 3, Report Details), but they were not completed until the next day, several hours after the reactor had been restarted.

f. A startup was initiated in that control rod withdrawal began at approximately 7:15 p.m. on February 23, 1977, without the condition which caused the scram being corrected. The high notch worths which were experienced before and during the scram at approximately 5:00 p.m. on the same day, were mainly attributable to a high moderator temperature and more significantly, to a high Xenon poisoning condition. Calculations to determine Xenon decay times were not completed until approximately 9:30 p.m. at which time control rod withdrawals had progressed to the point that 45 rods had been fully withdrawn and 16 more rods had been withdrawn to position 20. The failure to take corrective action prior to initiating control rod withdrawal constitutes noncompliance with Technical Specification 6.5.A.1 and Procedure C.1.

g. An evaluation was performed, as documented in the Operator's Daily Log at 9:30 p.m., which confirmed that rod coupling had been verified and that a control rod had not dropped. While the report discussed xenon decay and temperature drops, no specific corrective action was set forth to prevent recurrence.

h. The licensee contacted GE-San Jose at an unspecified time the evening of February 23, 1977. The events were described to GE. According to licensee representatives, GE expressed no alarm over the safety consequences of the events.

i. The inspector reviewed the Operations Committee Meeting Minutes dated March 1, 1977 during which the incident was reviewed. The licensee's final report on the incident, including long term corrective action, had not been completed and, therefore, had not yet been reviewed by the Safety Audit Committee.

j. The licensee did not have any written, approved procedure to define actions to be taken to correct abnormal reactivity changes, such as those which occurred on February 23, or to describe follow-up actions required for such an event. This is contrary to Technical Specifications 6.5.A.3.

4. Licensee Analysis and Review

Concurrent with the onsite review of the incident, personnel in the corporate offices were informed of the circumstances associated with the trips and they commenced computer analysis of rod worths for rods 06-27 and 46-27. The licensee utilizes the Nodal

Code 3D-B4 for this type of analysis. The Nodal Code is supplied constants from PDQ-7 Harmony which in turn is supplied four group cross sections from Leopard and Laser. The calculation was performed at an exposure of 6789 MWD/MT and assumed that the core had run at 100% power for 50 hours preceding the 7:00 a.m. trip. The code models nodal xenon decay and for the rod worth determination calculated xenon concentrations at 10.2 hours after the 7:00 a.m. trip. Since it was known that very near critical conditions (approximately 600 second period) existed at position 6 of rod 46-27, the eigenvalue was normalized to a corrected Keff of 1.0. In performing the calculation, the licensee used cross section data generated for 68°F reactor coolant temperatures. Since the actual reactor coolant temperature was 480°F, a correction for the increased temperature was applied using data accumulated at the plant during a startup. This data correlated the multiplication coefficient of the reactor versus reactor coolant temperature. A delta K (Model) of 0.0039 was also applied to the code calculated eigenvalue to account for analytical-experimental disagreement.

The results of the calculation for rod 46-27 are shown in Table 1. As can be seen by the data for rod 46-27, a rod drop from position 00 to position 12 would result in a reactivity addition of:

Integral worth at position 12	.0157 delta K
Integral worth at critical (Position 6)	.0062 delta K
Supercritical Worth	.0095 delta K

This value is below the Technical Specifications limit of 1.3% delta K supercritical. Results of the analysis were supplied to the plant personnel after the restart at 11:30 p.m.

As a result of safety review follow-up, the licensee stated that they would review and revise as necessary the rod sequence, procedures for establishing criticality, and procedures for providing operators with information relating to the potential for high worth rods. The licensee concluded that there was no evidence of fuel damage since there was no increase in off-gas activity.

5. Predicted Critical Position

Prior to criticality at 5:15 p.m. on February 23, station nuclear engineers calculated the following:

Estimated critical position - step 9, rod 46-35, position 22.

Estimated critical position - 1% delta K - step 6, rod 14-39.

Estimated critical position + 1% delta K - step 20, rod 30-27.

As was noted earlier criticality was achieved first on rod 06-27 on position 8 in step 15.

TABLE 1

Monticello Cycle 5
6789 MWD/STu 10.25 hrs after Shutdown
Group 8 Step 15 Rod Pattern except 06-27 at 06
Notching out Rod 46-27

3D Case	Rod 46-27 Notches	λ	*ΔK	Corrected K	Differential Worth (ΔK)	Integral Worth (ΔK)	Relative Integral Worth
75	100	1.0332	-.0394	.9938	.0011	0	0
74	102	1.0343	-.0394	.9949	.0022	.0011	.052
73	04	1.0365	-.0394	.9971	.0029	.0033	.156
72	06	1.0394	-.0394	1.0000	.0047	.0062	.294
71	08	1.0441	-.0394	1.0047	.0018	.0109	.517
70	10	1.0459	-.0394	1.0065	.0030	.0127	.602
69	12	1.0489	-.0394	1.0095	.0025	.0157	.744
68	16	1.0514	-.0394	1.0120	.0022	.0182	.863
67	24	1.0536	-.0394	1.0142	.0007	.0204	.967
66	32	1.0543	-.0394	1.0149	0	.0211	1.000
65	48	1.0541	-.0394	1.0147		.0211	1.000

*ΔK = ΔK(68°F to 480°F) + ΔK (Model)

ΔK(68°F to 480°F) + -.0433

ΔK(Model) = .0039

ΔK = -.0433 + .0039 = -.0394

Total Rod Worth = 2.11%

0 - 10 notches = 1.27%

0 - 12 notches = 1.57%