

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report Nos. 50-454/94003(DRS), 50-455/94003(DRS),  
50-456/94004(DRS), 50-457/94004(DRS)

Docket Nos. 50-454; 50-455;  
50-456; 50-456

License Nos. NPF-37, NPF-66  
NPF-73, NPF-77

Facility Names: Braidwood Station and Byron Station

Inspection Conducted At: Braceville, Illinois and Byron, Illinois

Inspection Conducted: December 16, 1993 through January 18, 1994

RIII Inspector: Ronald A. Langstaff  
Ronald A. Langstaff, Reactor Inspector  
Operational Programs Section

2/3/94  
Date

Approved By: Bruce L. Burgess  
Bruce L. Burgess, Chief  
Operational Programs Section

2/3/94  
Date

Inspection Summary:

Inspection on December 16, 1993 through January 18, 1994 (Reports No. 50-454/94003(DRS); No. 50-455/94003(DRS); No. 50-456/94004(DRS); No. 50-457/94004(DRS)).

Areas Inspected: Special, announced safety inspection to review licensee identification, assessment, and correction of a design deficiency associated with the auxiliary feedwater system.

Results: The licensee's corrective actions taken to address a design deficiency associated with the auxiliary feedwater system were good but not timely. Communication and teamwork between the Braidwood and Byron stations in performing corrective actions was good. One non-cited violation with respect to design control was identified. One cited violation with respect to corrective action was also identified. Two Licensee Event Reports which pertained to the design deficiency were closed. Understanding of the plant licensing basis among the engineering staff was identified as a weakness during this inspection. This weakness hindered recognition of a design deficiency as an operability issue.

## DETAILS

### 1. Persons Contacted

#### Commonwealth Edison Company (CECo):

- D. Cooper, Assistant Superintendent, Operations, Braidwood
- R. Kerr, Manager, Site Engineering and Construction, Braidwood
- \*T. Tulon, Manager, Operations, Byron
- R. Aker, Director, Site Quality Verification, Braidwood
- D. Brindle, Supervisor, Regulatory Assurance, Byron
- \*P. Enge, NRC Coordinator, Regulatory Assurance, Byron
- R. Gesior, Group Leader, Site Engineering and Construction, Byron
- J. Gosnell, Engineer, System Engineering, Braidwood
- A. Haeger, Supervisor, Regulatory Assurance, Braidwood
- D. Ibrahim, Engineer, System Engineering, Braidwood
- H. James, Group Leader, Site Engineering and Construction, Braidwood
- \*A. Javorik, Supervisor, System Engineering, Byron
- J. Lewand, NRC Coordinator, Regulatory Assurance, Braidwood
- D. Miller, Superintendent, Technical Services, Braidwood
- K. Passmore, Supervisor, Site Engineering and Construction, Byron
- \*J. Penick, Engineer, System Engineering, Byron
- H. Pontious, Licensing Group Supervisor, Regulatory Assurance, Braidwood
- \*P. Reister, Group Leader, System Engineering, Byron
- D. Saccomando, Nuclear Licensing Administrator, Braidwood
- D. Skoza, Supervisor, Site Engineering and Construction, Braidwood
- S. Stimac, Supervisor, Regulatory Assurance, Nuclear Engineering and Technical Services
- M. Turbak, Superintendent, Independent Safety Engineering Group, Braidwood

#### U.S. Nuclear Regulatory Commission

- \*C. Brown, Resident Inspector, Byron
- E. Duncan, Resident Inspector, Braidwood

All of the individuals listed above participated in the management exit meeting, held on January 16, 1994, at Braidwood Station. Individuals denoted by an asterisk (\*) participated via teleconference. Other people were contacted during the inspection including members of the licensee's operations and engineering staffs.

### 2. Previously Identified Items

The licensee submitted two licensee event reports (LERs), one for Braidwood and one for Byron, to report the potential inoperability of the auxiliary feedwater (AFW) automatic switchover to essential service water. The inspector concurred with the majority of the information presented in the LERs. Two minor discrepancies in the Braidwood LER

were identified. The licensee agreed to correct the LER discrepancies. As a result of the inspector's review, the following LER's are closed:

- a. (Closed) Braidwood Unit 1 LER, 50-456/93-006
- b. (Closed) Byron Unit 1 LER, 50-454/93-004

No violations were identified in this area.

### 3. Auxiliary Feedwater System

The AFW system for each unit at both Braidwood and Byron consisted of two redundant trains; one used a motor driven pump while the other used a diesel driven pump. The licensing basis for both plants specified that there be an automatic switchover to essential service water (ESW) should there be a loss of the preferred feedwater source, the condensate storage tanks (CSTs). Such capability was required should an earthquake or a tornado cause the CSTs, which were neither seismically qualified nor protected against tornados, to fail. Automatic switchover to the ESW system was designed to occur upon low suction pressure to the AFW pumps prior to tripping of the pumps during drain down of the CSTs.

The licensing basis is outlined in greater detail in Section 10.4 of the facilities' updated final safety analysis report and Section 10.4.9 of NUREG-0876, "Safety Evaluation Report related to the operation of Byron Station, Units 1 and 2." NUREG-1002, "Safety Evaluation Report related to the operation of Braidwood Station, Units 1 and 2" references NUREG-0876 as also being applicable to Braidwood for the auxiliary feedwater system.

No violations were identified in this area.

### 4. Time Delay Modifications

During August 1987 surveillance testing for loss of offsite power, a motor driven AFW pump tripped due to low suction pressure at Braidwood. Subsequently, modifications were performed to prevent tripping of the motor driven AFW pump and inadvertent switchover to ESW due to occurrence of a pump low suction pressure transient. However, these modifications defeated the automatic ESW switchover upon a sustained low suction pressure condition and increased the potential for damage to the motor driven AFW pump.

- a. Condition Which Necessitated the Modifications: During AFW pump startup, a low suction pressure transient is induced until the water in the suction line is accelerated to provide sufficient flow. The magnitude of the transient is accentuated by several factors such as dual AFW pump start (versus single pump start), speed of the pump start (motor driven versus diesel driven pump), and low pressure in one or more steam generators (versus normal operating pressure). The lowest pressure reached during the transient is affected by the available static net positive suction

head (NPSH) which is dependent upon CST level. Depending upon the plant conditions described above, the motor driven AFW pump could trip or an inadvertent ESW switchover could occur. The diesel driven AFW pumps were not affected in that neither the pump trip nor ESW switchover setpoints would be reached due to the slower starting speed of the diesels.

- b. Modification Details: The modifications performed in 1987 through 1990 installed time delay relays for the motor driven AFW pump for each unit. A time delay was installed on the pump trip function so that the pump would run for 2½ seconds before it could be tripped due to low suction pressure. An additional time delay was installed on the ESW switchover function so that ESW switchover could not occur until after the pump had run for 4 seconds. The time delay relays were installed in parallel such that both timers would be energized when the pumps were running. Installation of the relays prevented a pump trip and inadvertent ESW switchover due to the pump startup transient. However, the time delays still allowed automatic ESW switchover for a CST drain down event. The modifications which installed the time delay circuitry were:

Modification M20-1-87-079, Braidwood Unit 1, September, 1987  
Engineering Change Notice (ECN) 37022, Braidwood Unit 2,  
installed prior to startup

Modification M6-1-87-132, Byron Unit 1, February, 1990

Modification M6-2-87-132, Byron Unit 2, February, 1989

- c. Consequences of the Modifications: The above time delay modifications introduced the potential for preventing an automatic switchover to ESW and the potential for subsequent damage to the pumps. Under sustained low suction pressure conditions, a pump could trip after the 2½ second time delay relay had timed out and ESW switchover could be prevented because the relays were installed in parallel. When the pump tripped, the 4 second ESW switchover time delay relay would be deenergized, thereby resetting the timer along with the pump trip relay. The 4 second timer would not restart unless the pump restarted. However, with a sustained low suction pressure condition, even if the pump restarted, it would trip again prior to the 4 second time delay for ESW switchover being reached. Consequently, the potential existed for the pump to start and trip repeatedly without an automatic ESW switchover occurring. A sustained low suction pressure condition sufficient to trip a motor driven AFW pump could exist upon the loss of a CST. As discussed in Paragraph 3 above, loss of a CST was within the licensing basis and, as such, needed to be considered as part of the modification design. Neither the diesel driven AFW train nor manual ESW switchover were affected by the modifications.

- d. Failure to Implement Design Control: 10 CFR Part 50, Appendix B, Criterion III, "Design Control," requires that measures be

established to assure that the applicable regulatory requirements and the design basis, as specified in the license application, are correctly translated into specifications, drawings, procedures, and instructions. However, the time delay modifications did not correctly translate the design basis in that the modifications failed to address the potential loss of a CST. This is an example of a violation of 10 CFR Part 50, Appendix B, Criterion III. However, this violation was considered against the enforcement discretion criteria specified in Section VII.B. of 10 CFR Part 2. Given that the licensee identified the violation in late 1993, reported it, and promptly corrected it after identification, no notice of violation will be issued and this violation is considered closed.

One non-cited violation was identified in this area.

5. Onsite Safety Group Findings:

In January 1987, the Braidwood Onsite Nuclear Safety Group (BwONSG) identified the potential for the motor driven AFW pump to repeatedly trip and restart upon a sustained low suction pressure condition. BwONSG also noted that the potential existed for the time delay modifications to defeat the automatic ESW switchover and for subsequent pump damage to occur. These findings were reported in letter BwONSG 89-01, dated January 17, 1989, which discussed an auxiliary feedwater system reliability study.

In response to the BwONSG letter, Sargent & Lundy (S&L), the licensee's architect-engineer, addressed the recommendations, largely by dismissing a sustained low suction pressure condition as not being credible. The licensee's corporate engineering staff concurred with the S&L response by letter dated June 8, 1989. Although BwONSG did not initially accept the S&L response, BwONSG did not appropriately resolve the issue. As a result of a November 9, 1989 meeting between BwONSG, Braidwood station personnel, corporate engineering, and S&L, the concerns related to the time delay circuitry were not pursued.

10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," specifies that measures be established to assure that conditions adverse to quality, such as failure, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. The BwONSG findings demonstrated that the licensee understood the design deficiency well. Despite this understanding, the deficiencies associated with the time delay modifications were not corrected until December 10, 1993, for Braidwood, and December 11, 1993, for Byron. The inspector noted that the time delay modifications were installed at Byron after BwONSG had raised significant concerns associated with them. The failure to promptly correct the time delay circuitry is considered a violation 10 CFR Part 50, Appendix B, Criterion XVI. (454;455/94003-01(DRS), 456;457/94004-01(DRS))

One violation was identified in this area.

6. Development of the Issue:

Although the design deficiency was understood by the engineering staff, a weak understanding of the licensing basis hindered recognition that the deficiency was an operability concern. Questioning by Braidwood station management eventually led to the recognition that the deficiency was an operability concern.

The Braidwood AFW system engineer recognized that the time delay modifications had introduced the potential for defeating ESW switchover. The justification for a modification proposal, initiated on June 17, 1993, noted that if the CST supply to the motor driven AFW pumps was lost prior to the 4 second delay, there would be no feedwater provided to the steam generators from the motor driven AFW pumps. Although the engineering staff recognized the problem, the staff did not recognize the condition as being outside of the licensing basis, nor that an operability concern existed at that time. The issue was not considered significant, in part, because loss of the CST, such as by earthquake or tornado, was considered a low probability event. Correction of the problem was pursued as a system enhancement rather than a condition requiring immediate resolution for continued operation.

When the problem was briefly discussed during a technical issues meeting, the Braidwood system engineering supervisor recognized the issue as being an operability concern. At that time, the engineering staff recalled that the issue had been identified previously by BwONSG and had been closed out. Consequently, it was believed that the issue had been satisfactorily resolved. However, the system engineering supervisor requested that the operability determination be documented. At this time, the engineering staff considered the issue to be a documentation concern rather than an immediate operability concern and it was pursued accordingly.

By December 7, 1993, the Braidwood system engineering supervisor recognized that the issue might be genuine. The next day, the issue was verified to be a valid concern and it was recognized that an operability determination needed to be made.

No violations were identified in this area.

7. Corrective Actions:

Once the design deficiency was determined to be a genuine operability concern, the licensee investigated the concern in a timely and thorough manner. As a result of their investigation, the licensee appropriately determined that the affected train of the AFW system was inoperable. As such, the licensee met the intent of NRC guidance concerning operability determinations, Generic Letter (GL) 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability," dated November 7,

1991. Both stations performed temporary modifications to the motor driven AFW pump start circuitry to limit the potential for defeating the automatic ESW switchover.

- a. Operability Assessment: Braidwood operations and Byron management were informed of the concern on December 8, 1993, and the NRC resident inspectors at both sites were contacted (Byron, December 8, and Braidwood, December 9). Both resident inspectors reminded the licensee of the guidance concerning operability decisions outlined in GL 91-18.

The licensee initially believed that the AFW system operability would be confirmed with further investigation. Consequently, the affected trains were initially considered operable until the investigation concluded otherwise. Between the two stations, an action plan was developed to address the concern using a planned and logical approach. The action plan was intended to address three aspects of the concern as follows: 1) gaining a thorough understanding of the AFW pump start circuitry; 2) analyzing the hydraulics of the suction piping to establish whether a trip would occur upon loss of the CST; and, 3) determining the credibility of the initiating event - losing both CST and offsite power (which would cause AFW initiation). The inspector considered the development and use of the action plan to contribute towards the correct and timely operability decision.

At 4 pm December 9, 1993, the licensee made the determination that the motor driven AFW trains were inoperable. Voluntary emergency notification system (ENS) notifications were conservatively made within one hour after the pumps were declared inoperable. Based on review of the design deficiency, the inspector considered the determination that the pumps were inoperable to be appropriate and necessary.

- b. Modification Details: The temporary modifications performed to address the design deficiency were completed by December 10, 1993 for Braidwood and by December 11, 1993 for Byron, and the pumps were declared operable. The temporary modifications relocated the 4 second time delay relay for ESW switchover such that it would start when an automatic pump start signal was received. As relocated, the 4 second relays would not deenergize upon a pump trip. During modification testing, the licensee discovered a minor problem with the temporary modifications pertaining to the control room hand switch position. If the handswitch position was placed in the after close position, the 4 second relay would not be energized for the low steam generator or reactor coolant pump bus undervoltage signals for AFW pump start. The licensee provided an operator aide which sufficiently addressed the problem. The inspector considered the problem insignificant because the problem could only manifest itself during manual start of the AFW pumps (such as during surveillance testing) or if an operator matches targets on the switch (placing it in the run

position after an automatic start) within 4 seconds of an automatic initiation. The inspector considered the problem insignificant because the operators would likely have a heightened awareness of the AFW system condition during surveillance testing and the inspector considered it unlikely that an operator would match targets within 4 seconds of an AFW pump automatic start. The inspector considered the temporary modifications addressed the design deficiency well and were implemented in a prompt manner. The specific temporary modifications were:

Temporary Alteration 93-1-018, Braidwood Unit 1  
Temporary Alteration 93-2-025, Braidwood Unit 2  
Temporary Alteration 93-1-036, Byron Unit 1  
Temporary Alteration 93-2-037, Byron Unit 2

- c. Communication and Teamwork: Communication and teamwork between the Braidwood and Byron stations in making the operability determination and performing the temporary modifications were good. Both sites worked on assigned portions of the action plan and shared the information developed in the process. The operability decision was reached through mutual consensus of both sites.
- d. Discussion of Credibility: Although the licensee evaluated event credibility as part of their action plan, the inspector noted that the credibility of the event was a given. The event (losing CST and offsite power) is part of the licensing basis for most nuclear power plants in addition to Braidwood and Byron. 10 CFR part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," notes that multiple failures resulting from a single occurrence are considered to be a single failure. In this case, the loss of both the CST and offsite power due to an earthquake or tornado could be considered a single failure because neither are protected from earthquakes or tornados. GL 91-18 provides the following guidance with respect to consideration of single failures:

A design deficiency in which capability to withstand a single failure is lost should be evaluated and treated as a degraded and nonconforming condition.

- e. Discussion of Using Probabilistic Risk Assessments: While in the process of determining operability, the licensee also considered using probabilistic risk assessment (PRA) techniques to assess credibility. The inspector notes that GL 91-18 provides the following guidance with respect to the use of PRAs to determine operability:

Probabilistic risk assessment (PRA) is a valuable tool for the relative evaluation of accident scenarios while considering, among other things, the probabilities of occurrence of accidents or external events. The definition of operability states;

however, that the SSC [systems, structures, or components] must be capable of performing its specified function(s). The inherent assumption is that the occurrence conditions or event exists and that the safety function can be performed. The use of PRA or probabilities of the occurrence of accidents or external events is not acceptable for making operability decisions.

No violations were identified in this area.

8. Licensee Self-Assessment:

During this inspection, the licensee reviewed their actions associated with the AFW system design deficiency. The inspector concurred with most of the licensee's self-assessment conclusions and considered the review to be good. Specifically, the licensee identified that communication between Braidwood and Byron could have been better before the design deficiency was recognized as an operability concern, and that the minor problems associated with the temporary alterations should have been identified earlier. However, the inspector's assessment differed from the licensee's in that the inspector considered a poor understanding of the licensing basis a contributor towards not taking appropriate corrective action in 1989 and a hinderance to recognizing the design deficiency and operability of the motor driven AFW system in 1993.

No violations were identified in this area.

9. Exit Meeting:

The inspector met with licensee representatives (denoted in Paragraph 1) on January 18, 1994. The inspector summarized the purpose, scope, and findings of the inspection and the likely informational content of the inspection report. The licensee acknowledged this information and did not identify any information as proprietary.