U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No.:	50-456
License No.:	NPF-72
Report No.:	50-456/96018(DRP)
Facility:	Braidwood Nuclear Plant, Unit 1
Location:	RR #1, Box 79 Braceville, IL 60407
Dates:	October 12 - November 13, 1996
Inspectors:	T. M. Tongue, Project Engineer C. J. Phillips, Senior Resident Inspector D. W. Rich, Reactor Inspector
Approved by:	R. D. Lanksbury, Chief Reactor Projects Branch 3

EXECUTIVE SUMMARY

Braidwood Nuclear Plant, Unit 1
NRC Inspection Report 50-456/96018

This was a special inspection of the inadvertent opening of the pressurizer power operated relief valve during a plant cooldown on Braidwood Unit 1 on October 12, 1996.

Operations

- The Unit 1 shutdown and cooldown procedure allowed the operators to raise PZR level higher early in the cooldown process placing the plant in a condition that contributed to the lifting of the PORV. The failure to have a procedure or guideline adequate for bypassing 1CV-121 and the associated circumstances is considered a significant contributor to the event. A Notice of Violation was issued. (Section 03.1)

- The inspectors concluded that the desire to get through the evolution quickly and the lack of good communications contributed to the event. The disjointed communications between the control room and the field personnel is considered a significant contributor to the event. (Section 04.1)

- The inspectors concluded that the training provided on the characteristics of 1CV-121 did nothing to preclude this event from occurring. (Section 05.1)

- The licensee evaluations collectively were thorough and comprehensive. (Section 07.1)

Report Details

Summary of Event

On October 12, 1996, operators were cooling down and depressurizing Braidwood Unit 1 following a reactor shutdown for mid-cycle steam generator tube eddy current testing. The pressurizer (PZR) level was allowed to be higher than normal which contributed to the inadvertent opening of the PZR power operated relief valve (PORV). The PORV reseated quickly. The PORV block valve was operable and available in the event that the PORV had failed to reseat. Other contributing factors were a nonconservative schedule driven cooldown process, inadequate or inappropriate procedures or guidelines, communications related problems, a long standing equipment problem with the charging flow control valve 1CV-121, and training weaknesses. This event posed no immediate threat to the plant, workers, or the public. A detailed timeline is enclosed.

I. Operations

03 Operations Procedures and Documentation

03.1 Inadequate Shutdown/Cooldown Procedure

a. Inspection Scope (71707)

The inspectors reviewed 1BwGP 100-5, "Plant Shutdown and Cooldown," Revision 11; 1BwOA PRI-1, "Excessive Primary Plant Leakage," Revision 54; and interviewed the operators, supervisors and the managers involved in the event.

b. Observations and Findings

1BwGP 100-5 gave operators the option to raise PZR level as high as 80%. The operators chose this option of maintaining a high PZR level to help cooldown the pressurizer in preparation for going to a solid plant condition. As the cooldown and depressurization continued, letdown flow dropped due to decreased differential pressure across the letdown orifices. 1CV-121 automatically controlled charging flow to match letdown flow. At low primary plant pressures (about 370 psig) 1CV-121 had difficulty controlling flow because of the large differential pressure (dp) across the valve (about 2100 psid). When letdown flow decreased below the point where 1CV-121 could no longer reduce charging flow the PZR level began to rise due to the charging rate being greater than the letdown rate.

The inspectors learned through interviews that the operators knew about the erratic behavior of 1CV-121 and the inability to control flow at low pressures. This problem was not discussed at the pre-evolution brief or at any other time during the cooldown. When the operators could no longer control pressurizer level the decision was made to bypass 1CV-121 and control charging flow by using a manual bypass valve around 1CV-121.

The inspectors could find no specific procedure, instruction, or guideline in 1BwGP 100-5 for bypassing 1CV-121. Based on interviews with station personnel and procedure reviews, the use of bypass valves at Braidwood was considered "skill of the craft" for operators. On this occasion, the authorization to bypass 1CV-121 was an agreement between operators and supervisors that it was acceptable based on guidance in another procedure, 1BwOA PRI-1, "Excessive Primary Plant Leakage," Revision 54. However, the inspectors verified that the procedural guidance to bypass around 1CV-121 in 1BwOA PRI-1 was for a different set of circumstances involving excessive primary plant leakage.

During the bypassing of 1CV-121 the charging rate to the reactor coolant system and PZR became excessive causing the PZR level to increase rapidly resulting in the PORV opening. The inspectors verified that the PORV lifted and reset at the proper setpoints, and that cold over pressure protection limits were not exceeded.

c. Conclusions

1BwGP 100-5 allowed the operators to raise PZR level higher early in the cooldown process. This placed the plant in a condition that contributed to the lifting of the PORV. The failure to have a procedure or guideline adequate for bypassing 1CV-121 and the associated circumstances is considered a violation of 10 CFR Part 50, Appendix B, Criterion V "Instructions, Procedures and Drawings" (50-456/96018-01(DRP)).

04 Operator Knowledge and Performance

04.1 Contributing Factors to the Event

a. Inspection Scope (71707)

The inspectors interviewed the control room operators, field operators and their supervisors to determine what led to the event.

b. Observations and Findings

The inspectors learned through interviews that 1CV-121 had a long standing history of erratic behavior during low flow conditions. This was an automatically controlled, pneumatically operated valve. The valve's poor low flow control characteristic was common knowledge among the operators. However, there was no evidence of an action request or other method to report the condition and have it corrected. This was a known "operator work around" and was not placed on that list until after this event occurred.

The inspectors determined there were several instances where the lack of good communications contributed to the event.

- A high level of awareness (HLA) briefing was conducted at the beginning of the shift. The HLA discussion covered in detail, the plans to continue the cooldown to Mode 4 and then to shift to

residual heat removal (RHR) cooling. There was no discussion during the HLA briefing on plans to bypass 1CV-121.

- The inspectors learned through interviews that there was a desire for the cooldown evolution to go quickly and smoothly to reduce outage downtime. This was stated by several operators and was demonstrated by the use of steam generator PORVs to increase the available cooldown rate. The operators and supervisors also pointed out that shifting from the steam dumping cooldown technique to the RHR cooling process was attempted without a break to assess the situation. The operators stated that this was done in an effort to conserve time in achieving cold shutdown. Several individuals stated that they felt a hold point prior to reaching a reactor coolant system temperature of 350°F would have been an opportunity to consider the direction of the plant and would have resulted in the problems with flow control on 1CV-121 being discussed.

- When the decision was made to bypass 1CV-121, the situation had become urgent in that the pressurizer level was high and the erratic behavior of 1CV-121 was worse than in the past. An equipment operator (EO) and field supervisor who were working on other assignments (preparation for going to RHR cooling) were reassigned to bypass around 1CV-121 on short notice and without a briefing.

- The control room operator stated that he gave specific verbal instructions via radio to the EO and the field supervisor regarding opening of the 1CV-121 bypass valve, to the effect, "not one half turn open, not one quarter turn open, but just crack it open." However, neither the EO nor the field supervisor could recall that instruction but only recalled the urgency to get the bypass valve open. The bypass valve was opened considerably farther than the reactor operator wanted and resulted in a large increase in charging flow, rapid pressurizer level increase and the lifting of the pressurizer PORV.

c. Conclusions

The inspectors concluded that the desire to get through the evolution quickly and the lack of good communications contributed to the event. The disjointed communications between the control room and the field personnel was considered a significant contributor to the event.

05 Operator Training and Qualification

05.1 Operator Training Regarding The Operation Of 1CV-121 At Low Flow

a. Inspection Scope (71707)

The inspectors interviewed several operators and supervisors regarding their training, interviewed training instructors, and reviewed training records.

b. Observations and Findings

None of the operators interviewed could recall training on bypassing 1CV-121 on the simulator. There was no record of the classroom discussion on the topic of the erratic behavior of 1CV-121 at low flow. In addition, the simulator was not modeled to represent the erratic behavior of 1CV-121 at low flow conditions. Operations management did state however that the erratic behavior of 1CV-121 was discussed as a general topic during annual training on the chemical and volume control system. During the interviews the operators all appeared to have a knowledge of the problems with 1CV-121 at low flow.

c. Conclusions

The inspectors concluded that the training provided on the characteristics of 1CV-121 did nothing to preclude this event from occurring.

O7 Quality Assurance in Operations

O7.1 Licensee Self-Assessment Activities

a. Inspection Scope (71707)

At the completion of the inspection the inspectors reviewed the licensee's investigation reports and interviewed the members of the investigation teams.

b. Observations and Findings

The licensee commenced investigations and evaluations promptly after the event. The licensee generated three separate reports on this event. Although there were some variations in the licensees reports, collectively, each of the inspectors points were identified in at least one or more of the licensee reports.

c. Conclusions

The licensee evaluations collectively addressed all of the inspectors issues.

V. Management Meetings

X1 Exit Meeting Summary

The team presented the inspection results to members of licensee management at the conclusion of the inspection on November 13, 1996. The licensee acknowledged the findings presented.

The inspector 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

*T. Tulon, Station Manager
R. Flessner, Site Quality Verification Director
*L. Weber, Shift Operations Supervisor
*D. Hoots, Unit 1 Operating Engineer
*B. Claveau, Operations Self Assessment
*D. Hieggelke, Root Cause Team Leader
*P. Studdard, Root Cause Team Member
*H. Pontious, Acting Regulatory Assurance Supervisor
*M. Cassidy, Regulatory Assurance, NRC Coordinator
*J. Naleuajka, Integrated Assessment Analyst

NRC

J. Adams, Resident Inspector

IDNS

*T. Esper, Illinois Department of Nuclear Safety Resident Engineer

* Denotes those attending the exit brief on November 13, 1996

INSPECTION PROCEDURES USED

IP 71707: Plant Operations

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-456/96018-01	VIO	Failure to have procedural guidelines for bypassing CV-121.

LIST OF ACRONYMS

CV	Charging System
dp	Differential Pressure
ECCS	Emergency Core Cooling System
EO	Equipment Operator
HLA	High Level Awareness
PZR	Pressurizer
PORV	Power Operated Relief Valve
RCS	Reactor Coolant System
RHR	Residual Heat Removal

ENCLOSURE

EVENT TIMELINE

On October 12, 1996, Braidwood Unit 1 was in the process of proceeding to cold shutdown for the purpose of conducting a mid-cycle outage primarily for steam generator tube examinations. During the day shift, following the reactor shutdown, the plant was cooled down to 370 psig and 340°F. The reactor cooldown was conducted by use of the steam dump valves and the main condenser, and the use of the steam generator (SG) PORVs to the outside atmosphere. By about 3 p.m. preparations were being made to go on to the residual heat removal (RHR) cooling mode.

- For the shutdown and the process of going to cold shutdown, procedure BwGP 100-5, "Plant Shutdown and Cooldown" was being used. It gave the option of raising the pressurizer (PZR) level to 80% to assist in the cooldown of the PZR in preparation for going solid. During past cooldowns it had been held at 50-60% as a surge volume for emergency core cooling system (ECCS) testing. Since ECCS testing was not scheduled this time, PZR level was allowed to increase to 80% early in the process.

- BwGP 100-5, Step 25 required PZR level be maintained by manually adjusting 1CV-121, "Charging flow control valve."

- As the cooldown progressed to about 350°F, reactor coolant system (RCS) pressure decreased resulting in reduced letdown flow as expected. Charging was adjusted by use of 1CV-121 to compensate. At this lower flow condition, 1CV-121 became erratic and difficult to control because of the high differential pressure (dp) across the valve.

3:10 p.m.

- The decision was made to use the 1CV-121 bypass as a better technique to control charging flow. 1CV-121 had a history of erratic behavior at low flow conditions. The operators stated that this time, it was more erratic than in the past. This has been a known "operator-work-around"; however, it was not placed on the work-around list for correction until this event.

3:22 p.m.

- Excess letdown was commenced as an additional means of controlling PZR level and slowing the level increase. However, this was not very effective.

3:23 p.m.

- The plant entered Mode 4 (hot shutdown and RCS temperature at ≤350°F). Concurrently, personnel were stationed in preparation for going on RHR cooling.

3:26 p.m.

- As stated to the inspector, an equipment operator (EO) and a field supervisor were removed from other assignments and dispatched urgently to assist with bypassing CV-121 without a pre-job briefing.

- Instructions from the control room to the EO regarding opening the bypass valve were "Don't open it a half turn, not just a quarter turn, but just crack it open." Later, field personnel could not recall the details but only the urgency of the instruction. The field operators also encountered difficulty in opening the bypass valve which required both operators to open it. They also could not recall how far they had opened it. The field supervisor was then directed to proceeded to CV-121 to shut the inlet to CV-121 in order to reduce the flow to the RCS. Due to the high dp, the inlet valve was very difficult to shut and took some time (10 min) to shut. At about the same time, the EO was then instructed to shut the bypass valve which was also very difficult to shut due to the high dp. Both manual valves are located in positions that are not easily accessible and are difficult to operate. This resulted in a further delay (about 10 min.) and additional water in the RCS.

3:42 p.m.

- The large water addition to the RCS resulted in a sudden PZR level increase. PZR sprays were opened and heaters were deenergized. However, this was not effective enough and the PZR PORV opened on PZR high level/pressure.

- Concurrently, with the additional charging flow, flow to the reactor coolant pump (RCP) seals increased to greater than 15 gpm each (max. indication) which is normally 8-10 gpm each.

- In response, the running 1B charging (CV) pump was stopped.

3:45 p.m.

- As the RCP seal dp reduced to less than 200 psid, the 1A RCP was secured.

3:46 p.m.

- This was followed by securing 1B, 1C, and 1D RCPs. This resulted in no forced flow though the reactor core and depended on natural circulation cooling. Technical Specification 4.1.3 was entered due to no RCS pumps in operation. Natural convection cooling is acceptable and did commence but a concern was raised by the control room operators that since the RCS had not been degassed, gas pockets could form in the SG tubes resulting a flow blockage.

3:52 p.m.

- RHR cooling was placed in service creating the necessary forced convection cooling.

4:36 p.m.

- 1B CV pump was restarted with less flow to the RCS and creating the required RCP seal flow.

5:22 p.m.

- The 1D RCP was restarted to give greater RCS flow and cooling and stabilizing of parameters.

- Through out this event, steam dumps and SG PORVs remained in use for heat removal.