Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

DMB

January 30, 1984

Mr. James G. Keppler
Regional Administrator
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Dresden Station Unit 2
Out-of-Sequence Shutdown
Event on January 9, 1984
NRC Docket No. 50-237

Reference (a): J. G. Keppler letter to Cordell Reed
dated January 10, 1984.

Dear Mr. Keppler

As required by Commonwealth Edison Company procedure, the final report on the subject event has been completed by the Investigating Committee. In accordance with Item 4 of the referenced letter, we are enclosing the final report in the form of an attachment to this letter.

If you have any questions on this matter, please direct them to this office.

Very truly yours,

B. Rybak

B. Rybak
Nuclear Licensing Administrator

lm

Attachment

cc: NRC Senior Resident Inspector - Dresden
R. Walker - NRC Region III

7971N

FEB 1 1984

IE22

1/1

Dresden 2 Out-of-Sequence Shutdown

January 9, 1984

Investigative Committee - Final Report

INTRODUCTION

On January 9, 1984, Dresden Unit 2 was being shut down to the HOT STANDBY condition to repair 2B EHC pressure regulator. During control rod insertions to reduce reactor power, a number of steps in the control rod sequence were skipped, resulting in an out-of-sequence shutdown. As described below, on-site evaluation of the sequencing errors resulted in declaring a potentially significant event based on the guidelines established in Nuclear Stations Division Directive NSDD-A07. As a result, on 1/10/84 an investigative committee was established and an investigation initiated. This report presents the findings of the investigation and specifies long term corrective actions to be taken.

INVESTIGATION COMMITTEE

The committee was appointed by Mr. B. B. Stephenson, Operations Manager NSD and Mr. D. J. Scott, Dresden Station Superintendent on January 10, 1984. The committee consisted of the following personnel:

R. M. Ragan	Dresden Assistant Superintendent - Operating
J. R. Wojnarowski	BWR Plant Support Group Leader, NFS
D. J. Nelson	Dresden Assistant Lead Nuclear Engineer
T. E. Burns	Dresden Training Instructor
J. G. Uremovic	Nuclear Station Operator - Dresden (Operating Union Steward - local 1460)

Investigations were initiated by individual members of the committee on January 9 and 10. The full committee met on January 11 through 13 to continue and complete the investigation.

INITIAL CONDITIONS PRIOR TO EVENT

Dresden Unit 2 had been operating at full power when the determination was made by plant management that a shutdown to HOT STANDBY was required to repair 2B EHC pressure regulator. At 1900 hours on 1-9-84, a 200 MWe/hr load decrease on recirculation flow was begun in accordance with DGP 2-4. At 2100 hours minimum recirculation flow was reached with reactor power level at approximately 415 MWe. Control rod insertion then began in accordance with control rod sequence A2 revision 4. Rods were inserted beginning at step 149, in reverse order as required for shutdown.

EVENT DESCRIPTION

(Background - On 12-27-83, a new copy of control rod sequence A-2 rev. 4 was issued by the Nuclear Engineers. This was to replace the previous copy which had run out of space for NSO signoffs due to

previous control rod maneuvers. On the new copy of the sequence, steps which were currently withdrawn were indicated by a diagonal line drawn through the "OUT" box for the appropriate steps on the sequence [see attached]).

Subsequent to its issuance, the new copy of the A-2 rev. 4 sequence had been used for additional control rod maneuvers and therefore contained numerous steps which contained the NSO initials, date and time in the "OUT" boxes for the appropriate steps. Therefore the sequence contained a combination of initials (primarily towards the end of the sequence) and diagonal lines (primarily toward the beginning) to indicate the current status of sequence steps .

Control rod insertion was in progress, beginning at step 149. Step 123 of the sequence was the first step where the NSO encountered the diagonal line in the "OUT" box intended to mean the step had been withdrawn. However, the NSO interpreted the diagonal line to mean the step should be skipped and he proceeded to the next step which had been initialed and dated as withdrawn, step 121. He then inserted that step, and continued in this fashion, inserting steps which were initialed and skipping steps containing diagonal lines.

At step 112, a trainee began performing the rod insertions, under the direction of a new NSO who had came in early to assist in the shutdown (extra NSO in addition to Unit NSO). Control rod insertions continued, with steps containing diagonal lines continuing to be skipped until step 98 was reached. At this point (40% power) the extra NSO attempted to latch in the Rod Worth Minimizer (RWM). It would not latch in, with RWM error messages "97-NOT LOADED" and "81-INCOMPLETE SEQUENCE" being displayed. They then notified the SCRE who printed out an OD-7, Rod Position Display, off of the process computer to verify symmetrical rod pattern. It was determined that the rod pattern was symmetric and contained no unusual rod configurations (adjacent rod tips). It was then suspected that the RWM would not latch due to core power being at 40%, above the RWM Low Power Alarm Point of 35%. (Apparently error messages 81 and 97, indicating the sequence was not loaded, were not fully understood at this point.) Since RWM operability was not required above 20% power, control rod insertion was resumed (by trainee) using an independent verifier (extra NSO) to further reduce core power and re-attempt RWM initialization. Again, all arrays indicating a diagonal line through the corresponding steps were bypassed.

(Subsequent investigation by this committee determined that System Operational Analysis Department (SOAD) had performed maintenance on the RWM earlier on 1/9/84, culminating in a parity error condition and inability to load the RWM sequence. SOAD then departed from the site. Shift personnel were not informed of the RWM status.)

At step 88 (2145 hours), the NSO's noticed that all steps preceeding step 88 were also "lined-out", and that an apparent error had been made. This was verified, the Shift Engineer informed and a Qualified Nuclear Engineer called in. Reactor power was at 37% at this point, and further control rod manipulations were terminated (2150 hours)

until the Nuclear Engineer arrived on site (2230 hours). The Station Superintendent (D. J. Scott) was notified and a potentially significant event was classified (NSDD-A07), due to the potential for the Banked Position Withdrawal Sequence (BPWS) being violated if the error would have continued below 20% (when the RWM would have been required operable). Assistant Superintendent for Operations, Ron Ragan, was called in and initiated an independent investigation. D. P. Galle, Division V.P. Nuclear Stations, was immediately contacted for concurrence with the actions in progress.

The Qualified Nuclear Engineer evaluated BPWS concerns, preconditioning, rod pattern symmetry. He then proceeded to issue Change Log Instructions per DGP 3-4 to correct the control rod pattern and bring it into compliance with the BPWS rules. Refer to the Unit Nuclear Engineer's Log for a detailed description of the rod pattern recovery.

Attempts were then made to initialize the Rod Worth Minimizer. The RWM would not latch, with error message 61 displayed. The computer software technician was contacted and it was determined that an RWM hardware problem existed (parity error). At 0200 hours, control rod insertions were resumed to attain HOT STANDBY using an independent verifier. Sequence steps indicating a diagonal line were inserted.

SUMMARY OF INVESTIGATION

On 1/9/84, upon determination of the potentially significant event, Ron Ragan, Assistant Superintendent of Operations was called in to the site and conducted an initial investigation of the event. All personnel directly involved in the event were interviewed and log books, computer edits, the DVR and the control rod sequence package were reviewed. His findings concluded that a procedure violation had occurred in that steps in the control rod sequence were skipped without Qualified Nuclear Engineer approval. The steps were skipped when the NSO misinterpreted the meaning of the diagonal line drawn through the "out" box on the sequence steps. No guidance was provided in the procedure or sequence package denoting the intended meaning of the diagonal line.

In addition to the interviews conducted by Mr. Ragan, the following personnel were again interviewed by the full committee on 1/11/84 through 1/13/84 (in some cases by telephone):

Unit NSO
Extra NSO
Shift Engineer
SCRE
Computer Hardware Technician (SOAD)

The EA in training involved was unavailable for interviewing but had been interviewed by R. Ragan on 1/9/84. His role in the event was considered secondary due to his trainee status and the fact that he was acting under the supervision of a licensed NSO.

Also, the committee reviewed the NSO, Shift Engineer and Nuclear Engineer log books, the sequence package in use and relevant operating and general procedures (DGP 3-4, DGP 2-4, DOP 400-2). Computer output

was reviewed to confirm that no Technical Specifications had been violated. The circumstances surrounding the RWM being left inoperable without shift personnel being notified were also investigated (see event description).

As described in the event description, the error occurred when the Unit NSO was inserting control rod steps on the sequence in reverse order. The first 17 steps inserted, spanning over 2 pages in the sequence package had been indicated as withdrawn by NSO initials, date and time. Based on interviews with the Unit NSO, this developed a pattern of inserting steps with initials and skipping steps that were blank (i.e. had not been withdrawn). When the first step containing a diagonal line through the out box was encountered (step 123) the NSO said he immediately associated the diagonal line with "omit" or "not applicable" since that designation is frequently used on other procedures and surveillances to indicate a step was not performed or not required. In addition, he indicated he could not recall previous situations where diagonal lines had been used on the sequence. He proceeded to insert subsequent steps marked with initials and to skip steps marked with a diagonal line. When the EA in training took over rod insertions under the supervision of the extra NSO, the extra NSO reviewed the portion of the sequence that had been inserted, noting that steps with the diagonal line had been skipped. Discussions with the extra NSO on 1/12/84 revealed that he was not experienced with control rod insertion for reactor shutdown and therefore assumed the actions taken by the Unit NSO were appropriate (the Unit NSO is an experienced operator considered conscientious and reliable by others). As a result, he did not question the interpretation of the diagonal lines and rod insertions continued in the same manner as before.

This committee has concluded that use of the diagonal line for indicating the status of sequence steps was ambiguous in that its meaning was not defined in the procedure or sequence package, other designations had been used in the past to indicate steps were withdrawn ("X" or "OUT" written in) and the marking was more commonly used to indicate "not applicable" in other applications. This, in combination with the pattern established of inserting steps with initials and skipping steps without initials, led to the misinterpretation of the diagonal line and the resultant procedure violation when the corresponding steps were skipped.

Both the Unit NSO and the extra NSO indicated that there was no question in their mind that they were proceeding in accordance with the sequence and therefore there was no reason to seek assistance or guidance. It wasn't until essentially all remaining steps contained diagonal lines that it became apparent they had made an error. Immediately upon recognition of the error, rod motion was terminated and the proper management personnel informed. During the interviews with the operators, we questioned them with respect to the intent, purpose and requirements regarding control rod sequences and their familiarity wth the recent out-of-sequence shutdown at Quad Cities. It is our opinion that the operators (particularly the more experienced Unit NSO) are knowledgeable

regarding sequencing requirements and the reasons for skipping certain steps and were familiar with the Quad Cities event and its ramifications. We therefore determine that the cause of the procedure violation was human error and that at no time did the personnel involved knowingly violate a procedure or demonstrate any disregard or lack of concern for procedure requirements. Upon discovery of the error, the operators reacted promptly and in a responsible manner.

During discussions with the computer hardware technician, it became evident that maintenance and testing on the RWM is routinely performed without formal control and documentation. Although shift personnel are normally informed when process computer maintenance is performed, they typically are not informed of RWM maintenance. This issue is addressed further under EVENT CAUSES and CORRECTIVE ACTIONS.

The committee also noted that upon discovery of the error, the subsequent actions by station personnel in correcting and documenting the event were well organized, effective and promptly implemented. Nuclear Station Division Directive NSDD-A07 was effectively implemented and resulted in prompt definition of the event as potentially significant and fostered an environment of immediate investigation, general office involvement and establishment of interim corrective actions within 24 hours of the event.

The following sections specify the principal causes and contributing factors in the event in more detail and provide our recommendations for long term corrective actions. During the course of our investigation, a number of procedural shortcomings were identified which were unrelated to this specific event, but could potentially result in similiar misinterpretations or oversights in the future. Corrective actions in these areas have also been specified.

EVENT CAUSES

The investigation committee has identified two principal causes of the event described above.

1. The Control Rod Sequence Package lacked guidance with respect to the symbols and notes contained within it. Although these notations were properly recorded, there weren't sufficient instructions as to their meaning and significance.

2. On shift personnel failed to undergo a thorough review of the sequence prior to its use. This action is not required by station procedures, yet it is more than likely that the event could have been prevented had it been done. Lack of this review did not constitute good operator practice.

In addition to the root causes described above, the following additional factors contributed to the occurrence:

1. DGP 3-4 did not provide sufficient control over the issuance of new copies of the sequence package. As a result of this, symbols and other ways of denoting that a step in the sequence had been performed were not consistent. Also, the diagonal line through the "OUT" box that was recently being used was also used to mean "not applicable" or an omission in other applications.

2. The Control Rod Sequence Package did not provide a convenient or expedient way of verifying that the actual control rod pattern complied with the desired rod pattern at key points in the sequence.

3. The operating personnel failed to realize the significance of the BPWS break point and Rod Worth Minimizer (RWM) hold point in the context of ensuring they had the proper rod pattern. This is particularly significant in light of the fact that the RWM failed to latch at the proper point during the shutdown.

4. There was insufficient procedural guidance as to how to perform an independent verification of control rod movements in the event of a failure of the RWM. As a result, the independent verifier began without first establishing the proper initial conditions (i.e., correct rod pattern).

5. The unavailability of the RWM was also a contributing factor. The RWM was left in a degraded mode (no sequence loaded) following testing earlier in the day without the shift being informed. Had shift personnel been informed, the RWM could have been made available for the shutdown and would have resulted in the earlier detection of the event.

CORRECTIVE ACTIONS - SHORT TERM

The following items contain the short term corrective actions that were taken prior to Unit 2 startup from hot standby on 1/10/84:

1. Operating Order 23-84 was issued. It requires that a Qualified Nuclear Engineer be present in the Control Room during all control rod evolutions except CRD exercising, emergency conditions, CRAM arrays, or Flow Control Rod maintenance.

2. "Tailgate" training sessions were conducted with the licensed operating personnel from each shift prior to the assumption of their operating responsibilities. This session covered:

   a. the description and communication problems associated with the improper control rod insertion event

   b. the expected operator performance

   c. the expected response from the Nuclear Engineering Department

d. the expected actions of persons or groups working on station computers (particularly the RWM), including their responsibilities to inform the proper operating personnel of equipment status and to conduct their work under proper procedural controls.

3. Training sessions were conducted with the on-site Nuclear Engineers, the Operating Analysis Department, Technical Staff, Computer Engineering personnel and other appropriate personnel on the subject of item 2.d . above.

4. An investigation was begun in accordance with NSDD-A07 as described earlier in this report, and this report is a result of that investigation.

CORRECTIVE ACTIONS - LONG TERM

The investigation of this event, and the similiarities observed in the Quad Cities event indicate that even the most experienced and conscientious operators are susceptable to human error, particularly in situations where procedural guidance or instructions are unclear or ambiguous. Since regardless of administrative effort, human error cannot be totally precluded, the corrective actions for this event have been developed along two general philosophies. Number one, actions are recommended to minimize the occurrence of misinterpretation and resultant procedure violations. Secondly, actions are recommended to provide for the early detection of errors when they occur.

A third category of corrective actions is provided, relating to procedural shortcomings identified during the event. Although these items were not directly related to this event, they represent the potential for similiar misinterpretations or oversights in the future and therefore should be corrected.

Minimize Occurrence of Errors

1. DGP 3-4 should be revised to provide:

- A consistent method of designating that a sequence step has been performed when clean copies or revised sequences are issued. An accompanying legend should be provided, if necessary. The symbol "X" or a diagonal line are not to be used.

- A caution sheet in the Control Rod Sequence Package requiring a signoff by an NSO prior to use of its contents. This sheet would inform the operator to review and familiarize himself with the entire sequence package prior to use. It would also require that, while performing in sequence control rod maneuvers, the status of steps to be skipped should be confirmed by selecting the appropriate rod(s) and verifying their position.

- An index in the sequence package describing its contents.

- See items 1 and 2 of Early Detection of Errors.

- See items 1 and 2 of Additional Corrective Actions.

2. Station procedure DAP 9-1 should be revised to caution against any unexplained or ambiguous use of symbols in any procedures.

Early Detection of Errors

1. Revise DGP 3-4 to provide in the sequence package a convenient means of verifying the proper control rod pattern at key points in the sequence. For example, quarter core maps showing the BPWS breakpoint and the step 98 - RWM loaded rod patterns should be included with a requirement to verify the current rod pattern against them before proceeding.

2. Although DOP 400-2 provides some guidance as to when to bypass the RWM, a procedure review should be initiated to ensure that there is adequate guidance regarding RWM operability. Consideration should be given to require contacting a computer technician prior to bypassing the RWM. In addition, the procedure should describe the proper method for independent verification of control rod movement in the event of failure of the RWM. The independent verifier should be required to verify the current rod pattern is in compliance with the sequence prior to resumption of control rod movement. DGP 3-4 should also be revised to reference DOP 400-2 in the sequence package in order to determine RWM operability and for instructions on independent verification.

3. Establish measures to administratively control work on the RWM or process computer which could render them inoperable or degrade their performance. As a minimum, a procedure should be instituted which directs RWM/computer maintenance and establishes controls such as the caution card system to ensure shift personnel are kept informed of RWM computer status.

Additional Corrective Actions

1. DGP 3-4 should be revised to require that an independent Nuclear Engineer verify that the completed sequence steps have been properly transcribed onto a new copy of the sequence (or a revised sequence) prior to its issuance.

2. Before a new sequence is distributed, it should be verified that this sequence is loaded into the RWM. DGP 3-4 should be revised to reflect this.

3. DGP 3-4 should be revised to require a Qualified Nuclear Engineer to complete a Control Rod Maneuver Request Form (with the Shift Supervisor's approval) prior to any unplanned changes to the Control Rod Sequence Package.

4. The committee recommends that a task force shall be established to investigate control of computer maintenance at all company stations.

Finally, all licensed personnel, nuclear engineers, and other affected departments should receive training on the applicable procedures described above.

CONCLUSIONS

This report represents our final findings and recommendations regarding the Dresden 2 out-of-sequence shutdown on January 9, 1984. With the exception of the procedure violation resulting from inadvertently skipping steps in the sequence, all other aspects of the control rod manipulations and shutdown evolution were in compliance with station procedures and good operating practices. The NSO's involved were found to be knowledgeable and sufficiently trained on control rod sequencing and were well aware of the recent Quad Cities event. No evidence of negligence was found, the operators were guilty only of human error under circumstances which fostered misinterpretation. Procedural deficiencies have been identified and addressed under corrective actions.

We recommend that all corrective actions be implemented by April 1, 1984. Operating Order #23-84 should remain in affect until the recommended revision to DGP 3-4 are completed. At that time the Operating Order should be cancelled.

R. M. Ragan, Chairman

T. E. Burns

J. R. Wojnarowski

J. G. Uremovic

D. J. Nelson

Approved: D. J. Scott

D. P. Galle