STAFF EVALUATION REPORT

OF

INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS (IPEEE) SUBMITTAL

ON

BRUNSWICK STEAM ELECTRIC PLANT (BSEP), UNITS 1 AND 2

Enclosure 1

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1. INTRODUCTION

On June 28, 1991, the NRC issued Generic Letter (GL) 88-20, Supplement 4 (Ref. 1) along with NUREG-1407, Procedural and Submittal Guidance, requesting all licensees to perform individual plant examinations of external events (IPEEE) to identify plant-specific vulnerabilities to severe accidents and to report the results to the Commission together with any licensee-determined improvements and corrective actions. In a letter dated June 30, 1995, the licensee, Carolina Power and Light (CP&L) Company, submitted its response to the NRC (Ref. 2) for Brunswick Steam Electric Plant (BSEP), Units 1 and 2.

The staff contracted with Energy Research, Inc. (ERI) to conduct a Step 1 review of the licensee's IPEEE submittal in March 1995 and sent a request for additional information (RAI) to the licensee in April 1996 (Ref. 3). The licensee responded to the RAI in August 1996 (Ref. 4). Based on the results of the review, the staff concluded that the aspects of seismic; fires; and high winds, floods, transportation and other external events were adequately addressed. Staff and contractor review findings are summarized in the evaluation section below. Details of the contractor's findings are presented in the technical evaluation report attached to this staff evaluation report.

In accordance with Supplement 4 to GL 88-20, the licensee provided information to address the resolution of Unresolved Safety Issue (USI) A-45, "Shutdown Decay Heat Removal Requirements," Generic Safety Issue (GSI) GSI-57, "Effects of Fire Protection System Actuation on Safety-Related Equipment," the Sanida Fire Risk Scoping Study (FRSS) issues, and GSI-103, "Design for Probable Maximum Precipitation (PMP)." The licensee did not propose to resolve any additional USIs or GSIs as part of the BSEP IPEEE.

2. EVALUATION

The Brunswick Steam Electric Plant has two units which are General Electric-designed boiling water reactors (BWR)-4 located about 2 miles north of Southport, North Carolina. The plant was designed to a seismic acceleration level of 0.08g operating basis earthquake and 0.16g safe shutdown earthquake. For the seismic analysis, the licensee used Electric Power Research Institute's (EPRI's) seismic margin assessment (SMA) methodology in assessing the capacity of plant structures and equipment to withstand beyond-design basis earthquakes. High confidence of low probability of failure (HCLPF) values of critical equipment groups were also estimated for BSEP which is a 0.3g focused-scope plant. For the fire analysis, the licensee performed plant walkdowns, fire area screening, and quantification of unscreened fire areas. For the analyses of other external events, the licensee used the progressive screening procedure as described in NUREG-1407.

2.1 Core Damage Frequency Estimates

The BSEP was characterized in NUREG-1407 to be a 0.3g focused-scope plant. The licensee performed a SMA of major plant structures and equipment for both units and screened them based on EPRI-6041 (Ref. 5) screening criteria. Since the licensee used the SMA methodology rather than a seismic PRA (both methodologies are acceptable in accordance with NUREG-1407), no seismic CDF estimate was provided. HCLPF evaluations of major equipment groups were performed by the licensee's contractor. The licensee found that HCLPF values of applicable equipment at BSEP were higher than the NUREG-1407 criterion of 0.3g.

The total fire-induced CDF from unscreened fire areas was estimated to be about 3.4E-5 per year. The licensee compared design and operational differences between Unit 1 and Unit 2 and concluded that the Unit 1 fire CDF estimate was also applicable to Unit 2. The licensee estimated the CDFs due to high winds and external floods to be about 4E-6 per year and 1.5E-7 per year, respectively. The licensee estimated the CDF due to internal events, including internal floods, to be about 9.2E-6 per year.

2.2 Dominant Contributors

The licensee estimated HCLPF values of eight critical equipment groups as part of the SMA methodology, but the licensee did not provide a ranking of equipment HCLPF values with respect to the 0.3g review level earthquake (RLE). The licensee concluded that the estimates of plant level HCLPF capacity and the containment HCLPF capacity are both greater than the 0.3g RLE.

The licensee estimated the total fire-induced CDF to be about 3.4E-5 per year. Main control room (MCR) fires were found to contribute significantly (56%) to the overall fire CDF. The dominant fire areas that contributed to the total fire-induced CDF include the MCR (1.9E-5 per year), a fire area in the 20-foot level of the reactor building (RB) North (4.7E-6 per year), a fire area in the 20-foot level of the RB South (1.3E-6 per year), the cable spreading room (1.4E-6 per year), the E4 switchgear room (1.1E-6 per year), and the E8 switchgear room (1.1E-6 per year). Scenarios of MCR fires include: 1) uninhabitability of the MCR requiring a safe shutdown outside the MCR, and 2) habitable MCR, but individual operations of certain support systems, such as the emergency busses, the service water system, and the residual heat removal system controls, have to be performed outside the MCR.

The total high-wind-induced CDF was estimated to be about 4E-6 per year. The CDF contribution from hurricane-induced floods (also switchyard failure) is about 1.5E-7 per year. Failure of the switchyard leading to long term loss of offsite power was found to be a dominant contributor to the hurricane-induced CDF. Transportation and other external events contributed insignificantly to overall CDF.

The licensee's IPEEE assessment appears to have examined the significant initiating events and dominant accident sequences for BSEP.

2.3 Containment Performance

The licensee evaluated critical containment failure modes, such as containment bypass, containment isolation, and availability and performance of containment barriers, using applicable seismic analysis models and evaluation criteria. The containment walkdowns consisted of inspecting and evaluating unusual conditions or configurations (e.g., spatial interactions, unique penetrations, piping hard spots, and items or components bridging the seismic gap between the containment liner and interior structure). No unusual conditions were identified. Penetration cooling systems were also evaluated and found to be adequate. No cases of inflatable seals in equipment hatches and personnel hatches were identified. Failure of the containment structure was screened based on SMA guidance (EPRI-NP-6041). The potential for isolation and cooling failures were evaluated using the SMA approach. Based on the SMA evaluations, the licensee judged that the HCLPF value for both BSEP containments is greater than 0.3g.

The licensee evaluated the potential damage to containment isolation valve control circuits due to fires in the reactor building and the control building that could result in containment bypass. Fires in the service water building and the diesel building were evaluated, and the evaluation indicated no impact on containment isolation failures. Two containment vent paths (drywell vent path and hardened suppression chamber vent path) were also included in the evaluation of the failure of containment heat removal (CHR) due to internal fires. The licensee concluded that the mechanisms for containment failures due to loss of CHR are the same for internal fire scenarios as they are for other internal initiating events evaluated in the BSEP IPE. The IPEEE fire analysis did not identify any additional containment failure modes that were not evaluated in the BSEP IPE.

The licensee's containment performance evaluations for seismic and internal fires appeared to have considered important containment performance issues and are consistent with the intent of Supplement 4 to GL 88-20.

2.4 Generic Safety Issues

As a part of the IPEEE, a list of generic and unresolved safety issues (e.g., USI A-45, GSI-131, GSI-103, GSI-57, and the Fire Risk Scoping Study [FRSS] issues) were identified in Supplement 4 to GL 88-20 and its associated guidance in NUREG-1407 as needing to be addressed in the IPEEE. The staff's evaluation of these issues is provided below.

2.4.1 USI A-45, "Shutdown Decay Heat Removal Requirements"

The licensee's evaluation of the seismic portion of the shutdown decay heat removal (DHR) is documented in Section 3.1 and 3.2 of the IPEEE submittal. This evaluation included the development of a success path logic diagram and the development of a safe shutdown equipment list for frontline systems and support systems related to DHR. The licensee's evaluation of the DHR equipment needed in the event of a fire is documented in Sections 4.5.4 and 4.5.5 of the IPEEE submittal. The licensee made use of the IPE-developed system models and sequence models and evaluated frequency estimates of fire sequences due to fires in unscreened fire areas. The licensee's evaluation of the HFO portion of the DHR is documented in Sections 5.3 and 5.4 of the IPEEE submittal. The licensee made use of the IPE-developed system models and sequence models and evaluated frequency estimates of applicable sequences due to HFOs. The staff finds that

the licensee's USI A-45 evaluation is consistent with the guidance provided in Section 6.3.3.1 of NUREG-1407 and, therefore, the staff considers this issue resolved.

2.4.2 GSI-131, "Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System used in Westinghouse Plants"

BSEP is not a Westinghouse design. Therefore, GSI-131 is not applicable.

2.4.3. GSI-103, "Design for Probable Maximum Precipitation (PMP)"

The licensee addressed roof ponding loads and site flooding problems in Section 5.2.1 of the IPEEE submittal and concluded that the new PMP was not a concern for BSEP. The staff finds that the licensee's GSI-103 evaluation is consistent with the guidance provided in Section 6.2.2.3 of NUREG-1407 and, therefore, the staff considers this issue resolved.

2.4.4 GSI-57, "Effects of Fire Protection System Actuation of Safety-Related Equipment"

The licensee addressed applicable FRSS issues in Section 4.4 of the IPEEE submittal. One of the FRSS issues addresses safety problems (e.g., inadvertent actuation of fire protection systems on safety systems) documented in GSI-57. The safety concern of this GSI also includes seismically induced fires, seismically induced suppressant diversion, and seismically induced actuation of fire protection systems The staff finds that the licensee's overall GSI-57 evaluation is consistent with the guidance provided in Section 6.2 of NUREG-1407 and, therefore, the staff considers these issues resolved.

2.4.5 Fire Risk Scoping Study Issues

The licensee addressed FRSS issues in Section 4.4 of the IPEEE submittal. These FRSS issues include: (1) seismic/fire interactions, (2) adequacy of fire barriers, (3) smoke control and manual fire-fighting effectiveness, (4) equipment survival in a fire-induced environment, and (5) fire-induced alternate shutdown/control room panel interaction. The staff finds that the licensee's evaluation is consistent with the guidance provided in NUREG-1407, and therefore, the staff considers these issues resolved.

2.5 Other Generic Safety Issues

In addition to those USI and GSIs discussed above that were explicitly requested in Supplement 4 to GL 88-20, four GSIs were not specifically identified as issues to be resolved under the IPEEE program; thus, they were not explicitly discussed in Supplement 4 to GL 88-20 and NUREG-1407. However, subsequent to the issuance of the GL, the NRC evaluated the scope and the specific information requested in the GL and the associated IPEEE guidance, and concluded that the plant-specific analyses being requested in the IPEEE program could also be used, through a satisfactory IPEEE submittal review, to resolve the external event aspects of these four GSIs. The following discussions summarize the staff's evaluations of these GSIs at BSEP.

2.5.1 GSI-147, "Fire-Induced Alternate Shutdown/Control Room Panel Interactions"

The licensee addressed applicable FRSS issues in Section 4.4 of the BSEP IPEEE submittal. One of the FRSS issues addresses safety problems documented in GSI-147. The licensee's FRSS evaluation addresses applicable issues of GSI-147 through the fire scenario analysis of main control room fires (Section 4.5.5.7 and 4.5.5.8 of the BSEP IPEEE submittal). As part of this evaluation, the licensee did not find any plant vulnerability. Based on the results of the IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with this issue. On the basis that no potential vulnerability associated with this issue was identified in the IPEEE submittal, the staff considers this issue resolved for BSEP.

2.5.2 GSI-148, "Smoke Control and Manual Fire-Fighting Effectiveness"

The licensee addressed applicable FRSS issues in Section 4.4 of the BSEP IPEEE submittal. One of the FRSS issues addresses safety concerns documented in GSI-148. The licensee's FRSS evaluation addresses the applicable issues of GSI-148 in Section 4.4.3 and Section 4.4.4 of the BSEP IPEEE submittal. As part of this evaluation, the licensee did not find any plant vulnerability. Based on the results of the IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with this issue. On the basis that no potential vulnerability associated with this issue was identified in the IPEEE submittal, the staff considers this issue resolved for BSEP.

2.5.3 GSI-156, "Systematic Evaluation Program (SEP)"

The licensee's IPEEE submittal contains information addressing the following nine SEP-related issues: site hydrology and ability to withstand floods (Sections 2.1.2 and 5.4), industrial hazards (Section 5.5), tornado missiles (Section 5.3), severe weather effects on structures (Sections 5.3 and 5.4), design codes, criteria, and loads combinations (BSEP-1 FSAR and BSEP-2 FSAR), dam integrity and site flooding (Sections 5.2.1 and 5.4.2), settlement of foundations and buried equipment (Sections 5.2.1 and 5.2.2), seismic design of structures, systems, and components (Section 2.2.1), and shutdown systems and electrical instrumentation and control (Sections 2.1.5 and 3.2). Based on the results of the IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential external events-related vulnerabilities associated with these nine SEP issues. On the basis that no potential vulnerability associated with this issue was identified in the IPEEE submittal, the staff considered the IPEEE-related aspects of this issue resolved for BSEP.

2.5.4 GSI-172, "Multiple System Responses Program (MSRP)"

The licensee's IPEEE submittal contains information addressing the following external events-related MSRP issues: effects of fire protection system actuation on safety-related equipment (Sections 4.4.1 and 4.4.4), smoke control and manual fire-fighting effectiveness (Section 4.4.4), effects of hydrogen line rupture (Sections 4.4.1 and 5.5.5), seismically induced spatial interactions (Sections 3.1.3 and 3.1.5), seismic-fire interactions (Sections 3.1.6 and 4.4.1), seismically induced fire suppression system actuations (Section 4.4.1), seismically induced flooding (Sections 3.1.6 and 4.4.1), seismically induced relay chatter (Section 3.1.4), evaluation of earthquake magnitude greater than safe shutdown

earthquake (Section 3.1.1), the IPEEE-related aspects of common cause failures related to human errors (Sections 4.3.3, 4.4.4, and 4.5), non-safety-related control system/safety-related system dependencies (Sections 3.1.3, 3.1.5, 4.5.5.7, and 4.5.5.8), and effects of flooding and/or moisture intrusion on non-safety related and safety-related equipment (Sections 5.2.1 and 5.4.2). Based on the results of the BSEP IPEEE submittal review, the staff considers that the licensee's process is capable of identifying potential external events-related vulnerabilities associated with this issue. On the basis that no potential vulnerability associated with this issue was identified in the IPEEE submittal, the staff considered the IPEEE-related aspects of this issue resolved for BSEP.

2.6 Unique Plant Features, Potential Vulnerabilities, and Improvements

BSEP is located in a relatively moderate seismicity region in eastern United States. The licensee did not identify any potential seismic design vulnerabilities. Resolution of seismic outliers that were identified by the IPEEE program were closely coordinated with the walkdown findings and associated seismic evaluations of the USI A-46 program. The licensee stated that seismic outliers found in the IPEEE program would be corrected by maintenance and minor upgrades of plant equipment.

BSEP MARK I containment, which are inerted during plant operation, are not vulnerable to fires inside containment.

The licensee did not explicitly define a potential severe accident vulnerability for BSEP. However, they did apply the industry guidance provided in NEI-91-04, "Severe Accident Closure Guidance" (Ref. 6) and used the CDF criterion of 1E-6 per year to decide on the appropriate resolution for each significant accident sequence. No significant design or operational vulnerabilities were identified. However, the licensee plans to include extreme winds in its severe accident management guidance to better enable BSEP to withstand the effects of high winds. Also, in the seismic-fire interactions area, the licensee made one housekeeping improvement related to the placement of cart-mounted carbon-dioxide bottles in the cable spreading room.

3. CONCLUSIONS

On the basis of the above findings, the staff notes that (1) the licensee's IPEEE is complete with regard to the information requested by Supplement 4 to GL 88-20 (and associated guidance in NUREG-1407), and (2) the IPEEE results are reasonable given the BSEP design, operation and history. Therefore, the staff concludes that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the BSEP IPEEE has met the intent of Supplement 4 to GL 88-20 and the resolution of specific GSIs discussed in this SER.

It should be noted, that the staff focused its review primarily on the licensee's ability to examine BSEP for severe accident vulnerabilities. Although certain aspects of the IPEEE were explored in more detail than others, the review was not intended to validate the accuracy of the licensee's detailed findings (or quantitative estimates) that underlie or stemmed from the examination. Therefore, this SER does not constitute NRC approval or endorsement of any IPEEE material for purposes other than those associated with meeting the intent of Supplement 4 to GL 88-20 and the resolution of specific GSIs discussed in this SER.

4. REFERENCES

1. NRC Generic Letter 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - Title 10 CFR 50.54(f)," June 28, 1991.

2. Letter from Roy A. Anderson of CP&L to NRC, subject: "Brunswick Steam Electric Plant, Unit 1 and Unit 2: Response to Generic Letter 88-20 Supplement 4 - Submittal of Individual Plant Examination for External Events (IPEEE)," June 30, 1995.

3. Letter from NRC to G. D. Hicks of CP&L, subject: "Request for Additional Information related to Review of Brunswick Steam Electric Plant, Unit 1 and Unit 2 IPEEE Submittal," April 18, 1996.

4. Letter from G. D. Hicks of CP&L to NRC, subject: "Brunswick Steam Electric Plant, Unit 1 and Unit 2: Response to Request for Additional Information Related to Review of June 30, 1995, Submittal of Individual Plant Examination for External Events (IPEEE)," August 16, 1996.

5. "0 methodology for assessment of Nuclear Power Plant Seismic Margin," EPRI-NP-6041-SL, Revision 1, August 1991.

6. NEI-91-04, "Severe Accident Issue Closure Guidelines, Revision 0," October 1994.