UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

STAFF EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INDIVIDUAL PLANT EXAMINATION FOR

COMMONWEALTH EDISON COMPANY

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-237 AND 50-249

1.0 INTRODUCTION

On January 28, 1993, the Commonwealth Edison Company (ComEd, the licensee) submitted the Individual Plant Examination (IPE) for Dresden, Units 2 and 3, (the base IPE) in response to Generic Letter (GL) 88-20 and associated supplements. On August 24, 1994, the staff sent a request for additional information (RAI) to the licensee. The licensee responded in a letter dated October 28, 1994.

A staff evaluation report (SER) was issued on November 9, 1995. In this report, the staff concluded that it "could not reach the conclusion that ComEd has met the intent of GL 88-20." The licensee responded to the staff's concerns by revising and submitting the "Dresden Individual Plant Examination, Response to NRC Staff Evaluation Report and Modified Dresden IPE" (the modified IPE submittal), on June 28, 1996. A teleconference also took place on January 13, 1997, between the licensee, the staff, and its consultant, Brookhaven National Laboratory.

The staff's review of the modified IPE submittal focused on whether the licensee addressed the concerns documented in the November 9, 1995, SER. This evaluation documents the staff's findings and conclusions regarding the licensee's resolution of the staff's concerns for the Dresden IPE.

2.0 EVALUATION

In the SER of November 9, 1995, the staff expressed concerns in several areas. In particular, it was noted that the licensee did not provide sufficient evidence for the staff to conclude that the following were treated appropriately and/or comprehensively: support system failures resulting in initiating events; isolation condenser (IC) seal leakage during station blackout (SBO); and human events under pre- and post-initiating event conditions. In addition, the common-cause failures (CCF) used in the base IPE were significantly lower than generic boiling water reactor (BWR) factors. The licensee explicitly addressed the staff's concerns in the modified IPE submittal.

Regarding support system failures resulting in initiating events, the licensee modeled eight new support system failure-based initiators: one related to loss of service water (LSW); four related to loss of major 4kV alternating current buses; one related to loss of instrument air; and two related to loss of room cooling. The initiating event frequencies used appear to be reasonable and major failure modes appear to have been considered. The combined core damage frequency (CDF) contribution from all new initiators is less than 1 percent.

The licensee addressed the IC seal leakage by modifying the long-term SBO model to account for pump seal failure upon loss of all seal cooling. It also incorporated control rod drive cross-tie as an IC makeup source, and a newly proceduralized operator action to open the IC makeup valves before a loss of direct current (dc) power, in order to prevent IC failure upon battery depletion. The staff found the licensee's treatment of IC pump seal leakage to be reasonable.

Regarding human reliability analysis (HRA), the staff had noted the apparent exclusion of most pre-initiator human events (including those associated with calibration activities). In response to this issue, the licensee notes that while only six pre-initiator human actions were assigned human error probabilities (HEP) in the base IPE, it actually included numerous ("out-of-calibration") basic events for single and multiple instruments whose failure probabilities were derived by generic data that involved both miscalibration human events and hardware failures.

To address the pre-initiator human event analysis issue, the licensee revised the quantification of these basic events on the basis of an approximate 5-year period (1991-1995) event history. The licensee reviewed thousands of "actual performance personnel" records. One actual miscalibration event was found and was taken into consideration in the estimation of HEPs related to miscalibration. A discussion of the derivation of the HEPs is provided and the resulting HEPs appear to be reasonable. In addition, the revised pre-initiator human event analysis did lead to the identification of insights and improvements. Therefore, the staff finds the licensee's treatment of pre-initiators in the modified IPE to be reasonable.

Another limitation of Dresden's HRA was the treatment of post-initiator event analysis, specifically the incorporation of plant-specific performance shaping factors (PSF), the treatment of diagnostic error, the consideration of the time needed and the time available to perform an action, and the treatment of the influence of accident progression on human performance.

In order to address these concerns, the licensee reanalyzed approximately 15 "important" post-initiator human actions (importance was based mainly on risk achievement worth values) and added 18 new actions using two methods: one method for modeling failures in detection, diagnosis, and decision-making (also identified by the licensee as "cognitive" failures); and one for failures in task executive. The Cause-Based Decision Tree (CBDT) method (developed by the Electric Power Research Institute [EPRI]) was used to quantify the likelihood of errors in detection, diagnosis, and decision-making, and the Technique for Human Error Rate Prediction (THERP) described in NUREG/CR-1278 was used to quantify errors associated with task executive. Compared with the method used in the base IPE for Dresden, the combination of the CBDT and THERP methods provides a more realistic basis for assessing post-initiator human actions.

Application of the CBDT method requires the analysts to consider plant-specific and scenario-specific factors. In addition, it appears that for the reanalysis, the licensee reviewed plant operating history, had discussions with training staff and operating personnel, and looked at detailed control room reviews, NRC and Institute of Nuclear Power Plant Operations audits of training, and "other initiatives." The revised approach appears to have adequately addressed the staff's concerns regarding consideration of plant-specific factors.

Regarding cognitive error, it is stated in the modified IPE submittal that the CBDT method evaluates it on the basis of an assessment of PSF, such as data availability, attention failure, miscommunication and misreading of data, misleading information, missing or misreading procedural steps, misinterpretation of instructions or decision logic, and deliberate violations. Recovery factors, such as reviews by other crew members, including the shift technical advisor are also taken into consideration to reduce the calculated HEPs only if there is sufficient time. On this basis, the staff concludes that the licensee did address the staff's concern regarding the treatment of diagnosis for the more important human factors.

Regarding the treatment of time, unlike other EPRI methods, the CBDT method incorporates time implicitly. Therefore, those actions in which the difference between the time available and the time required to perform the actions is short and the possibility exists for the operators to fail to accomplish the actions in time are not evaluated directly as a function of time. Consequently, with the CBDT method, the potential exists for underestimating HEPs for events with short timeframes. However, the licensee did state that the time pressure was taken into account by increasing the stress factor (addressed within THERP) in the evaluation of the basic HEPs. The time available and the time required to perform an action were provided for all of the post-initiator events modeled. A review of these actions, their timing, and the new and old HEPs listed suggests that the revised HEPs are reasonable.

Regarding the influence of accident progression on human performance, the licensee stated that during the revision to the HRA, operator actions were reviewed on a sequence-by-sequence basis. The appropriate HEP was determined, considering plant conditions, dependency on previously failed operator actions, the time available to perform the action, stress levels, and opportunities for recovery. Dependencies between operator actions were addressed using the dependency model from THERP (NUREG/CR-1278). The different cases (and HEP) associated with an action during different accident conditions were provided. Therefore, the staff concludes that the licensee addressed its concerns for the treatment of the accident progression on human performance.

The base IPE had assumed that the operators will be 100 percent successful in inhibiting the automatic depressurization system during an anticipated transient without scram (ATWS). The licensee revised this success criterion and calculated an operator failure probability of 3.0E-3. It is noted in the submittal that this change resulted in a 44 percent increase of the total CDF for each unit.

Regarding the use of low CCF, the licensee established a threshold value of 0.01 for systems with a two-of-two train configuration. This resulted in an automatic raise of those factors that were below 0.01. With this approach, the licensee addressed the staff's concerns about very low CCF, but in a limited way. The CCF factors remained lower than generic and the licensee did not provide a strong support for their applicability at Dresden. For example, it was indicated that the plant-specific beta factors for motor-operated valves (MOV) were estimated by examining MOV failures occurring close in time. However, CCF do not have to only occur close in time and, if the examination for common cause is only limited to close-in-time related failures, it may lead to an underestimation of CCF. The staff believes that it is unlikely that this limitation has affected the licensee's overall conclusions from the IPE and its capability to identify vulnerabilities. It may, however, have limited its ability to gain insights and identify improvements.

In the modified IPE submittal, the licensee reported a CDF for Unit 2 of about 3E-6/reactor-year from internally initiated events and internal floods, and a CDF of about 5E-6/reactor-year for Unit 3. The contribution from internal flooding was found to be insignificant on both units. The difference in the CDF estimates between the two units is due to a hardware modification that eliminated loss of dc power as an initiating event at Unit 2. It is noted that these CDF values are essentially the same with the CDF values of about 4E-6/reactor-year reported in the October 1994 RAI ("the enhanced model), but significantly lower from the CDF of about 2E-5/reactor-year reported in the base IPE.

The relative initiating event CDF contributions for Unit 2 are as follows: loss-of-coolant accidents (LOCA) contribute about 40 percent (medium about 39 percent, large and small combined <1 percent); loss of offsite power (LOSP) about 32 percent (dual unit about 24 percent, single unit about 8 percent); ATWS about 23 percent; general transients about 4 percent; LSW about 1 percent; and interfacing system LOCAS (ISLOCA) <1 percent. As an accident type, SBO contributes about 20 percent.

The relative initiating event CDF contributions for Unit 3 are as follows: loss of dc contributes about 32 percent; LOCAs about 27 percent (medium about 26 percent, large and small combined about 1 percent; LOSP about 22 percent (dual unit about 16 percent, single unit about 6 percent); ATWS about 15 percent; general transients about 3 percent; LSW about 1 percent; and ISLOCA <1 percent. The SBO CDF contribution was not explicitly stated for (dual unit about 16 percent, single unit about 6 percent); ATWS about 15 percent; general transients about 3 percent; LSW about 1 percent; and ISLOCA <1 percent. The SBO CDF contribution was not explicitly stated for Unit 3 in the updated submittal; it appears, however, that it is about 13 percent.

The licensee did not report in the modified IPE submittal any vulnerabilities for Dresden, Units 2 or 3. The licensee, however, made a hardware modification to Units 2 and 3 by which the reactor does not scram upon loss of dc bus. This modification eliminated loss of dc bus as an initiator for both units. The licensee also improved procedures for continued use of the IC following discharge of station batteries and for the continued use of emergency core cooling low-pressure pumps upon loss of the suppression pool cooling. These modifications, combined with the revisions of the base IPE, resulted in a decrease in the CDF by a factor of about one order of magnitude for Unit 2, and a factor of about four for Unit 3.

3.0 CONCLUSION

On the basis of these findings from the review of the modified IPE submittal, the staff finds that the licensee's IPE is complete with regard to the information requested by GL 88-20 (and associated guidance, NUREG-1335) and concludes that the licensee's IPE process meets the intent of GL 88-20.

It should be noted that the staff's review primarily focused on the licensee's ability to examine Dresden, Units 2 and 3, for severe accident vulnerabilities. Although certain aspects of the IPE were explored in more detail than others, the review is not intended to validate the accuracy of the licensee's detailed findings (or quantification estimates) that stemmed from the examination. Therefore, this SER does not constitute NRC approval or endorsement of any IPE material for purposes other than those associated with meeting the intent of GL 88-20.

Principal Contributor: E. Lois

Date: October 2, 1997