APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-298/90-35 Operating License: DPR-46

Docket: 50-298

Licensee: Nebraska Public Power District (NPPD)
P.O. Box 499
Columbus, Nebraska 68602-0499

Facility Name: Cooper Nuclear Station (CNS)

Inspection At: CNS, Brownville, Nebraska

Inspection Conducted: October 24-26, 1990

Inspector: P.C. Wagner 11/1/90
P. C. Wagner, Reactor Inspector, Plant Systems Section, Division of Reactor Safety Date

Approved: [signature] 11/2/90
T. F. Stetka, Chief, Plant Systems Section Division of Reactor Safety Date

Inspection Summary

Inspection Conducted October 24-26, 1990 (Report 50-298/90-35)

Areas Inspected: Reactive, announced inspection of the licensee's actions in response to the failure of a motor operated throttle valve in the residual heat removal (RHR) system on about October 21, 1990.

Results: Within the scope of the inspection, no violations or deviations were identified. The inspector observed the licensee's actions in response to the valve failure and considered those actions to be thorough and well planned. The inspector noted that numerous meetings and discussions were being conducted to provide assurance that all concerns and consequences of actions were being considered.

9011140015 901105
PDR ADOCK 05000298
Q PNU

DETAILS

1. PERSONS CONTACTED

1.1 NPPD Personnel

*L. Bray, Regulatory Compliance Specialist
*J. Flaherty, Engineering Manager
S. Freborg, Acting Manager, Staff Support
*R. Gardner, Senior Manager of Operations
J. Mecham, Division Manager of Nuclear Operations
*C. Moeller, Acting Senior Manager of Staff Support
*S. Peterson, Senior Manager of Technical Support Services
*G. Smith, Quality Assurance Manager

1.2 NRC Personnel

*R. Bennett, Senior Resident Inspector, CNS

*Indicates persons who attended the exit interview on October 26, 1990.

The inspector also contacted and interviewed other licensee personnel during the course of the inspection.

2. FOLLOWUP ON EVENT (93702)

A special inspection was conducted in order to evaluate the licensee's actions in response to a valve failure. The motor operated valve functioned as both a shutdown cooling flow throttle valve and as a safety injection admission valve for the residual heat removal (RHR) system. During shutdown cooling operations on October 19, 1990, the licensee observed a flow of 8000 gallons-per-minute with the valve (RHR-MOV-MO27B) in the indicated closed position. Subsequent disassembly of the valve on October 21, 1990, disclosed damage to the internal, anticavitation, trim elements which had been installed in the valve as a modification during the previous refueling outage.

The inspector examined the failed and the replacement valve trim parts, reviewed the licensee's evaluations of the failure and corrective actions, and reviewed the evaluations of the effects of the failed portions of the trim elements which were not recovered from the piping system.

2.1 Background

The NRC informed all licensees of a concern related to the erosion of valves used for throttling service in Information Notice (IN) 89-01, "Valve Body Erosion" dated January 4, 1989. NPPD inspected several throttle valves in safety-related systems and determined that six valves were susceptible to the body thinning phenomenon described in the IN. Included in the selected valves were the RHR injection throttle valves; RHR-MOV-MO27A and RHR-MOV-MO27B.

The licensee later reevaluated the valve body erosion problem and expanded the scope of the issue to include eight additional valves. The licensee also evaluated corrective actions to resolve the erosion problem and initiated a Justification for Interim Operation (JIO) until final repairs/corrective actions could be implemented. The inspector reviewed Revision 5 of JIO Number 89-02, dated October 25, 1990, and noted that valve RHR-MOV-MO27B had been reinstated. The valve had been removed from the JIO following modifications during the previous refueling outages.

The modifications that had been made to RHR-MOV-MO27B were designed to eliminate the cavitation and thereby the erosion problem. The valve was originally an ordinary Anchor Darling, 24 inch, angle, globe valve. The valve was modified by the replacement of the valve disk and seat assembly with new trim components. The new trim consisted of a redesigned disk, a disk guide (cage) and eight multistage - multipath (MS-MP) flow elements. The eight MS-MP elements were stacked one on top of the other and provided small flow passages between the elements. The positioning of the valve disk in the area of MS-MP elements provided fine control of system flow while eliminating internal cavitation.

The relative positioning of the MS-MP elements was maintained by two antirotation pins. These pins were 3/8 inch in diameter by 3 1/4 inches long and were positioned circumferentially 180 degrees apart. The spacing between the elements was maintained by eight, integral, stacking blocks on each of the elements. These "blocks" were approximately 1/2 inch by 1/2 inch by 1 inch in size. All of these components were fabricated from Type 316 stainless steel.

Similar modifications were planned for the injection throttle valve in the "A" RHR loop (RHR-MOV-MO27A) during the next refueling outage.

When RHR-MOV-MO27B was disassembled on October 21, 1990, to determine the cause of the loss of flow control capability, significant damage to the MS-MP elements was observed.

2.2 Licensee Evaluation of Valve Failure

The licensee observed that the stack of MS-MP elements had slipped, from the cylindrical configuration in which the valve disk traveled, to an out of alignment configuration. When the valve disk was moved downward to stop system flow, the disk struck the MS-MP elements which distorted and broke off sections. Following valve disassembly, the licensee determined that the following pieces were missing: the two antirotation pins, 18 of the stacking blocks, and one section of a MS-MP element approximately 12 inches in length.

The licensee determined that the failure of the valve was caused by flow turbulence or cavitation induced vibrations in the thin area of the MS-MP elements. These vibrations led to fatigue cracking and ultimately to the displacement of the MS-MP elements from the raised (approximately 0.05 inches) lip on the valve seat.

Although parts were available onsite for the future modification of the "A" RHR loop valve that could have been used for replacement of the damaged parts in the "B" loop valve, the licensee elected to implement an alternate design. In order to maintain some of the anticavitation characteristics of the modified design (the original valve trim components had previously been discarded) the licensee developed an interim modification. The new modification consisted of replacing the stack of MS-MP elements with a short section of 18 inch, Schedule 80, A106, Grade B pipe. The section of pipe was machined to the same dimensions as the MS-MP element stack and was to be installed in a similar configuration. This 3 1/2 inch high "spacer" ring would have three windows approximately 1 1/2 inches high by 14 inches long cut through it to provide throttling capability.

As added protection against lateral displacement, as had occurred with the MS-MP elements, the spacer ring was to be bolted to the trim cage by three 3/8 inch bolts. These bolts were in addition to the compressive force that was provided by the downward force of the valve's backing ring acting against the cage. These modifications were approved by the valve manufacturer.

The licensee was also attempting to repair damage to the valve seat caused by the disk closing on the dislodged MS-MP elements. A special tool was obtained by the licensee to perform valve seat refurbishment, but problems were encountered that delayed this effort beyond the period of this inspection.

The licensee determined that the spacer ring design could allow more erosion of the valve body to occur in comparison to the MS-MP trim design. However, the licensee determined that acceptable valve wall thickness would be maintained to justify interim operations. This evaluation was summarized in JIO 89-02, Revision 5.

The licensee further determined that the valve flow capacity would be slightly greater for the spacer ring design. The increase in flow areas was determined to be insignificant, however, in relation to the effects on RHR pump runout protection provided by the orifice plate installed in the pump discharge piping.

The licensee prepared a Work Instruction (WI) package to implement the modification and to test the system prior to restart. The provisions of WI 90-3941, "RHR-MOV-MO27B Modification," were approved by the CNS Station Operations Review Committee (SORC) on October 25, 1990. Included in WI 90-3941 were provisions to verify throttle capability and to ensure that the minimum safety injection flow capability could be achieved.

2.3 Licensee Evaluation of Loose Parts

As mentioned above, a number of pieces of the MS-MP element assembly were broken off and were not located in the disassembled valve. The licensee undertook a program to locate and retrieve the missing pieces and/or evaluate the effects of operating the facility with the pieces remaining loose in the system.

The licensee was able to retrieve the large (12") segment of the broken MS-MP element but could not locate the two antirotation pins nor the 18 missing stacking blocks. The licensee, therefore, contracted General Electric Company (GE) to evaluate the potential effects of operating the facility with these parts loose in the system. A summary of the GE analysis was provided to NPPD on October 25, 1990. The analysis considered the potential for fuel bundle flow blockage, the potential for control rod interference, the potential for corrosion and chemical reaction with other reactor materials, and other operational concerns.

The GE summary indicated that the analysis determined that flow velocity in the RHR piping had been high enough to carry the missing parts into the recirculation line and subsequently into the jet pump riser piping. The pins and blocks were assumed to have passed through the jet pump nozzle and into the reactor vessel lower plenum region. The analysis determined that the pieces were small enough to preclude flow blockage but were large enough to prevent passing through the grid openings and into the fuel bundle. The analysis also determined that the loose pieces would not interfere with the operation of the control rods.

Since the missing pieces were made from stainless steel, the GE analysis concluded that corrosion or chemical reactions with other reactor materials would not be a concern.

In addition, the analysis determined that there was no potential for interference with the operation of any valves downstream from RHR-MOV-MO27B. (The licensee's modification plan [WI 90-3941] further required operability tests of these valves.)

The GE analysis concluded that the safe operation of the CNS would not be compromised by the presence of the parts lost from RHR-MOV-MO27B. The CNS SORC evaluated and accepted the GE evaluation summary on October 25, 1990.

2.4 Summary

The licensee evaluated and determined the probable cause of the valve failure. Based on the failure determination, a revised modification was to be implemented to allow interim plant operations until the next refueling outage. The licensee also determined that plant operations would not be adversely affected by the existence, in the reactor vessel, of the parts missing from the damaged valve.

The inspector reviewed the licensee's determinations and had no further questions nor problems with the licensee's approach.

3. EXIT INTERVIEW

The inspector met with the personnel denoted in paragraph 1 on October 26, 1990, and summarized the scope and findings of this inspection. The licensee did not identify as proprietary any of the information provided to, or reviewed by, the inspector.