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NUCLEAR REGULATORY COMMISSION
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APR 19 1993

MEMORANDUM FOR: Denwood F. Ross, Acting Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

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

SUBJECT: HUMAN PERFORMANCE STUDY REPORT - PALO VERDE UNIT 3 (2/4/93)

At 3:22:52 p.m. on February 4, 1993, with Unit 3 at 100 percent power, the "A" main feedwater pump turbine (MFWPT) high vibration annunciator alarmed when the MFWPT had decreased to 1500 rpm from its normal 4500 rpm. All eight steam bypass control valves had opened and steam generator (SG) levels were decreasing rapidly. The primary side reactor operator (RO) verified a reactor cutback had not occurred and alerted the Shift Supervisor (SS) and the Control Room Supervisor (CRS). After verifying low steam generator levels and low MFWPT suction pressure, the SS concurred with the secondary side RO's recommendation to trip the "A" MFWPT. Tripping this pump would initiate a reactor power cutback and potentially avoid a reactor trip. However, an automatic reactor trip on low SG #2 level occurred at 3:23:52 p.m. before the MFWPT could be manually tripped. Auxiliary feedwater actuation system (AFAS 1 and 2) followed immediately.

By 3:24:34 p.m., the reactor coolant system temperature and pressure had decreased, causing safety injection and containment isolation signal (SI/CIS) actuations. By the time the secondary side RO checked SG levels and flow using the safety function flow charts, he found no auxiliary feedwater (AFW) flow (because the control system had recovered the SG levels). SG 1 level was slightly higher than SG 2 level. AFW valve HV-30 indication showed that it was not in its required position despite a proper control signal. Both the valve and its associated pump were declared inoperable. This produced confusion as to the status of the AFW valves and response of the main feedwater (MFW) downcomer valves. The CRS and secondary RO discussed using the operating B MFWPT to feed the SGs, which was not included in the emergency procedure (EP). The operators took manual control of the SG 2 downcomer valve and closed the SG 1 downcomer isolation valves to stabilize SG levels.

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The SS declared a Notification of Unusual Event at 3:46 p.m. and terminated it at 5:00 p.m. after the SI termination criteria was verified satisfactory and the high and low pressure safety injection pumps were secured. SI/CIS signals were reset at 6:00 p.m. and diesel generators A and B, which had started on the SI and never loaded, were stopped at 8:05 p.m. and 8:10 p.m..

As part of the AEOD program to study the human performance aspects of operational events, a team was sent to the site February 9. The team leader was Jose Ibarra of AEOD; other team members were Robert Spence of AEOD, and William Steinke of the Idaho National Engineering Laboratory (INEL). The team was at the site for 2 days and gathered data from discussions, plant logs, strip chart recordings, and interviews with the plant staff. Enclosed is the INEL report on the results of this human performance study. Specific human performance aspects of this event are addressed in this memorandum.

Shift Staffing and Operator Response

The shift staffing was adequate. Having a third RO as part of the normal shift crew was beneficial since it allowed the other two ROs to address their EPs without having to divert their attention to backpanels. Additional personnel were available due to the time of the event. An administrative aide assisted the emergency coordinator. A dedicated shift technical advisor for each of the three units also provided additional resources. Licensee personnel quickly diagnosed the problem, made a decision to trip the MFWPT, and initiated recovery actions. When control board indication was incorrect or unavailable, operators used backup indication or field personnel. A similar loss of feedwater (FW) without a MFWPT trip occurred on February 17; the same operators were able to more quickly diagnose the problem and had authority to trip the "A" MWFPT which caused an automatic reactor power cutback to lower power instead of a reactor trip.

Operations Procedures

The operators satisfactorily used safety function flowcharts which were an improvement over the past procedures. They had simulator training on the new EPs, issued 6 months before the event, and found them more comprehensive but more time consuming. Overriding the HPSI and LPSI systems was done by procedure and reinitiation criteria was monitored closely by the primary RO. Several difficulties with the EPs occurred during recovery. Procedures did not quickly restore the electrical system and did not consider using the FW system to feed the SGs. The procedure directed manual control of the pressurizer spray valve which could result in excessive RO task workload in other emergency conditions. The EP prolonged the time from automatic initiation to shutdown of the emergency diesel generators.

Command, Control, and Communications

Based on post event interviews, operator communications were good during the course of the event. The SS and CRS worked with operators who had been together as a crew for 1 month. The licensee practice of keeping SS and CRS teams intact was a positive influence. Within a few seconds, effective teamwork allowed assessment and decision making. Command and control was effectively shifted from the SS to CRS, as the situation dictated. As the number of people increased in the control room (CR), the SS demonstrated proper command and control by moving extra personnel to the satellite technical support facility to lower noise levels and minimize distractions. The SS stationed himself in the CR in a manner making him readily available to the crew. Transferring the emergency coordinator duties to an available qualified person enhanced the SS oversight capability.

Training

The experience of personnel interviewed was above industry norm. Although operators had been trained on a loss of a MFW pump, this event required them to diagnosis conditions not previously seen.

Human-Machine Interface

The CR SG level on the CRT was behind actual plant conditions since the current computer system is not able to adequately display fast transients. AFW and SI flows do not have a recorder to readily identify the amount of water injected.

Overall

The response to this event was successful. Many strengths were identified. The operators responded quickly to assess the situation and recover with minimal problems. There were some concerns identified in the areas of human-machine interface and EPs. This report is being sent to the Office of Nuclear Reactor Regulation for appropriate distribution to the licensee and region.

Original signed by Jack E. Rosenthal
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Office for Analysis and Evaluation
of Operational Data

Enclosure: As stated

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