



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20545-0001

STAFF EVALUATION REPORT ON INDIVIDUAL PLANT EXAMINATION  
OF EXTERNAL EVENTS SUBMITTAL  
FOR POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

I. INTRODUCTION

On June 28, 1991, the NRC issued Generic Letter (GL) 88-20, Supplement 4 (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. The licensee for Point Beach Nuclear Plant, Units 1 and 2, Wisconsin Electric Power Company (WE), submitted its response to the NRC in June 1995.

A "Step 1" review was performed which examined the IPEEE submittal and the licensee's response to a staff request for additional information (RAI). This review focused on the completeness and "reasonableness" of the IPEEE, considering the design and operation of Point Beach. On the basis of the Step 1 review and further review by a senior review board (SRB), the NRC staff concluded that the aspects of high winds, floods, transportation, and other external events were adequately addressed. However, the seismic and fire IPEEE needed a supplemental review because of specific concerns related to the seismic analyses (e.g., seismic capacity estimates, resolution of reported anomalies and outliers, and relay chatter issue) and fire analyses (e.g., potential for loss of offsite power due to fire, modeling of oil-filled transformers in the cable spreading room, and the analysis of hot shorts). (For a detailed discussion of these concerns, see Section 3 of the Technical Evaluation Report (TER) (Attachment 1). The SRB consisted of NRC staff from the Office of Nuclear Regulatory Research (RES) and the Office of Nuclear Reactor Regulation (NRR), and RES consultants (Sandia National Laboratories) (SNL), with probabilistic risk assessment expertise for external events.

In March 1998, the NRC staff sent a supplemental RAI to the licensee that focused on the seismic and fire concerns identified during the Step 1 review. The licensee submitted its response to this RAI in July 1998 and a follow-up response in December 1998. Based on the review of the licensee's response to this RAI, Energy Research, Inc. (ERI), completed the supplement to its TER in March 1999. The review findings are summarized in the evaluation section below. Details of the ERI's findings are presented in the TER and its supplemental TER, which are attached to this SER.

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

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Requirements," Generic Safety Issue (GSI) 57, "Effects of Fire Protection System Actuation on Safety-Related Equipment," GSI-103, "Design for Probable Maximum Precipitation," GSI-131, "Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System Used in Westinghouse Plants," and the NUREG/CR-5088 Fire Risk Scoping Study (FRSS) issues that were explicitly requested in Supplement 4 to GL 88-20 and its associated guidance in NUREG-1407. The licensee did not propose to resolve any additional USIs or GSIs as part of the Point Beach IPEEE.

## II. EVALUATION

The Point Beach Nuclear Plant consists of a dual-unit, Westinghouse 2-loop pressurized water reactor (PWR), with a large dry containment. The seismic category I structures were designed to a seismic acceleration level of 0.12g peak ground acceleration (PGA) with a spectral shape conforming to a Housner spectrum. The licensee performed a seismic probabilistic risk assessment (PRA), including a qualitative and quantitative containment performance analysis for Point Beach, Units 1 and 2. The licensee's seismic PRA uses the existing Individual Plant Examination of Internal Events (IPE) level 1 logic models and the level 2 containment event tree model for quantifying seismic risk. The seismic PRA approach uses a surrogate element to represent the seismic failure effects of all components that were screened out at a high confidence of low probability of failure (HCLPF) value of 0.3g PGA. Simplified fragility calculations and detailed fragility calculations were performed for components that were not screened out. Since Point Beach is a USI A-46 plant, the resolution of outliers and the walkdowns were performed in coordination with evaluation and walkdowns under Point Beach's USI A-46 program.

The licensee's fire IPEEE analysis was based on the Electric Power Research Institute's (EPRI's) fire-induced vulnerability evaluation (FIVE) method. However, the licensee stated that the data was modified using EPRI's Fire PRA Implementation Guide to reduce the conservatism in the FIVE fire propagation analysis. The licensee's fire analysis made extensive use of the plant information gathered for Appendix R compliance. The licensee used the IPE model to establish the possibility of core damage resulting from a fire-initiated event. The conditional core damage probability was based on the equipment and systems unaffected by the fire. Human actions considered in the IPE plant model were included in the fire impact assessment. The IPE human error probabilities were modified to take into account the additional stress that could be caused by the occurrence of a fire.

For other external events, the licensee used the progressive screening approach as described in NUREG-1407 to evaluate high winds, floods, transportation, and nearby facility accidents. The licensee reviewed and updated the results of a Point Beach PRA performed previously for USI A-45, "Shutdown Decay Heat Removal Requirements" (under NRC Task Action Plan A-45), based on screening, bounding, and some probabilistic calculations. Among high winds, floods, and other external events, the licensee analyzed tornadoes and external floods further using quantitative bounding and PRA evaluations. Historical data were used for determining straight wind, tornado, and external flood frequencies. Some site-specific data were used for the analyses of aircraft crashes, land transportation accidents, and nearby facility events. No formal PRA or bounding analysis was performed for transportation and nearby facility accidents. These events were screened out due to their low frequency of occurrence.

### Core Damage Frequency and Seismic Capacity Estimates

The licensee estimated a seismic core damage frequency (CDF) of  $1.4E-5$ /reactor year (RY) using the 1989 seismic hazard curves developed by the Electric Power Research Institute, and a CDF of  $1.3 E-5$ /RY using the 1993 seismic hazard curves developed by Lawrence Livermore National Laboratory. The licensee also estimated the plant seismic capacity, in terms of high confidence of low probability of failure (HCLPF) value, as 0.16g PGA with operator actions and random (nonseismic) failures included, or 0.25g PGA with these actions and failures excluded.

The licensee estimated a fire CDF of  $5.1E-5$ /RY in its IPEEE submittal. The licensee estimated that the CDF due to internal events is about  $1.2E-4$ /RY, including internal flooding.

The licensee estimated that the CDF due to external floods is about  $2.8E-6$ /RY and the CDF due to high winds is  $3.4E-7$ /RY. Other external events (e.g., transportation and nearby facility accidents) were considered as risk insignificant based on their low hazard frequencies.

### Dominant Contributors

The licensee reported that the seismic CDF is dominated by seismically induced sequences such as failure of cable trays inside the cable spreading room (62%), failure of cable trays outside the cable spreading room (7%), and failure of a surrogate element (16%), as discussed below. The licensee used an approach of a surrogate element to represent the seismic failure effects of all components (e.g., soils, building/structures, reactor vessel) that were screened out at a HCLPF value of 0.3g PGA. Although the contribution of the seismic sequence involving the surrogate element appeared to be exaggerated at Point Beach (i.e., the combined CDF contribution of those sequences involving soils, building/structures, and the reactor vessel as an individual component, based on the conventional PRA approach, would be far less than that of the sequence represented by the surrogate element), the ranking of the dominant sequences is not changed (see Section 2.1.10 of the attached TER). The inside cable spreading room sequence consisted of the seismically induced failure of cable trays leading to loss of indication and/or control combined with failure to shut down the plant remotely. The outside cable spreading room sequence consisted of the seismically induced failure of cable trays leading to loss of power to all essential equipment. The dominant seismic contributors to the estimated CDF are operator actions (e.g., failure to shut down the plant from the remote shutdown panel, failure to provide service water backup to auxiliary feedwater (AFW) pump suction), seismic faults that lead directly to core damage (e.g., failures of cable trays, surrogate element (e.g., failure of soils, building structures), and failures of critical equipment (e.g., transformers, 480V load centers, level transmitter for condensate storage tank (CST)).

The fire CDF is dominated by fires in the control room, the cable spreading room, the AFW pump room, the gas turbine room, the vital and nonvital switchgear rooms, the diesel generator rooms, and the monitor tank room. All fire event sequences were quantified assuming all equipment/cables in the area would fail by the fire. However, no fire in a single area or compartment (by itself), except the cable spreading room, would have the potential of directly causing core damage. In addition to the damage caused by the fire in these areas and compartments, other failures (e.g., a reactor coolant pump (RCP) seal loss-of-coolant accident, operator failure to establish RCP seal injection via the refueling water storage tank, failure of the safety relief valves), in combination with a fire, contributed to the calculated fire CDF.

The external flood CDF is dominated by flooding as a result of the rising water level of Lake Michigan, combined with wind wave effects and water runup, which would result in flooding of the turbine building and leads to loss of the ability to remove decay heat. The dominant tornado/wind-induced core damage sequences were determined to involve failures of the diesel generator exhaust stacks, which lead to failure of both diesel generators.

The licensee's IPEEE analyses appear to have examined the significant initiating events and dominant accident sequences at the plant.

#### Containment Performance

The licensee performed both qualitative and quantitative assessments of the containment performance under seismic conditions at Point Beach. The qualitative assessment examined containment safeguards systems significant to large early release, including containment integrity, mechanical penetrations, containment isolation, and containment cooling. The quantitative assessment focused on bypass and containment isolation failure sequences using the Point Beach IPE plant damage states, release categories, and containment response analysis. The licensee estimated the frequency of early release to be  $2.1E-6/R$ , and the dominant contributors were failures of containment isolation due to the loss of either AC or DC power and failures of the containment low and intermediate range pressure transmitters due to the impact of the seismically induced collapse of the adjacent block walls.

The licensee's evaluation of containment performance with regard to fire hazard focused on assessing the potential for containment isolation or bypass failure. The licensee identified and evaluated areas that could potentially impact the function of containment isolation. The licensee concluded that fire is not expected to result in any significant containment isolation failure or bypass.

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

#### Generic Safety Issues

As part of the IPEEE, a set of generic and unresolved safety issues (USI A-45, GSI-131, GSI-103, GSI-57, and the SNL FRSS issues) were specifically identified in Supplement 4 to GL 88-20 and its associated guidance in NUREG-1407 as needing to be addressed in the IPEEE. The NRC staff's evaluation of these issues is provided below.

##### 1. USI A-45, "Shutdown Decay Heat Removal Requirements"

The licensee has chosen to subsume its resolution of USI A-45 in the USI A-46 program. However, the licensee provided a brief discussion of decay heat removal (DHR) capabilities following a seismic event in its IPEEE submittal. The seismic PRA modeled the systems available for DHR, and the CDF contributions due to failures of DHR systems and support systems were tabulated in the IPEEE submittal. The licensee credited the AFW system for providing DHR capability under fire conditions and provided the analysis to address the USI A-45 issue in the IPEEE submittal. The NRC 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 NRC staff considers this issue resolved.

2. GSI-131, "Potential Seismic Interaction Involving the Movable In-Core Flux Mapping System Used in Westinghouse Plants"

Even though this issue is not directly applicable to Point Beach because the flux mapping cart is not movable, as stated in the submittal, the licensee provided a discussion on the seismic capability of the cart. The licensee pointed out that the Point Beach cart is identical to the Kewaunee Nuclear Power Plant flux mapping cart, which was analyzed under the Kewaunee IPEEE. Since the seismic demands for both plants are quite similar, and the Kewaunee IPEEE result showed that the cart possesses adequate seismic capability, the licensee concluded that the Point Beach cart also has adequate seismic capability. In addition, the licensee pointed out that two lateral struts, added to the cart for lateral restraints by a previous modification, will increase its capability under seismic conditions. The NRC staff considers this issue resolved for Point Beach on the basis of the information provided in the IPEEE and the TER.

3. GSI-103, "Design for Probable Maximum Precipitation"

As part of the IPEEE flood analysis, the licensee reviewed and updated the results of the USI A-45 study, including the assessment of GSI-103 (local precipitation in Section 5.2.5 and roof ponding in Section 5.2.6 of the IPEEE submittal), and concluded that the frequency of Probable Maximum Precipitation (PMP) events is below  $1E-6/R_Y$  and has insignificant impact on Point Beach. The NRC 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 NRC staff considers this issue resolved.

4. Fire Risk Scoping Study issues

The licensee has explicitly addressed the SNL FRSS issues (Section 4.8 of the IPEEE submittal). The NRC staff finds that the licensee's evaluations are consistent with the guidance provided in FIVE, which was accepted by the NRC staff and, therefore, the NRC staff considers these issues resolved.

5. GSI-57, "Effects of Fire Protection System Actuation on Safety-Related Equipment"

Although the licensee's IPEEE submittal did not explicitly discuss GSI-57, the information provided in the submittal (Section 4.8) addressing seismic-fire interactions and total environment equipment survival is related to this issue. The NRC staff finds that the licensee's evaluation is consistent with the guidance provided in NUREG-1407 and, therefore, the NRC staff considers this issue resolved.

In addition to those safety issues discussed above that were explicitly requested in Supplement 4 to GL 88-20, four generic safety issues were not specifically identified as issues that should be resolved under the IPEEE program; thus, they were not explicitly discussed in Supplement 4 to GL 88-20 or NUREG-1407. However, subsequent to the issuance of the generic letter, the NRC evaluated the scope and the specific information as requested in the

generic letter and the associated 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 safety issues. The following discussions summarize the NRC staff's evaluation of these safety issues at Point Beach.

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

The licensee's IPEEE submittal contains information (Section 4.8.5 of the Point Beach IPEEE submittal) addressing this issue. The licensee reviewed the circuits associated with Point Beach alternate shutdown capability and did not discover any control system interaction concerns. The hot short concerns (e.g., the possibility of inadvertent opening of a power-operated relief valve of an atmospheric steam dump valve) were discussed in its response to an NRC staff RAI (Section 2.4.1 of the attached TER). Based on the results of the IPEEE submittal review, the NRC staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with this issue. On the basis that no vulnerability associated with this issue was identified in the IPEEE submittal, the NRC staff considers this issue resolved for Point Beach.

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

The licensee addressed this issue in Section 4.8.3 of its IPEEE submittal. The licensee provided a discussion of the Point Beach's fire protection program and its associated fire brigade training program related to this issue. Based on the results of the IPEEE submittal review, the NRC staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with this issue. On the basis that no vulnerability associated with this issue was identified in the IPEEE submittal, the NRC staff considers this issue resolved for Point Beach.

3. GSI-156, "Systematic Evaluation Program (SEP)"

The licensee's IPEEE submittal contains information directly addressing the following external-events-related SEP issues: settlement of foundations and buried equipment (Sections 3.1.2.1, 3.1.3.10, and 3.1.4.2); dam integrity and site flooding (Section 5.2.2); site hydrology and ability to withstand floods (Section 5.2); industrial hazards (Section 5.3); tornado missiles (Section 5.1) and severe weather effects on structures (Sections 5.1 and 5.2). Although the licensee's IPEEE submittal did not contain information explicitly addressing the other SEP issues (i.e., design codes, criteria, and load combinations; and seismic design of structures, systems, and components), a conclusion may be drawn that these issues were implicitly addressed as part of the licensee's IPEEE process at Point Beach because the seismic PRA has taken the as-built, as-operated condition into consideration in its structural response and component fragility analyses, and no potential seismic vulnerabilities were identified. Based on the results of the IPEEE submittal review, the NRC staff considers that the licensee's process is capable of identifying potential vulnerabilities associated with this issue. On the basis that no vulnerability associated with this issue was identified in the IPEEE submittal, the NRC staff considers this issue resolved for Point Beach.

#### 4. GSI-172, "Multiple System Responses Program (MSRP)"

The licensee's IPEEE submittal contains information directly addressing the following external events-related MSRP issues: (1) effects of fire protection system actuation on non-safety-related and safety-related equipment (Sections 4.8.1 and 4.8.4), (2) seismically induced fire suppression system actuation (Section 4.8.1), (3) seismically induced fires (Sections 3.1.3 and 4.8.1), (4) effects of hydrogen line rupture (Sections 4.12 and 5.3.3), (5) the IPEEE-related aspects of common cause failures related to human errors (Sections 3.1.3, 3.1.5, 4.6.2, 4.8.4, 5.1.5, and 5.1.6), (6) non-safety-related control system/safety-related system dependencies (Sections 3.1.2, 3.1.3, 3.1.4, and 4.8.1), (7) effects of flooding and/or moisture intrusion on non-safety-related and safety-related equipment (Sections 3.1.3 and 4.8.1), (8) seismically induced spatial/functional interactions (Sections 3.1.2, 3.1.3, 3.1.4, and 4.8.1), (9) seismically induced flooding (Sections 3.1.3 and 4.8.1), (10) seismically induced relay chatter (Sections 3.1.2 and 3.1.4), and (11) evaluation of earthquake magnitude greater than safe shutdown earthquake (Section 3).

Based on the results of the IPEEE submittal review, the NRC staff considers that the licensee's process is capable of identifying potential external events-related vulnerabilities associated with GSI-172. On the basis that no potential vulnerability associated with this issue was identified in the IPEEE submittal, the NRC staff considered the IPEEE-related aspects of this issue resolved for Point Beach.

#### Unique Plant Features, Potential Vulnerabilities, and Improvements

The licensee did not identify any unique safety features at the plant.

The licensee's definition of vulnerability associated with external events is the same as that used in their IPE. The licensee's criteria for determining if any plant vulnerability exists are: a CDF goal of less than  $1E-4/RY$  and a goal for frequency of large fission product release of less than  $1E-6/RY$ . Although the IPEEE did not identify any vulnerabilities associated with external events at Point Beach, the licensee has implemented certain plant modifications and proposed to take certain actions related to relay and anchorage issues. These licensee-identified improvements and proposed actions are listed below:

##### High Winds

- The diesel generator stacks were modified to accommodate higher winds.

##### Fire

- The control logic for automatic start of the motor-driven AFW pumps was modified such that a fire in the nonsafeguards switchgear will not prevent the motor-driven pumps from starting.
- The procedure for mitigating fires in the control room and cable spreading room was revised to include verification of closure of an additional containment isolation valve.

### Seismic

- Numerous equipment anchorages (e.g., transformers, a reactor trip breaker cabinet, inverters and battery chargers) were fixed for seismic concerns (see SER on USI A-46 resolution, dated July 7, 1998).
- The seismic capacity concerns of certain tank anchorages were either reanalyzed or upgraded by modification (see SER on USI A-46 resolution).
- The supports for certain cable and conduit raceways in the cable spreading room were modified to increase their seismic capacities (see SER on USI A-46 resolution).
- Certain relays, identified as outliers during an IPEEE/A-46 walkdown, will be reevaluated and resolved by the fall of 1999, except those pertaining to the diesel generators. The licensee plans to replace the controls for the diesel generators by the year 2002 (see SER on USI A-46 resolution).

In addition, the licensee stated that they intend to use the Point Beach IPEEE as a decision-making tool in many aspects of engineering support and plant operations as long as the tool adds value (Section 8 of the IPEEE submittal). The licensee also stated that a clear understanding of the assumptions, limitations, uncertainties is required in order to avoid misinterpretation of the IPEEE results. Although the implications of using surrogate element in the seismic PRA (e.g., limitations, uncertainties) were not discussed in the submittal (see Section 3.1 of Attachment 2), the impact on finding the dominant sequences at Point Beach may not be very significant. As discussed previously in the section on dominant contributors, the ranking of the dominant seismic sequences would not be significantly changed. Therefore, the NRC staff believes that, as a whole, the licensee has gained some significant insights related to potential vulnerabilities to severe accidents through the IPEEE.

### III. CONCLUSION

On the basis of the above findings, the NRC 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 Point Beach design, operation, and history. Therefore, the NRC 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 Point Beach, Units 1 and 2, IPEEE has met the intent of Supplement 4 to GL 88-20 and the resolution of specific generic safety issues discussed in this SER.

It should be noted that the NRC staff focused its review primarily on the licensee's ability to examine Point Beach for severe accident vulnerabilities. Although certain aspects of the IPEEE 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 IPEEE material for purposes other than those associated with meeting the intent of Supplement 4 to GL 88-20 and resolving the generic safety issues discussed in Section II of this SER.

Attachments: 1. Technical Evaluation Report  
2. Supplemental Technical Evaluation Report

Date: September 15, 1999

In addition, the licensee's IPEEE submittal contains some specific information that addresses the external event aspects of GSI-147, "Fire-Induced Alternate Shutdown/Control Room Panel Interactions," GSI-148, "Smoke Control and Manual Fire-Fighting Effectiveness," GSI-156, "Systematic Evaluation Program (SEP)," and GSI-172, "Multiple System Responses Program." The specific information associated with each issue is identified and discussed in the enclosed SER. Based on the review of the information contained in the submittal, the NRC staff considered that the licensee's process is capable of identifying potential vulnerabilities associated with these issues. On the basis that no vulnerabilities associated the external event aspects of these issues were identified at Point Beach, the NRC staff considers these issues resolved for this plant site.

This completes the NRC staff's efforts in regard to TAC Nos. M83661 and M83662. The NRC staff appreciates your efforts in regard to this matter. If you have any questions concerning the staff's review of your IPEEE submittal, please contact me at (301) 415-1355.

Sincerely,

Original signed by:

Beth A. Wetzel, Senior Project Manager, Section 1  
 Project Directorate III  
 Division of Licensing Project Management  
 Office of Nuclear Reactor Regulation

Enclosure: Staff Evaluation Report

cc w/enc: See next page

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