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MEMORANDUM FOR: T. M. Novak, Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

FROM: J. E. Rosenthal, Chief
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SUBJECT: HUMAN FACTORS TEAM REPORT - PEACH BOTTOM 3 (1/28/90)

On January 28, 1990, at 8:55 am, Peach Bottom Station Unit 3 operators manually scrammed the plant upon recognition of a large leak of hydraulic fluid from the main turbine electro-hydraulic control (EHC) system. As part of the AEOD program to study the human factors aspects of operational events, a team was sent to the site January 30. The team leader was Matthew Chiramal of AEOD; other team members were George Lanik and Earl Brown from AEOD, and Orville Meyer and Dr. Jerry Harbour from the Idaho National Engineering Laboratory. The team was at the site for three days and gathered data from discussions, plant logs, strip chart recordings, and extensive interviews of plant operators. This memorandum provides a discussion of the event and some findings relevant to human performance.

The plant was at 99.8% power when an alarm sounded indicating low level in the EHC hydraulic fluid reservoir. A major leak from a main turbine control valve was visually confirmed and the Shift Manager directed a fast power reduction. The plant was then manually scrammed from 50% power.

Although manual actions were taken to trip feedwater pumps A and B, the level transient following the scram resulted in a high reactor water level turbine trip signal, which tripped the remaining feedwater pump C. The operators' intent to control reactor water level by using the feedwater system was prevented because they were unable to restart feedwater pump C and did not attempt to restart feedwater pump A or B. Restart of feedwater pump C was hindered by confusion regarding the indicating lights for the feedwater pump turbine reset.

As boil-off reduced reactor level, Reactor Core Isolation Cooling (RCIC) was manually initiated. RCIC was unable to maintain reactor level and High Pressure Coolant Injection (HPCI) was manually operated to inject to the vessel as needed. Swings in reactor water level occurred between the Group II containment isolation set-point and the high level turbine trip set-point. Some difficulties with level control were experienced because HPCI flow instrumentation measures pump discharge flow rather than flow to the vessel. Also, wide range reactor water level indication provided at the HPCI operating panel is not very useful for fine level control.

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With the intent to establish reactor feed via the condensate pumps, a fast reactor pressure reduction was initiated by lowering the EHC pressure set-point to control the turbine bypass valves. Use of the condensate pumps would allow automatic level control and relieve some of the burden on the operators.

However, although reactor pressure was reduced to well below the shutoff head of the condensate pumps, reactor feedwater flow from the condensate system was not achieved because the operators failed to recognize the need to isolate the feedwater pump minimum flow lines.

Because of the continued use of the turbine bypass valves for pressure reduction, by 9:35 am reactor pressure had decreased to about 410 psig and the main steam isolation valves were closed to prevent exceeding the 100 degree per hour cool-down limit. The EHC pumps were stopped which ended the leakage of hydraulic fluid. Reactor cool-down continued with the use of RCIC and HPCI until about 1:30 pm when condensate flow and automatic level control were established.

A more detailed discussion of some of the aspects of this event are provided in the Attachment to this report.

The findings of the team are summarized as follows:

1. STRESSFUL SITUATION: A high degree of mental stress was experienced by the control room crew due to the concern that a potential transient of turbine trip without bypass was about to occur. The high stress continued although a manual reactor scram eliminated the potential for that transient. Equipment problems and unexpected system responses contributed to the stressful situation.

2. ADDITIONAL DEMANDS ON OPERATORS: The reactor level transient following the manual scram caused a trip of the reactor feedwater pump turbine on high reactor water level. This resulted in the need to use HPCI and RCIC to provide reactor inventory and control reactor level. A reluctance to use the suppression pool as a heat sink and the decision to quickly reduce reactor pressure resulted in the need for operator actions to remove as much heat as possible to the condenser before the condenser became unavailable.

3. TEAM CONCEPT: Communications and crew actions during the event demonstrated cooperation and teamwork. Training of control room crews as a team, including the shift technical advisor, is standard policy at this plant and was effective in establishing confidence and trust among the team members. This allowed the crew to function well in spite of the stressful situation.

4. MAN-MACHINE INTERFACE: The operators experienced some difficulty in accomplishing their goals due to problems with the man-machine interface. The lights on the unit 3 control panel for reset of the feedwater pump turbine were not identical with the other unit or with the simulator, which resulted in uncertainty regarding the operability of the feedwater pump.

During some modes of operation, the HPCI and RCIC flow sensors detect pump discharge flow, not flow into the vessel, which precludes accurate control of flow to the vessel. Operators use position indication on the HPCI injection check valve as a means to detect HPCI flow into the the vessel; and this crude means was inoperable during this event.

5. TRAINING AND PROCEDURES: Procedures and training were generally adequate for response to this event. However, procedures and training were not effective for restart of feedwater pumps or to use the condensate pumps to feed the reactor and provide automatic level control. Also, simulator training for alignment of condensate pumps to feed the reactor did not adequately address the need to isolate the minimum flow lines. The procedure used by the operators during this event is a flow-chart with operator actions listed in outline form; detailed actions are addressed in other procedures or training.

The investigation of this event provided valuable information on the performance of a control room crew during a stressful event with several unexpected equipment responses. The AEOD program to investigate human performance during operating events will use this information and investigate other relevant events to provide a basis for generic findings and suggestions for good practices to aid human performance.

/D/

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