UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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

FROM: Jack E. Rosenthal, Chief
Reactor Operations Analysis Branch
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

SUBJECT: HUMAN PERFORMANCE STUDY REPORT - CRYSTAL RIVER UNIT 3 (12/8/91)

On December 8, 1991, the plant was starting up after a short maintenance outage and was at about 10 percent power preparing to roll the main turbine when a slow loss of reactor coolant system (RCS) pressure transient became apparent to the operators. A failure of the actuator for the pressurizer spray line control valve had occurred, which left the valve partially open but indicating closed. The reactor tripped on low pressure and the operating crew bypassed automatic engineered safeguards (high pressure injection, emergency feedwater, emergency diesel generators, and partial containment isolation) actuation for about six minutes. Engineered safeguards were then unbypassed and the high pressure injection and other systems activated. Operators then established manual control of the high pressure injection system to maintain RCS pressure above 1500 psig. The cause of the decrease in RCS pressure remained unknown to the operators until the spray line isolation (block) valve was closed about an hour later, which stopped the pressurizer spray flow and permitted the pressurizer heaters to re-establish control of pressure. It is noted that the operator further withdrew control rods after the RCS pressure decrease began in an effort to control pressure.

As part of the AEOD program to study the human performance aspects of operational events, a team was sent to the site on December 10th. The team leader was John Kauffman of AEOD, other team members were Dr. Harold Ornstein of AEOD, and Orville Meyer of the Idaho National Engineering Laboratory (INEL). The team was onsite for three days and gathered data from discussions, plant logs, strip chart recordings, the station's event investigation report, and interviews with control room operators and other station staff. Region-based inspectors attended interviews conducted by the team.

Enclosed is the report prepared of the results of the human performance study. Specific human performance aspects of this event are addressed in this memorandum.

Bypass of Engineered Safeguards (ES)

The initial bypass of the ES, while the plant pressure decrease was not understood, was an inappropriate operator action, not directed by abnormal or emergency procedures, and not directed by the shift supervision. Because the unexplained pressure decrease could have been a symptom of a small break loss-of-coolant accident (LOCA) that could potentially worsen (leak before break), ES bypass prior to its initiation in this event had significant safety implications. Procedural guidance that limits use of ES bypass is needed. The licensee planned to develop such guidance. A second bypass of ES was in accordance with procedures. However, the second bypass was not conservative with regard to maintaining adequate subcooling margin which suggests that the procedural guidance for ES termination be revisited.

Man-Machine Interface

The event was complicated by the failure of the pressurizer spray valve and its indication due to a common cause. The team considers the dependence on spray valve position indication to be a human factors design weaknesses deserving further examination as a potential generic issue.

Command, Control, Communications and Teamwork

Several observations were made during the event review that indicate that improved operator response might have resulted if there were closer adherence to general principles of command, control, and communications. Examples include the operators' lack of use of the annunciator response procedure for low RCS pressure; the initial bypass of engineered safeguards without direction or concurrence by shift supervision, and shift supervision being unaware or uniformed that ES was bypassed for about six minutes; shift supervision's late declaration of an unusual event and related notifications; and a shift turnover process that did not ensure that all crew members were aware of recent significant changes in the observed operating characteristics of the pressurizer spray valve. Further, if these recent changes had been investigated, the equipment problem with the pressurizer spray valve may have been corrected and the event averted. The team noted that the involvement of "management on shift" for the reactor startup contributed positively to the event progression. "Management on shift" noted that ES was bypassed and recommended that the pressurizer spray block valve be closed.

Procedures

Several observations were made regarding the contribution of procedures to the event. The annunciator response procedure for RCS low pressure, although not used by the operators, was written to be applicable for response to control circuit faults. At the beginning of the event the annunciator response procedure did not provide or reference the operator to the appropriate actions to diagnose and correct the cause of the pressure decrease like those contained in AP-380, "Engineered Safeguards Actuation" abnormal procedure. Operators did not execute all steps of AP-380 because ES termination criteria were met. The station's administrative procedures do not caution against or prevent exiting an abnormal or emergency response procedure before checking the remaining sections of the procedure. This appears to be particularly relevant in cases where the event or transient is not understood and where the abnormal or emergency response procedure may contain the needed guidance for the operators. Thus, there are areas where the technical content of procedures, or the coordination (cross reference) between procedures, or logic for procedure exit can be improved.

Overall

Although the consequences of the Crystal River event were benign, the event illustrates potentially serious generic concerns. During this event, an operator bypassed ECCS even though the plant was experiencing an undiagnosed depressurization. The core damage at Three Mile Island Unit 2 was a direct result of operators manual termination of safety injection based on an inaccurate diagnosis of existing plant conditions. The greatest concern from this review is that the lesson learned from Three Mile Island regarding inappropriate bypassing of ECCS was not retained.

Another similarity of the TMI-2 and Crystal River events were deficiencies in the man-machine interface. As a result of TMI-2, plants were backfitted with positive flow indication on some important equipment such as PORVs. The reliance upon pressurizer spray valve position indication raises the question of whether another means such as flow indication is needed. Clearly, these are not as significant as PORV indication because an open PORV causes a loss of coolant. However, the issue may warrant further study.

The event also highlighted several areas for improvement at Crystal River 3, including the need for improved formality of the conduct of control room activities, knowledge of emergency preparedness requirements, and the shift turnover process.

This report is being sent to Region II for appropriate distribution within the region. The ROAB staff is preparing a proposed generic communication concerning this event.

Original signed by
Earl J. Brown for

Jack E. Rosenthal, Chief
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Enclosure: As stated

cc w/enclosure:
P. F. McKee, Director
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or the coordination (cross reference) between procedures, or logic for procedure exit can be improved. In addition to the station lacking procedural guidance for the bypass of ES prior to initiation, it appears that guidance for ES termination be revisited as discussed previously.

Overall

Although the consequences of the Crystal River event were benign, the event illustrates potentially serious generic concerns. During this event, an operator blocked ECCS even though the plant was experiencing an undiagnosed depressurization. We also note an earlier event at McGuire Unit 1 on March 7, 1989, where operators blocked ECCS during a steam generator tube rupture event. The core damage at Three Mile Island Unit 2 was direct result of operators manual termination of safety injection based on an inaccurate diagnosis of existing plant conditions. Our generic concern is that the lessons learned from Three Mile Island have been forgotten.

Another similarity of the TMI-2 and Crystal River events were deficiencies in the man-machine interface. As a result of TMI-2, plants were backfitted with positive flow indication on some important equipment such as PORVs. The lack of flow indication on the pressurizer spray line and the lack of direct pressurizer spray valve position indication are similar man-machine deficiencies. Clearly, these are not as significant as PORV indication because an open PORV causes a loss of coolant. However, the issue may warrant further study.

The event also highlighted several areas for improvement at Crystal River 3, including the need for improved formality of the conduct of control room activities, knowledge of emergency preparedness requirements, and the shift turnover process.

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