50-282

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

MAY 12 1992

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 - PRAIRIE ISLAND UNIT 2 (02/20/92)

On February 20, 1992, the Unit 2 reactor was in a cold shutdown condition, approximately 2 days into a scheduled refueling outage. Reactor vessel draindown to "midloop" was in progress so that steam generator primary side manways could be removed to allow steam generator nozzle dam installation. As draining progressed, the licensee observed indications of gas ingestion in the running residual heat removal (RHR) pump. Draindown was stopped and the RHR pump secured. Water level was raised by using two charging pumps. When reactor water temperature reached 190° F, operators entered their emergency operating procedures (EOP)s and used the unaffected RHR pump with suction from the refueling water storage tank to restore reactor water level. After level was restored, the unaffected RHR pump was realigned in the shutdown cooling mode.

The shutdown cooling function of RHR was lost for approximately 21 minutes. Core temperature as indicated by the trended core thermocouple increased from 133° F to 221° F. Subsequent chemistry samples indicated that no fuel damage occurred. No release to the environment occurred.

Later on February 20, 1992, Region III formed an NRC Augmented Inspection Team (AIT) to perform an onsite special review of this event. The AIT team leader was Mr. B. Jorgensen of Region III. Other team members included J. D. Smith, Region III/Zion SRI, W. Lyon, NRR/SRXB, A. Masciantonio, NRR/PD31, J. Kauffman, AEOD/ROAB, D. Gamberoni, NRR/OEAB, M. Leach, Region III, and W. Steinke, Idaho National Engineering Laboratory (INEL). INEL provided assistance as part of an AEOD program to study human performance. The team was onsite February 22 through February 25, 1992, and gathered data from discussions, plant logs, strip chart recordings, and interviews of plant operators.

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

Procedures and Training–Control of Nitrogen Overpressure

The draindown procedure contained numerous weaknesses. The guidance for control of nitrogen overpressure (a nitrogen overpressure was maintained to facilitate draindown) was sparse. Control of nitrogen overpressure was important because it affected the draindown rate and the reactor water level instruments. With nitrogen pressure greater than about 3.5 psi, the new electronic level instruments (ELIs) would not indicate due to being over-ranged. Additionally, the tygon tube readings required manual corrections for nitrogen overpressure. The operators and System Engineer (SE) were not aware that the ELIs would not indicate with a high nitrogen pressure.

Operators had difficulty performing the tygon tube correction calculations, partially due to rounding errors (operators did not realize that rounding 0.4 psi when multiplied by a correction factor of 2.307 feet per psi would introduce an unacceptable error of nearly one foot) and partially because the draindown procedure contained a correction factor table that only went to 1.5 psi nitrogen overpressure. In addition, the calculations required conversions from feet and inches to feet and tenths of feet. The calculations also caused a time delay and contributed to operator frustrations.

Procedures and Training–Prerequisites for Draindown

Per the draindown procedure, operators considered the ELIs to be "operable" prior to commencing draindown. It would have been more appropriate for the operators and the procedure to consider the ELIs inoperable until a cross-comparison of tygon tube and ELIs could be made that showed the ELIs were on-scale, responding and accurate (in addition, a final functional test of the ELIs remained to be completed during the draindown). An appropriate stop point for a true "operability" determination would be when reactor water level was near the reactor vessel flange. Considering the ELIs inoperable would have placed additional procedural restrictions on the operators. The procedure did not contain an appropriate stop point to ensure that the ELIs were responding, rather, the procedure required a comparison when the ELIs came on scale, but the ELIs were not responding (were inoperable) due to the high nitrogen overpressure. Hence, a comparison was not made.

The draindown procedure contained a strength in that much important plant equipment was required to be operable before commencing draindown. Another strength was the requirement to calculate a "time to boiling" if RHR cooling was lost. This calculation highlighted the expected rapid heatup.

Procedures and Training–Draindown

The draindown procedure did not contain several "good practices" that might have averted the loss of the operating RHR pump. For example, the procedure did not require that the drain rate be reduced as "midloop" was approached, nor were operators required to periodically record water level during the draindown. Recording water level would have allowed the supervisors a better awareness of draindown progress. Operators informally recorded uncorrected water level when the parameter of interest was corrected water level. Operator training on draindown evolutions was limited to classroom instruction and walkthroughs because of simulator modeling limitations.

Teamwork, Command, Control, and Communications

The control room operating crew was augmented by an extra crew of three reactor operators (ROs). Two of these extra ROs were assigned to the draindown. The junior of the two ROs was placed in charge of the draindown as he was the first to arrive. The draindown ROs were assisted by an SE who had only participated in a portion of a prior draindown. There was an assumption by the shift supervision that the ROs and SE were experienced in draindowns and did not require continual supervision. There was apparent confidence because of many prior successful draindowns.

There was an apparent hesitation by the draindown crew to communicate some of their concerns to shift supervision. This may have been because the ROs were not working with their normal crew and supervisors. In interviews, an RO stated that he was very uncomfortable with the progress of the evolution, but that he felt he needed a more concrete reason to stop the draindown.

Weak command and control, and lack of an aggressive questioning attitude [illegible] ere evident in that the draindown was not stopped when unexpected instrument and [illegible] response was experienced, or when operators had difficulty determining corrected [illegible] level. Shift supervision did not anticipate the difficulty the ROs would have performing level correction calculations when the SE left the control room, nor was supervision of the draindown increased when the SE departed the control room. Operations had apparently relied on SE guidance in this and prior draindowns to successfully accomplish the evolution without recognizing their dependence on that guidance.

Shift supervision exercised strong command and control in responding to the loss of shutdown cooling. Shift supervision insisted that the emergency response procedures be followed which resulted in a thoughtful, organized, pre-planned response.

Procedures and Training–Event Response

The abnormal and emergency response procedures used in the event were a strength, although the AIT report of this event contained specific technical comments regarding emergency procedure deficiencies for other situations. From a human factors perspective, operators and other licensee staff appeared to be uncertain whether the EOP entry conditions were "or" or "and" conditions, the text of the EOP involved in this event did not state whether the entry conditions were "or" or "and" either. One of the EOP entry conditions was reactor coolant system temperature of 190° F, which in this event did not allow much time for EOP implementation before an unplanned mode change occurred. Some of the phrases in the EOP and the event classification procedure were vague and open to interpretation, (e.g., "RHR pumping capability has been lost and cannot be restored in a timely fashion").

Design Limitations

One of the fundamental causes for many of the weaknesses described above was an incomplete understanding of the design limitations of the new ELIs. If the design were understood, for example, the procedure writer would not have required (and the onsite review process would not have approved) a nitrogen overpressure that precluded the ELIs from being operable. Further, the ELIs were intended to be independent from each other, and the tygon tube, when, in fact, all were pressure-compensated, either manually or electronically using input from a single pressure transmitter. The operating crew may have discounted the importance of the new ELIs because many previous draindowns had been successfully accomplished without the ELIs.

Overall

A combination of factors led to a situation where the draindown crew believed they knew the current water level when they did not. Despite questions about instrument and system behavior, operators continued to drain and reached a level below that necessary for continued operation of the running RHR pump, resulting in a temporary loss of shutdown cooling. Contributing factors to low situational awareness included weaknesses in procedures and training; weaknesses in command, control, and communications; engineering support that was reduced compared to prior draindowns; and a limited understanding of the new electronic level instruments design.

The event, overall, was benign. However, it reaffirmed several important lessons about "midloop" operations such as the need for operable and accurate instrumentation, control of risk by maintaining redundant backup systems available, and the need to have and follow good emergency response procedures.

Three licensee strengths prevented this event from being more significant than it was: (1) shift supervision was strong during the recovery portion, (2) event response procedures were followed and were adequate, once entered, for this event, and (3) equipment was available to support recovery.

The event also highlighted numerous areas for potential enhancement at Prairie Island. If this event is viewed as a random sample of the "state" of Prairie Island; then the number, variety, and significance of the observations of the AIT report and the INEL human performance report suggest that while Prairie Island is doing many things well, the internal oversight processes are not functioning proactively. Similarly, operators and their supervisors did not display an aggressive, questioning attitude during the event. Site staff, however, appeared to be making an honest effort to learn from this event and were taking appropriate corrective actions for specific identified problems.

This report is being sent to Region III for appropriate distribution within the region.

Original signed by Jack E. Rosenthal

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

Enclosure: As stated

cc: M. Sellman, Plant Manager
Prairie Island Nuclear Generating Plant
1717 Wadonade Dr. E. (Rt. 2)
Welch, MN 55089

Distribution w/enclosure:

PDR	EJordan	SRubin	AMasciantonio, NRR
Central File	DRoss	PBaranowsky	BJorgensen, RIII
ROAB R/F	TNovak	KBlack	MDapas, SRI
DSP R/F	VBenaroya	MTaylor, EDO	FCoffman, RES
JKauffman	LSpessard	RSavio, ACRS	JWermiel, NRR
GLanik	EWeiss	KRaglin, TTC	JLieberman, OE
JRosenthal	ETrager	AChaffee, NRR	WSteinke, INEL
	PLewis, INPO	DQueener, NOAC	VChexal, EPRI

ROAB:DSP:AEOD	ROAB:DSP:AEOD	ROAB:DSP:AEOD
JKauffman:mmk	GLanik	JRosenthal
5/5/92	5/6/92	5/7/92