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Licensee: Northern States Power Company

Facility: Prairie Island Nuclear Generating Plant

Location: 1717 Wakonade Drive East
Welch, MN 55089

Dates: March 11 through 17, 1997

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EXECUTIVE SUMMARY

Prairie Island Nuclear Generating Plant, Unit 2
NRC Special Inspection Report 50-306/97006

This special inspection focused the Unit 2 events of March 6-7, 1997, involving the mispositioning of a pressurizer vent valve during execution of Procedure 2D8, "Filling and Venting the Reactor Coolant System," and the excessive drain of reactor coolant that occurred while attempting to establish a specified pressurizer level.

While hanging equipment control tags in accordance with an isolation for Work Order 9701175, an auxiliary operator left valve 2RC-8-16 in the closed position rather than placing it in the required open position. This resulted in isolating the vent path for the reactor coolant system. When control room operators subsequently reduced pressurizer level by draining to the reactor coolant drain tank, air was unable to enter the pressurizer and replace the drained water. This resulted in a drain down from the pressurizer, reactor pressure vessel and U-tubes of both steam generators. Water draining from the reactor pressure vessel and steam generator U-tubes was not monitored by control room operators. This resulted in an excessive drain of water from the reactor coolant system. Control room operators subsequently performed procedure 2D8 again to remove the gas that had accumulated in the high points of the reactor coolant system.

Two violations, including one with two examples, were identified during the inspection for failure to follow procedures and for using an inadequate procedure. Additional performance weaknesses were identified, involving evaluation of a change in the specified vent path and control of plant configuration, the pre-evolution briefing, interpretation and evaluation of available data by control room operators to determine that an excessive amount of coolant had been drained from the reactor coolant system, and logkeeping practices.

Report Details

I. Operations

O1 Conduct of Operations

O1.1 Overdraining the Unit 2 Reactor Coolant System

a. Inspection Scope (71707, 92901, 93702)

A special inspection was performed to review the circumstances of the Unit 2 reactor coolant system (RCS) drain evolution without an RCS vent path, on the night of March 6-7, 1997. The inspectors conducted interviews with personnel, reviewed operator logs, and plant computer data. Additionally, the following documents were reviewed as applicable.

- 2D8 Filling and Venting the Reactor Coolant System, Revision 7
- 2C12.2 Purification and Chemical Addition-Unit 2, Revision 1
- SP 2001 Unit 2 Daily Log, Revision 47
- SP 2071.4 Integrated Leakage Rate Test Prerequisites to the Containment Vessel Integrated Leakage Rate Test, Revision 6 (ILRT)
- SP 2071.5 Integrated Leakage Rate Test Final Preparations and Test Procedure, Revision 12 (ILRT)
- SP 2083 Unit 2 Integrated SI Test with a Simulated Loss of Offsite Power, Revision 21
- SP 2248 Cycling RCS Gas Vent System Solenoid Valves-Unit 2, Revision 7
- WO 9701175 Repair SV-37096
- 5AWI 3.10.0 Control and Operation of Plant Equipment, Revision 5
- X-HIAW-1001-3 Flow Diagram - Unit 2 Reactor Coolant System, Revision AF

b. Observations and Findings

During the week of March 2, 1997, the licensee was performing some of the final major work activities of the Unit 2 refueling outage schedule. The principal controlling procedure for operations during this time was 2D8. This procedure accomplished an initial filling and venting of the RCS and established part of the necessary plant configuration to perform the ILRT and integrated SI test. This included draining the RCS to 50 percent pressurizer level.

The inspectors constructed a chronological sequence of events that occurred prior to, during, and following the draining evolution:

On February 28, 1997, WO 9701175 was initiated to repair SV-37096, the RCS vent system to containment atmosphere solenoid valve, because it had failed a surveillance test.

On March 2, 1997, operators performed Step 5.2.55.H of procedure 2D8 which vented the reactor vessel head and pressurizer to the containment atmosphere using the RCS head vent system in preparation for the ILRT.

On March 3, a problem was identified with the way the RCS and containment penetrations were administratively controlled. To address this, a different RCS vent path was chosen, one that required closing the RCS head vent solenoid valves that were opened in 2D8. The licensee wrote a procedure deviation to establish a different RCS vent path, and it was reviewed and accepted by the plant operations committee. The "procedure deviation" and "temporary restoration" processes were used to accomplish this on March 4. The new vent path vented the RCS through SV-37096 to the containment atmosphere from the pressurizer only and not the reactor pressure vessel (RPV) head.

The ILRT data collection phase was completed on March 5, 1997, and recovery from the test continued through March 6. The next planned major evolution was the integrated SI test and it was scheduled for March 7. After completing the ILRT recovery on March 6, the licensee decided that it was acceptable to drain the RCS to 50 percent pressurizer level for the integrated SI test using only the pressurizer vent and not an RPV vent. This was consistent with what was described in the above paragraph.

On the night shift of March 6-7, approval was granted to start work on WO 9701175 to replace SV-37096. This was a change from what was planned during the day shift. Night shift operations personnel determined that another RCS vent path was available without using SV-37096 that would allow the RCS to be drained in preparation for the integrated SI test while providing an isolation boundary for maintenance personnel to work on SV-37096. Again, the vent path chosen provided a vent for the pressurizer but not the RPV head.

While hanging equipment control tags for the isolation, an auxiliary plant equipment operator (APEO) incorrectly left valve 2RC-8-16 shut. This defeated the RCS vent path.

At midnight on March 7, 1997, control room operators drained water from the RCS for three hours to lower pressurizer level in accordance with 2D8 Step 5.2.57.B. They noted that the time required to perform the drain seemed to be excessive and observed that the RCS pressure was decreasing from its initial value of approximately 17 psig (indicating a vacuum existed in the RCS). However, they thought the small vent path size was the cause for the slow pressurizer level decrease. After three hours of draining, they stopped draining to review their progress, convinced themselves that plant response was appropriate, and continued the drain one additional hour until pressurizer level was 49 percent.

On day shift on March 7, the oncoming crew noted that RCS pressure had not recovered to the pre-evolution value and that the Reactor Vessel Level Instrumentation System (RVLIS) reading was only 92 percent. The licensee concluded that a gas bubble must have accumulated in the RPV head because it was not vented during the drain.

On the night shift of March 7-8, the operations crew planned to vent the RPV head to the containment atmosphere to remove the gas bubble. During discussions about the RCS vent path, the APEO who completed the isolation for WO 9701175 the night before, informed control room operators that he had ensured that 2RC-8-16 was shut when he performed his isolations. Operations shift management then recognized that a valve tagging error had occurred the night before that resulted in isolation of the RCS vent path.

The APEO was directed to open 2RC-8-16. When it was opened, pressurizer level began to slowly decrease. Pressurizer level was allowed to decrease from 50 percent to 30 percent, at which time the APEO was directed to shut 2RC-8-16. Control room operators started a charging pump and added about 2650 gallons of water into the RCS to increase pressurizer level back to 50 percent. The APEO was directed to again open 2RC-8-16. This time there was no change in pressurizer level. Operations shift management then decided to vent the RPV head to the containment atmosphere by opening manual RPV vent valves. When the APEO opened these valves, RVLIS level increased as expected but pressurizer level was unexpectedly slowly increasing also. When RVLIS level indicated the RPV was full, the APEO was directed to close the RPV vent valve.

Meanwhile, pressurizer level continued to rise. Control room operators evaluated possible sources of water inventory that may have been contributing to the increase in pressurizer level, and after excluding other possibilities, concluded that the source of water into the pressurizer was the steam generator U-tubes. When pressurizer level had increased to 90 percent, control room operators isolated the pressurizer vent path using the power operated relief valves (PORVs) and the pressurizer level increase stopped.

Procedure 2D8 was performed again on March 8-9 to replace the excess water inventory that had been drained from the RCS and remove the gas that accumulated. Additional guidance for draining the RCS was included in the procedure when it was performed the second time to account for the inventory removed from the system. The additional guidance included monitoring chemical and volume control system (CVCS) holdup tank level and RVLIS level. The drain of the RCS to 50 percent pressurizer level was successfully performed on March 9 and the integrated SI test was performed on March 10, 1997.

After the event occurred, the licensee and the inspectors reviewed available logs and plant computer historical data to determine the quantity of inventory that had been drained from the RCS. The most conservative value was obtained from the CVCS holdup tank level data. The level in this tank increased approximately 7300 gallons. The amount expected to be drained from an initial condition of

100 percent pressurizer level to 50 percent level was approximately 3700 gallons. Therefore, approximately 3600 gallons of water was drained from the RCS in excess of what was intended. This additional inventory was drained from other high points of the RCS including the RPV head and steam generator U-tubes because the system was not vented.

c. Conclusions

Unit 2 decay heat removal capability was neither interrupted nor threatened as a result of the RCS overdraining that occurred during this evolution. However, the inspectors considered the event significant. Specific concerns are identified in the following sections.

03 Operations Procedures and Documentation

a. Inspection Scope (71707, 92901, 93702)

The inspectors reviewed procedures identified above and operations logs during the course of the inspection.

b. Observations and Findings

Instructions to the operators in procedure 2D8 regarding draining the pressurizer were contained in Step 5.2.57. The step did not contain guidance regarding amount of inventory to be drained, rate of drain, or plant parameters to monitor before or during the drain. Additionally, this information was not discussed during the pre-evolution briefing.

The Unit 2 reactor log indicated that the RCS drain began on March 7, 1997, at 0000 and was terminated at 0507. During interviews, the inspectors learned that control room operators actually drained the RCS for approximately 3 hours, stopped for about 1 hour to observe plant response, and then continued for another hour until pressurizer level was 49 percent. The interruption of the drain was not recorded in the Unit 2 reactor log.

The Unit 2 reactor log indicated that the pressurizer PORVs were closed on March 8, 1997, at 0132. No other log entries were made regarding the PORVs. However, during interviews, the inspectors learned that control room operators opened the PORVs about an hour later to determine if pressurizer level would increase further. Level did continue to increase to about 92 percent, until the operators closed the PORVs. The second cycling of the PORVs was not recorded in the Unit 2 reactor log.

c. Conclusions

The inspectors considered procedure 2D8 inadequate in that it did not provide control room operators with sufficient guidance regarding inventory to be drained, drain rate, or plant parameters to monitor during the drain. Title 10 of the Code of

Federal Regulations, Part 50, Appendix B, Criterion V, required that activities affecting quality shall be prescribed by documented procedures of a type appropriate to the circumstances and shall be performed in accordance with these procedures. As discussed above, 2D8 was not of a type appropriate to the circumstances and this was considered a violation (50-306/97006-01).

The inspectors considered the licensee's logkeeping practices weak. Two examples (one on March 7, and one on March 8, 1997) were identified of significant component manipulations that were not recorded in the reactor log.

O4 Operator Knowledge and Performance

a. Inspection Scope (71707, 92901, 93702)

The inspectors evaluated aspects of operator knowledge and performance demonstrated during the event.

b. Observations and Findings

Many refueling outage work activities were planned to occur while procedure 2D8 was in effect, including SP 2071.4 and SP 2083. Procedure 2D8 identified in Step 5.2.55 that, "IF the Integrated SI Test or the Integrated Leak Rate Test is scheduled, THEN vent the RCS to containment by reducing RCS pressure and aligning the head vent system to containment..." Step 5.2.55.H stated, "Vent the vessel head and pressurizer to containment..." and included a note that the isolation used to establish the vent, "is to prevent gas accumulation in the reactor vessel head and to ensure accurate RCS level indication." When operations department shift management considered draining the RCS without the RPV vented, they did not adequately evaluate the impact on the ability to drain the RCS, prevent accumulation of gas in the RPV head, or ensure accurate RCS level indication. The intended RCS vent path was not in accordance with the requirements of 2D8 when the RCS drain was performed.

The equipment isolation order issued for WO 9701175 required opening valve 2RC-8-16. The APEO assigned to perform the isolation on March 6, 1997, incorrectly placed an equipment control tag on the valve indicating that the valve was open when it was actually closed. The APEO did not read the required valve position, but believed the valve was to be shut because of statements made by the Shift Manager earlier during the shift that stressed the need to maintain RCS integrity.

During the draining of the RCS, operators drained the pressurizer for approximately four hours before reaching the desired 50 percent level. After three hours of draining the operators stopped to review the drain down and determined that everything was proceeding as expected, and that the slow drain down was due to a smaller vent path than normal. Operators did not note the decreased indication on RVLIS or call for hold up tank levels at the beginning and end of the drain down. Personnel interviewed by the inspectors expressed differences in opinion as to the

quality and content of the pre-evolution briefing that was conducted prior to starting the drain of the RCS.

c. Conclusions

The operations department shift management performed an inadequate evaluation of the impact of a change in the specified RCS drain path and did not use proper administrative controls for performing the change. Procedure 2D8 required that a vent path be established from the RPV head and pressurizer and the planned vent path selected, if successful, would have only vented the pressurizer. Title 10 of the Code of Federal Regulations, Part 50, Appendix B, Criterion V, required that activities affecting quality shall be prescribed by documented procedures of a type appropriate to the circumstances and shall be performed in accordance with these procedures. The licensee did not follow the requirements of procedure 2D8, which required that the RPV head and pressurizer be vented to the containment atmosphere prior to draining the pressurizer. This was considered an example of a violation of procedure adherence requirements (50-306/97006-02a).

The APEO displayed a lack of attention to detail by failing to properly position the valve in accordance with the I&R. Title 10 of the Code of Federal Regulations, Part 50, Appendix B, Criterion V, required that activities affecting quality shall be prescribed by documented procedures of a type appropriate to the circumstances and shall be performed in accordance with these procedures. The licensee's administrative procedure 5AWI 3.10.0, "Control and Operation of Plant Equipment," Revision 5, stated in Section 6.11.6.d.5 that personnel were required to verify that equipment was in the correct configuration prior to installing hold cards. The APEO did not verify that 2RC-8-16 was in the correct configuration prior to installing the hold card. This was considered another example of a violation of procedure adherence requirements (50-306/97006-02b).

Operators failed to use all available information in determining the actual status of the plant resulting in an excessive drain down of the RCS. Operators failed to apply training received to the actual plant conditions and limit the drain down time. The inspectors considered these to be examples of operator performance weaknesses. Additionally, from the interviews conducted, the inspectors concluded that the pre-evolution briefing prior to draining the RCS was weak.

07 **Quality Assurance in Operations**

a. Inspection Scope (71707, 92901, 93702)

The inspectors reviewed the licensee's self-assessment efforts in response to the event.

b. Observations and Findings

The licensee initiated an investigation of the event by its Error Reduction Task Force (ERTF). The ERTF conducted independent interviews with personnel, reviewed

plant records and procedures, and provided assessment of the event and causal factors to line management. The ERTF was also identifying areas of weakness and recommendations for improvement. Additionally, the ERTF was conducting a detailed review of the technical details of the event to develop a "case study" of the event that would be suitable for staff training.

c. Conclusions

The inspectors concluded that the licensee had a self-assessment effort in progress to review the circumstances of the event, and identify causes and areas for improvement. The ERTF investigation was not completed at the conclusion of the inspection; however, the inspectors concluded that its efforts to date were thorough.

O8 Miscellaneous Operations Issues

a. Inspection Scope (71707, 92901, 93702)

The inspectors reviewed corrective actions from previous events including the February 20, 1992 draindown event.

b. Observations and Findings

Extensive procedure and engineering changes were made after the 1992 event. A self-limiting hot leg drain path was designed, fabricated, and installed on the reactor coolant system (RCS), with piping routed to limit the RCS lower level to just below the top of the inside diameter of the hot leg during the draining process. The location of the tap off of the RCS used for shutdown purification was changed to the loop A pressurizer spray line. This location is at the centerline of the cold leg which limits any potential overdraining while in the shutdown mode. This was the line that was used in the most recent event on March 7-8, 1997. Procedures were revised to keep track of inventory during a draindown to reduced inventory conditions, but not during a decrease in pressurizer level as was the case in this event.

c. Conclusions

While the corrective actions were adequate to support residual heat removal pump operation and prevent any significant vortexing, they did not prevent draining without an adequate vent path.

V. Management Meetings

X1 Exit Meeting Summary

The inspectors presented the inspection results to members of the licensee management at the conclusion of the inspection on March 17, 1997. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

J. Sorensen, Plant Manager
K. Albrecht, General Superintendent Engineering
R. Lindsey, General Superintendent Safety Assessment
T. Silverberg, General Superintendent Plant Operations
J. Anderson, Shift Manager
P. Ryan, Shift Manager
P. Valtakis, Shift Manager

INSPECTION PROCEDURES USED

IP 71707: Plant Operations
IP 92901: Followup - Operations
IP 93702: Prompt Onsite Followup of Events

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

306/97006-01	VIO	Inadequate Procedure for Filling and Venting the Reactor Coolant System
306/97006-02	VIO	Two Examples of Operators Failing to Follow Procedures: Did Not Establish Prescribed RCS Vent Path and Valve Tagging Error

LIST OF ACRONYMS USED

APEO	Auxiliary Plant Equipment Operator
CFR	Code of Federal Regulations
CVCS	Chemical and Volume Control System
ERTF	Error Reduction Task Force
ILRT	Integrated Leakage Rate Test
IP	Inspection Procedure
NRC	Nuclear Regulatory Commission
NSP	Northern States Power Company
PDR	Public Document Room
PORV	Power Operated Relief Valve
RCS	Reactor Coolant System
RPV	Reactor Pressure Vessel
RVLIS	Reactor Vessel Level Instrumentation System
SI	Safety Injection
SP	Surveillance Procedure
SRO	Senior Reactor Operator
SV	Solenoid Valve
USAR	Updated Safety Analysis Report
VIO	Violation
WO	Work Order