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

STAFF EVALUATION REPORT

INDIVIDUAL PLANT EXAMINATION

DAVIS-BESSE NUCLEAR POWER STATION, UNIT NO. 1

DOCKET NO. 50-346

1.0 INTRODUCTION

On February 26, 1993, the Toledo Edison Company submitted the Davis-Besse Nuclear Power Station (DBNPS) Individual Plant Evaluation (IPE) in response to Generic Letter 88-20, "Individual Plant Examination For Severe Accident Vulnerabilities," and associated supplements. On June 22, 1995, the staff sent questions to the licensee requesting additional information. The licensee responded in a letter dated September 11, 1995.

A "Step 1" review of the DBNPS IPE submittal was performed and involved the efforts of Brookhaven National Laboratory (BNL). The Step 1 review focused on whether the licensee's method was capable of identifying vulnerabilities. Therefore, the review considered (1) the completeness of the information and (2) the reasonableness of the results given the DBNPS design, operation, and history. A more detailed review, a "Step 2" review, was not performed for this IPE submittal. The details of BNL's review findings are included in the technical evaluation report (TER) appendix to this staff evaluation report (SER).

In accordance with GL 88-20, Toledo Edison Company proposed to resolve Unresolved Safety Issue (USI) A-45, "Shutdown Decay Heat Removal Requirements." The licensee also proposed, and the staff agreed to consider USI A-17, "Systems Interactions in Nuclear Power Plants," for resolution with the submission of the internal flood portion of the IPE submittal.

In addition, the following Generic Safety Issues (GSIs) were included by the licensee in the IPE submittal for resolution:

GSI-23, "Reactor Coolant Pump Seal Failures,"

GSI-105, "Interfacing Systems Loss-of-Coolant-Accidents in Pressurized Water Reactors,"

GSI-128, "Electric Power Reliability and Related Issues,"

GSI-143, "Availability of Chilled Water Systems and Room Coolers," and

GSI-153, "Loss of Essential Service Water in Light Water Reactors."

Section II of this SER discusses resolution of these USIs and GSIs.

2.0 EVALUATION

Davis-Besse is a Babcock and Wilcox (B&W) pressurized water reactor (PWR) with a large, dry containment. The reactor coolant system (RCS) is a "raised loop design" with the steam generators above the reactor core to allow an inventory of RCS coolant to flow back into the core in the event of a LOCA and to promote natural circulation. This raised loop design of the RCS is unique in that all other B&W plants are lower loop designs. The DBNPS IPE has estimated a core damage frequency (CDF) of 6.6E-05 per reactor-year from internally initiated events, including the contribution from internal floods. The DBNPS CDF compares reasonably with that of other B&W PWR plants. The CDF contribution from station blackout (SBO) is less than that typical of many PWRs (about 2 percent) due to the existence of two turbine-driven auxiliary feedwater (TDAFW) pumps, and one motor-driven auxiliary feedwater (MDAFW) pump, with the TDAFW pumps capable of manual control after a DC power failure. The SBO CDF is further reduced by the existence of an SBO diesel generator, sturdy reactor coolant pump seals, and a backup supply of emergency feedwater. Transients contribute 86.4 percent (including 2 percent from SBO), LOCAs 8.6 percent, internal flooding 3 percent, interfacing system LOCA 1.3 percent, and steam generator tube rupture 0.7 percent. The important system/equipment contributors to the estimated CDF that appear in the top sequences are TDAFW pump failures, component cooling water (CCW) system failures, and failure of makeup/high pressure injection (HPI) cooling. The licensee's Level 1 analysis appears to have examined the significant initiating events and dominant accident sequences.

Based on the licensee's IPE process used to search for decay heat removal (DHR) vulnerabilities, and review of the DBNPS plant-specific features, the staff finds the licensee's DHR evaluation consistent with the intent of the USI A-45, Decay Heat Removal Reliability, and is, therefore, acceptable. Furthermore, the licensee did not identify any vulnerabilities with respect to GSIs 23, 77, 105, 128, 143, and 153. According to GL 88-20, if a licensee concludes "that no vulnerability exists at its plant that is topically associated with any USI or GSI, the staff will consider the USI or GSI resolved for a plant upon review and acceptance of the results of the IPE." Accordingly, the staff concludes that the licensee resolved USIs A-45 and A-17 and GSI-77, 105, 128, 143, and 153. Regarding GSI-23, the Commission has decided not to take additional rulemaking action at this time and plans to issue a generic communication on this issue at a future date; therefore, the staff cannot conclude that GSI-23 has been resolved.

The licensee performed a human reliability analysis (HRA) to document and quantify potential failures in human-system interactions and to quantify human-initiated recovery of failure events. The licensee identified the following operator actions as important in the estimate of the CDF: failure to start the MDAFW pump and initiate makeup/HPI cooling, failure to locally control the TDAFW pumps during a SBO, and failure to start the SBO diesel generator and control the TDAFW pumps.

The licensee evaluated and quantified the results of the severe accident progression through the use of a containment event tree and considered

uncertainties in containment response through the use of sensitivity analyses. The licensee's back-end analysis appeared to have considered important severe accident phenomena. According to the licensee, the DBNPS conditional containment failure probabilities are as follows: early containment failure is 0.6 percent with direct attack of debris on the containment side wall being the primary contributor; late containment failure is 9.1 percent with containment overpressurization and basemat melt-through being the primary contributors, and bypass is 2.6 percent with interfacing system LOCA and SGTR being the primary contributors. According to the licensee, the containment remains intact 87.7 percent of the time. Isolation failure (due to failure to isolate the sump drain line), estimated at 1.4 percent of CDF, was lumped into "intact" due to the small radiological releases associated with it. Radiological releases, not categorized into early and late components, are dominated by transients including SBO. The licensee's response to containment performance improvement (CPI) program recommendations is consistent with the intent of GL 88-20 and associated Supplement 3.

According to the licensee, some insights and unique plant safety features identified at DBNPS are:

1. The turbine-driven main feedwater pumps will continue to run for most transients, as the pump flow output is automatically matched to the decay heat level.

2. The two TDAFW pumps can be manually controlled locally in SBO conditions, even after depletion of the batteries. However, with the usual system configuration, failure to control one pump will lead to failure of both TDAFW pumps due to water carryover in the steam lines.

3. The MDAFW pump has to be started manually by the operators. If offsite power is lost, the pump is powered from the SBO diesel generator only.

4. One pressurizer power operated relief valve (PORV) and two safety valves can be used for makeup/HPI cooling, i.e., feed and bleed. This gives Davis-Besse a diversity of options for makeup/HPI cooling.

5. Three emergency diesel generators are available for onsite AC power.

6. There is a high level of service water (SW) system and CCW system redundancy with each system having three 100% capacity pumps. In addition, the dilution pump can be used as a backup SW system pump.

7. A reasonably large area is available under the reactor vessel for corium spreading. This results in a corium thickness of about 10 inches, at nominal corium density, if the entire available corium mass is spread in the reactor cavity.

8. The containment shell is protected by a 1.5 foot wide by 2.5 foot high curb at the basemat floor elevation. This feature protects the steel shell from direct contact with corium if it was to relocate to the lower containment and, thus, serves to lower the probability of this shell failure mode.

The licensee defined a vulnerability as either (1) a CDF significantly higher then 1.0E-4 per reactor year with one or a few aspects of the plant design or operating practices contributing to such a high frequency, (2) a single plant feature (or a few features) which causes a disproportionately high contribution to the CDF, or (3) a CDF that is very sensitive to a highly uncertain aspect of plant response. Based on this definition, the licensee did not identify any vulnerabilities.

Plant improvements, however, were identified. These improvements, listed below, have been implemented:

1. Shedding of DC loads. At the time of the IPE analysis, procedural guidance existed only for the case when power was unavailable to both AC divisions. The EOP procedural revisions provide guidance when only one division of AC power is lost.

2. Enhanced procedures and training for makeup to the boric water storage tank (BWST) in the SGTR scenarios where the BWST is depleted by injection before the RCS is depressurized.

3. Improved fuel oil monitoring for the station blackout diesel generator (SBODG). The SBODG has a limited fuel oil supply (4 to 8 hours of run time). Operational procedures have been revised to include direction for monitoring the level and consumption rate of fuel oil during emergency operations. Specific direction is provided to initiate refill efforts for the supply tank upon reaching a predetermined level.

3.0 CONCLUSION

Based on the above findings, the staff notes that (1) the IPE is complete with regard to the information requested by GL 88-20 (and associated guidance in NUREG-1335), and (2) the IPE results are reasonable given the DBNPS design, operation, and history. As a result, the staff concludes that DBNPS's IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the DBNPS IPE has met the intent of GL 88-20.

It should be noted that the staff's review primarily focused on the licensee's ability to examine DBNPS 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, the 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.

APPENDIX

TECHNICAL EVALUATION REPORT

FOR THE

DAVIS-BESSE NUCLEAR POWER STATION