

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

JAN 2 2 1991

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 FACTORS STUDY REPORT - BRAIDWOOD 1 (10/04/90)

On October 4, 1990, at 1:24 a.m., Braidwood Unit 1 experienced a loss of approximately 600 gallons of water from the reactor coolant system (RCS) while in cold shutdown. Braidwood 1 technical staff was conducting two residual heat removal (RHR) system surveillances concurrently, an isolation valve leakage test and valve stroke test. After completing a leakage measurement per one surveillance procedure, a technical staff engineer (TSE) in the control room directed an equipment attendant to close an RHR system vent valve. However, before those instructions could be carried out, another TSE in the control room directed that an RHR isolation valve be opened per another surveillance procedure. While the equipment attendant was still closing the vent valve, RCS coolant at 360 psig and 180 °F exited the vent valve, ruptured a tygon tube line and sprayed two engineers and the equipment attendant in the vicinity of the vent valve. This loss of coolant was reported to the control room and control room personnel quickly identified the cause of and isolated the leak.

Later on October 4, 1990, Region III formed an NRC Augmented Inspection Team (AIT) to perform an onsite special review of this event. The AIT team leader was Mr. W. D. Shafer of Region III. Other team members included S. Diab, NRR/PRAB, S. G. Du Pont, Region III/Dresden SRI, W. J. Kropp, Region III/Byron SRI, S. D. Sands, NRR/PD32, E. A. Trager, AEOD/ROAB, and J. L. Harbour, Idaho National Engineering Laboratory (INEL). INEL provided assistance as part of an AEOD program to study the human factors aspects of events. The team was at the site October 4 through 6 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 factors study. Specific human performance aspects of this event are addressed in this memorandum.

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Task Awareness

Braidwood operational and technical personnel were at three levels of task involvement and awareness: low, medium, and high. This was a major factor contributing to this event.

The shift engineer (SE), shift control room engineer (SCKE), Unit NSO and SA did not participate in the execution of the two surveillances and are considered to have had a low level of involvement and awareness. In addition, these personnel were unaware that the stroke test was being conducted.

Technical staff engineer (#3) and the auxiliary NSO had a moderate level of task involvement and awareness. Although they directly participated in some of the activities associated with the two procedures, both individuals appeared to lack an overall understanding of the systems configuration at all times. The auxiliary NSO did not involve himself in monitoring the state of the system while executing the valve manipulations and, thus did not serve to provide redundancy to the activities of technical staff engineers 1 and 2.

Technical staff engineers 1 and 2 had a high level of task involvement and awareness and were directly involved in all aspects of conducting and coordinating the two procedures. As a result success in this activity depended to a large extent on the performance of TSEs 1 and 2. However, their performance was affected because they were trying to conduct a difficult coordination task (perform two different surveillance procedures simultaneously on the same system) while fatigued (having been on the job for more than 17 hours). Furthermore, there were no redundancies or checks on their performance by operations personnel, which would be expected in a normal command, control, and communications structure in the control room.

Task Coordination

The task of coordinating two procedures in parallel without any written guidance is fairly complex and dynamic and requires knowledge-based behavior as opposed to rule-based behavior, and the probability of making an error is relatively high in such situations. This probability can be increased if the person involved in the activity is in a state of physical or mental fatigue, as might be the case after working for more than 17 hours. In executing dynamic tasks, it is critical that system redundancies or checks be in place to catch and prevent such errors. No such checks or redundancies were in place at Braidwood Unit 1 immediately preceding the event at 1:20 a.m. on October 4, 1990.

Command, Control, and Communications

A normal command, control, and communications structure was not present during the execution of these two surveillances. The SE, SCRE, and Unit 1 NSO were not sufficiently in the

command, control and communication loop to offer oversight of the technical staff engineering activities, nor be aware of changes in the RCS configuration.

This event emphasizes the need for the operations shift organization to be thoroughly aware and in control of activities that may have an effect on the reactor plant.

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

Original signed by

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

Enclosure: As stated

cc: Kurt Kofron, Station Manager Braidwood Nuclear Power Station Route 1, Box 84 Braceville, IL 60407

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