22.0 REGULATORY TREATMENT OF NONSAFETY SYSTEMS

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22.0 REGULATORY TREATMENT OF NONSAFETY SYSTEMS

22.1 Introduction

This section of the ESBWR safety evaluation report (the report) addresses the regulatory treatment of nonsafety systems. Unlike the current generation of light-water reactors or the evolutionary advanced light-water reactors (ALWRs), the economic simplified boiling-water reactor (ESBWR) plant design uses passive safety systems that rely almost exclusively on natural forces, such as density differences, gravity, and stored energy, to supply safety injection water and provide core and containment cooling. These passive systems do not include pumps; however, they do include some active valves. All safety-related active valves require direct current (dc) safety-related electric power (supplied by batteries), are air operated (and fail safe on loss of air), or are check valves. The ESBWR design does not include any safety-related sources of alternating current (ac) power for the operation of passive system components. All active systems (i.e., systems requiring ac power to operate) are designated as non-safety-related, except for the instrumentation and control systems, which use safety-related ac power converted from safety-related dc power.

Because the ESBWR relies on passive safety systems to perform the design-basis, safety-related functions of reactor coolant makeup and decay heat removal, different portions of the passive systems also provide certain defense-in-depth backup to the primary passive features. For example, while the passive isolation condenser system (ICS) is the primary safety-related heat removal feature in a transient that does not result in a loss of coolant, the automatic depressurization system (ADS), together with passive safety injection features, provides a safety-related, defense-in-depth backup.

The ALWR Utility Requirements Document (URD) for passive plants, issued by the Electric Power Research Institute (EPRI) in 1992, includes standards related to the design and operation of active, nonsafety-related systems. The URD recommends that the plant designer specifically define the active systems relied upon for defense-in-depth and necessary to meet passive ALWR plant safety and investment protection goals. Defense-in-depth systems provide long-term, postaccident plant capabilities. Passive systems should be able to perform their safety functions independent of operator action or offsite support for 72 hours after an initiating event. After 72 hours, nonsafety or active systems may be required to replenish the passive systems or to perform core and containment heat removal duties directly. The ESBWR includes active systems that provide defense-in-depth (or investment protection) capabilities for reactor coolant system makeup, decay heat removal, and containment heat removal. These active systems are the first line of defense in reducing challenges to the passive systems in the event of transients or plant upsets. As noted above, most active systems in the ESBWR are designated as nonsafety-related.

Examples of nonsafety-related systems that provide defense-in-depth capabilities for the ESBWR design include the fuel and auxiliary pools cooling system (FAPCS), control rod drive (CRD) system injection function, reactor water cleanup/shutdown cooling (RWCU/SDC) system, and the reactor component cooling water system (RCCWS). For these defense-in-depth systems to operate, the associated systems and structures to support these functions must also be operable, including nonsafety-related standby diesel generators (DGs) and the plant service water system (PSWS). The ESBWR includes other active systems, also designated as nonsafety-related, such as the heating, ventilation, and air conditioning (HVAC) system that removes heat from the instrumentation and control cabinet rooms and the main control room

(MCR). These systems also prevent the excessive accumulation of radioactive materials in the control room to protect control room personnel.

In existing plants, as well as in the evolutionary ALWR designs, many of these active systems are designated as safety-related. However, by virtue of their designation in the ESBWR design as nonsafety-related, the licensing design-basis transient analyses described in ESBWR design control document (DCD), Tier 2, Revision 9, Section 15, do not model active systems (except in certain cases in which operation of a nonsafety-related system could make a transient worse). In SECY-90-406, "Quarterly Report on Emerging Technical Concerns," dated December 17, 1990, the staff of the U.S. Nuclear Regulatory Commission (NRC) listed the role of these active systems in passive plant designs as an emerging technical issue. In SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," dated April 2, 1993, the staff discussed the issue of the regulatory treatment of nonsafety systems (RTNSS) and stated that it would propose a process for the resolution of this issue in a separate Commission paper. The staff subsequently issued SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Nonsafety Systems in Passive Plant Designs," dated March 28, 1994, which discusses that process. In SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Nonsafety Systems in Passive Plant Designs," dated May 22, 1995, the staff essentially revised SECY-94-084 to respond to Commission comments on that paper and to request Commission approval of certain revised positions. However, the Commission approved the staff's position on RTNSS as discussed in SECY-94-084 in a staff requirements memorandum (SRM) dated June 30, 1994; this position remained unchanged in SECY-95-132.

In SECY-94-084, the staff cited the uncertainties inherent in the use of passive safety systems resulting from limited operational experience and the relatively low driving forces (e.g., density differences and gravity) in these systems. The uncertainties relate to both system performance characteristics (e.g., the possibility that check valves could stick under low differential pressure conditions) and thermal-hydraulic phenomena (e.g., critical flow through ADS valves). In some cases, design enhancements addressed the system performance issues. For example, designers improved check valve performance by using normally open check valves in the gravity-driven cooling system (GDCS) discharge lines. In addition, GE-Hitachi (GEH or the applicant) addressed uncertainties associated with passive system reliability, as well as thermal-hydraulic uncertainties, by virtue of the test programs reviewed and approved by the staff in the pre-application phase of the NRC review and as discussed in Section 21 of this report.

The residual uncertainties associated with passive safety system performance increase the importance of active systems in providing defense-in-depth functions to back up the passive systems. Recognizing this, the NRC and EPRI developed a process to identify important active systems and to maintain appropriate regulatory oversight of those systems. This process does not require that the active systems brought under regulatory oversight meet all safety-related criteria, but rather that these controls provide a high level of confidence that active systems having a risk-significant role are available when they are challenged.

The ALWR URD specifies standards concerning the design and performance of active systems and equipment that perform nonsafety-related, defense-in-depth functions. These standards include radiation shielding to permit access after an accident, redundancy for the more probable single active failures, availability of nonsafety-related electric power, and protection against more probable hazards. The standards also address realistic safety margin analysis and testing to demonstrate the systems' capabilities to satisfy their nonsafety-related, defense-in-depth functions. However, the ALWR URD does not include specific quantitative standards for the reliability of these systems.

SECY-94-084 and SECY-95-132 describe the scope, criteria, and process used to determine RTNSS for the passive plant designs. The staff has incorporated this information into Regulatory Guide (RG) 1.206, “Combined License Applications for Nuclear Power Plants,” issued June 2007.

The following five key elements make up the RTNSS process:

1. The ALWR URD describes the process to be used by the designer to specify the reliability/availability (R/A) missions of risk-significant structures, systems, and components (SSCs) needed to meet regulatory requirements and to allow comparisons of these missions to NRC safety goals. An R/A mission is the set of requirements related to the performance, reliability, and availability of an SSC function that adequately ensures the accomplishment of its task, as defined by a focused probabilistic risk assessment (PRA) or deterministic analysis.

2. The designer applies the process to the design to establish R/A missions for the risk-significant SSCs.

3. If active systems are determined to be risk significant, the staff reviews the R/A missions to determine whether they are adequate and whether the operational reliability assurance process or technical specifications (TS) can provide reasonable assurance that the missions can be met during operation.

4. If active systems are relied upon to meet the R/A missions, the designer imposes design requirements commensurate with the risk significance of those elements involved.

5. A design certification rule will not explicitly state the R/A missions for risk-significant SSCs. Instead, the rule will include deterministic requirements for both safety-related and nonsafety-related design features.

The following two sections discuss the steps of the RTNSS process to address the five key elements described above.

22.2 Scope and Criteria for the Regulatory Treatment of NonSafety Systems Process

The RTNSS process applies broadly to those nonsafety-related SSCs that perform risk-significant functions and therefore are candidates for regulatory oversight. The RTNSS process uses the following five criteria to determine those SSC functions:

1. SSC functions relied upon to meet deterministic NRC performance requirements, such as Title 10 of the *Code of Federal Regulations* (10 CFR) 50.62 and 10 CFR 50.63;

2. SSC functions relied upon to ensure long-term safety (beyond 72 hours) and to address seismic events;

3. SSC functions relied upon under power-operating and shutdown conditions to meet the Commission's safety goal guidelines of a core damage frequency (CDF) of less than 1×10^{-4} per reactor year and a large release frequency (LRF) of less than 1×10^{-6} per reactor year;

4. SSC functions needed to meet the containment performance goal, including containment bypass, during severe accidents; and

5. SSC functions relied upon to prevent significant adverse systems interactions.

Regarding Criterion 4, the staff discussed this issue in detail in SECY-93-087. For the ESBWR, the criterion for assessing containment performance is the degree to which the design comports with the Commission's probabilistic containment performance goal of less than 0.1 conditional containment failure probability (CCFP) when no credit is provided for the performance of the nonsafety-related, defense-in-depth systems for which there will be no regulatory oversight. The CCFP is a containment performance measure that provides perspectives on the degree to which the design has achieved a balance between core damage prevention and core damage mitigation. The staff used CCFP in a qualitative manner to confirm that the ESBWR design, combined with the regulatory oversight for identified SSCs, has maintained an acceptable balance between core damage prevention and mitigation. However, it did not use CCFP as a criterion for establishing the availability requirements for nonsafety-related, defense-in-depth systems.

22.3 Specific Steps in the Regulatory Treatment of Nonsafety Systems Process

The staff established the specific steps described below for design certification applicants to implement the process discussed above. Section C.IV.9 of RG 1.206 incorporates these steps.

22.3.1 Comprehensive Baseline Probabilistic Risk Assessment

The RTNSS process starts with a comprehensive Level 3 baseline PRA, which includes all appropriate internal and external events for both power and shutdown operations. The process also includes adequate treatment of R/A uncertainties, long-term safety operation, and containment performance. A margins approach is used to evaluate seismic events. In addressing containment performance, the PRA considers the sensitivities and uncertainties in accident progression, as well as the inclusion of severe accident phenomena, including the explicit treatment of containment bypass. The PRA uses mean values to determine the availability of passive systems and the frequencies of core damage and large releases. The process estimates the magnitude of potential variations in these parameters and identifies significant contributors to these variations using appropriate uncertainty and sensitivity analyses. Finally, the RTNSS process calls for an adverse systems interaction study to be performed and its results to be considered in the PRA. Section 19 of this report discusses the ESBWR baseline PRA, NEDO-33201, Revision 6, "ESBWR Probabilistic Risk Assessment," (ESBWR PRA), issued October 2010.

22.3.2 Search for Adverse Systems Interactions

The RTNSS process includes the systematic evaluation of adverse interactions between the active and passive systems. The results of this analysis are used to initiate design improvements to minimize adverse systems interactions and are considered in developing PRA models, as noted above.

22.3.3 Focused Probabilistic Risk Assessment

The focused PRA for the ESBWR design is a sensitivity study performed on the baseline ESBWR PRA that credits the passive systems and only those active systems necessary to meet the safety goal guidelines approved by the Commission in SECY-94-084 (see Criterion 3 in Section 22.2 of this report). The focused ESBWR PRA results are used in several ways to determine the R/A missions of nonsafety-related, risk-significant SSCs.

First, the focused PRA maintains the same scope of initiating events and their frequencies as that identified in the baseline ESBWR PRA. As a result, nonsafety-related SSCs used to prevent the occurrence of initiating events will be subject to regulatory oversight commensurate with their R/A missions.

Second, following an initiating event, the event tree logic of the comprehensive, Level 3 focused PRA will not include the effects of nonsafety-related standby SSCs. This will allow the combined license (COL) applicant to determine whether the passive safety systems, when challenged, can provide sufficient capability (without nonsafety-related backup) to meet the NRC safety goal guidelines for a CDF of less than 1×10^{-4} per reactor year and for an LRF of less than 1×10^{-6} per reactor year. The design certification applicant will also evaluate the containment performance, including bypass, during a severe accident. If the design certification applicant determines that nonsafety-related SSCs must be added to the focused PRA model to meet the safety goals, these SSCs will be subject to regulatory oversight based on their risk significance.

22.3.4 Selection of Important Nonsafety-Related Systems

The RTNSS process includes the identification of any combination of nonsafety-related SSCs that are necessary to meet NRC regulations, safety goal guidelines, and the containment performance goal objectives. These combinations are based on Criteria 1 and 5 in Section 22.2 of this report, for which NRC regulations are the bases for consideration, and Criteria 3 and 4 in Section 22.2 of this report, for which PRA methods are the bases for consideration. To address the long-term safety issue in Criterion 2 of Section 22.2 of this report, the design certification applicant will use PRA insights, sensitivity studies, and deterministic methods to establish the ability of the design to maintain core cooling and containment integrity beyond 72 hours. Nonsafety-related SSCs that are required to meet deterministic regulatory requirements (Criterion 1), resolve the long-term safety and seismic issues (Criterion 2), and prevent significant adverse systems interactions (Criterion 5) are subject to regulatory oversight.

The staff expects regulatory oversight for all nonsafety-related SSCs needed to meet NRC requirements, safety goal guidelines, and containment performance goals, as identified in the focused ESBWR PRA model. Using the focused PRA to determine the nonsafety-related SSCs important to risk involves the following three steps:

1. Determine those nonsafety-related SSCs needed to maintain the initiating event frequencies at the comprehensive baseline ESBWR PRA levels.

2. Add the necessary success paths (i.e., an event sequence in the PRA event tree that results in no core damage) with nonsafety-related systems and functions to the focused PRA to meet safety goal guidelines, containment performance goal objectives, and NRC regulations. Choose the systems by considering the factors for optimizing the design effects and benefits.

3. Perform PRA importance studies to assist in determining the importance of these SSCs.

22.3.5 Nonsafety-Related System Reliability/Availability Missions

Upon completion of the selection steps described in Section 22.3.4 of this report, the design certification applicant should determine and document the functional R/A missions of those active systems needed to meet safety goal guidelines, containment performance goals, and NRC performance requirements. The design certification applicant should also propose regulatory oversights as discussed in Section 22.3.6 of this report. The design certification applicant should repeat the steps described in Sections 22.3.4 and 22.3.6 of this report to ensure that it selects the most appropriate active systems and associated R/A missions. As part of this process, the design certification applicant should establish graded safety classifications and graded requirements for systems subject to RTNSS based on the importance to safety of the functional R/A missions.

22.3.6 Regulatory Oversight Evaluation

Upon completing the steps detailed in the previous five sections, the design certification applicant should conduct the following activities to determine the means of appropriate regulatory oversight for the RTNSS-important systems:

- Review the information in DCD Tier 2, Revision 9; the ESBWR PRA; and plant performance calculations to determine whether the design of the risk-significant, nonsafety-related SSCs satisfies the performance capabilities and R/A missions.

- Review the information in DCD Tier 2, Revision 9, to determine whether it includes the proper design information for the reliability assurance program, including the design information necessary for compliance with 10 CFR 50.65, which is referred to as the Maintenance Rule.

- Review the information in DCD Tier 2, Revision 9, to determine whether it includes proper short-term availability control (AC) mechanisms if required for safety and as determined by risk significance.

22.4 Other Issues Related to Regulatory Treatment of Nonsafety Systems Resolution

SECY-94-084 discussed several other issues related to overall passive plant performance or the performance of specific passive safety systems. The staff tied resolution of these issues to an acceptable resolution of the RTNSS issue. On the basis of the availability of short-term administrative controls for defense-in-depth equipment, as discussed in Section 22.5.9 of this report, the staff was able to reach acceptable conclusions regarding the ESBWR design related to (1) safe-shutdown requirements as discussed in Section 6.3.1.3 of this report, (2) SBO as discussed in Sections 8.4.2 and 15.5.5 of this report, and (3) General Design Criterion (GDC) 17, “Electric power systems,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” which addresses ac offsite power sources, as discussed in Section 8 of this report.

22.5 NRC Review of the Applicant's Evaluation of Systems for Inclusion in the Regulatory Treatment of Nonsafety Systems Process

DCD Tier 2, Revision 9, Section 19A, describes the applicant's implementation of the RTNSS process for the ESBWR. The applicant used this process to determine which nonsafety-related systems in the ESBWR should be subject to regulatory treatment and under what conditions that treatment should apply. The implementation of the RTNSS process for the ESBWR followed the scope, criteria, and specific steps described in SECY-94-084 and SECY-95-132, which are discussed in Sections 22.2 and 22.3 of this report. The applicant based the criteria used to determine which systems required regulatory oversight on PRAs of passive system performance (i.e., it used focused PRAs) and a study of initiating event frequency. In addition, the applicant evaluated containment performance challenges; seismic considerations; deterministic assessments of the design's response to events, such as anticipated transients without scram (ATWS) and station blackout (SBO); long-term safety (beyond 72 hours); and adverse systems interactions.

22.5.1 Focused Probabilistic Risk Assessment

As discussed above, one of the steps in the RTNSS process is the use of focused PRA results to identify nonsafety systems needed to meet the CDF and LRF safety goal guidelines. Section 11 of the ESBWR PRA report (NEDO-33201) provides the detailed results of the focused PRAs. Section 19.1.6.1 of this report summarizes the staff's evaluation of the focused PRA results.

22.5.1.1 *Summary of Technical Information*

22.5.1.1.1 Probabilistic Risk Assessment Event Mitigation Evaluation

Chapter 11 of NEDO-33201 describes the focused PRA sensitivity studies performed by the applicant to quantify the importance of nonsafety-related systems in mitigating events. The focused PRA sensitivity studies calculate the CDF and LRF without reliance on nonsafety-related SSC mitigation. If the focused PRA sensitivity studies rely on a nonsafety-related SSC mitigation function to ensure that the calculated CDF and LRF meet the safety goal guidelines, this function is designated as risk important and will be subject to regulatory oversight. The focused PRA sensitivity studies include an evaluation of internal and external events that occur at power and during shutdown operation.

The focused PRA sensitivity studies modify the ESBWR baseline PRA by setting the failure probability of each nonsafety SSC to one. The initiating event frequencies remain the same as in the baseline ESBWR PRA. The failure of the nonsafety and RTNSS systems significantly impacts the Level 1 PRA model CDF. Sections 11.3.3, 11.3.4, and 11.3.5 of the ESBWR PRA list the nonsafety systems considered in the focused PRA sensitivity studies. A series of additional studies were conducted to evaluate the impact of crediting individual nonsafety systems. These sensitivity studies showed that the impact on CDF is significantly reduced with the availability of the diverse protection system (DPS). The unavailability of the DPS, coupled with general transient initiator and common-cause failures of safety-related distributed control and information system (DCIS) software or reactor protection system (RPS) failures, are dominant contributors to CDF.

The CDF and LRF goals will be met with the addition of portions of the DPS that provide the capability to initiate several safety functions. These features include initiating GDCS injection, initiating ADS actuation, opening isolation condenser/passive containment cooling system (IC/PCCS) pool cross-connect valves, and closing RWCS/SDC isolation valves. The DPS functions are needed to counter the effects of a dominant risk contribution because of common-cause failures of actuation instrumentation and controls. The DPS has displays and control and actuation functions that are independent from those of the safety-related protection system and engineered safety feature (ESF) functions. They are not subject to the same common-mode/common-cause failures as the safety-related protection system components.

In addition, the DPS provides the following backup functions that are modeled in the ESBWR PRA:

- Scram
- Main steam isolation valve (MSIV) closure
- Safety/relief valve (SRV) actuation
- Fine motion control rod drive (FMCRD) actuation
- ICS actuation
- Standby liquid control (SLC) actuation for loss-of-coolant accident (LOCA)

These functions are not highly risk significant; therefore, the proposed regulatory oversight for these functions is treatment in the Availability Controls Manual (ACM). The ACM contains operational requirements to assure that the actual availability of selected SSCs is commensurate with the assumptions in the risk assessment and with the results of applying the RTNSS process. The NRC reviewed and approves the ACM.

Portions of the nonsafety digital instrumentation and controls system (N-DCIS) support the DPS functions. Consequently, the scope of the RTNSS program also includes the N-DCIS.

Tables 11.3-20 through 11.3-39 of NEDO-33201 compare the results for the baseline PRA, focused PRA sensitivity studies, and RTNSS sensitivity studies. Table 19A-2 in DCD Tier 2, Revision 9, lists the nonsafety-related systems and functions credited in the RTNSS sensitivity study. The RTNSS sensitivity study credits safety systems and systems covered by RTNSS; the focused PRA sensitivity study credits only safety systems.

Since portions of the DPS are credited to meet the CDF and LRF safety goals, these functions are identified as RTNSS important and subject to regulatory oversight. In accordance with 10 CFR 50.36(c)(2)(ii)(D), Criterion 4, the plant's TS must establish limiting conditions of operation (LCOs) for an SSC that either operating experience or the PRA has shown to be significant to public health and safety. Therefore, as described in DCD Tier 2, Revision 9, Section 16.0, the availability of these functions is enforced through the TS.

22.5.1.1.2 Uncertainty Evaluation

DCD Tier 2, Revision 9, Section 19A.4.2, considers potential uncertainties associated with assumptions made in the ESBWR PRA models of passive systems (e.g., failure rates of GDCS injection line check and squib valves). This PRA uncertainty evaluation determines which nonsafety-related SSCs should be included in the scope of the RTNSS program to add margin to compensate for the uncertainties in the ESBWR PRA. As a result of this evaluation, the low-pressure core injection capability of the FAPCS, including support systems for that system, was designated as RTNSS to add margin to compensate for potential uncertainties. Two injection trains provide this function of the FAPCS. These injection trains are physically and electrically separated such that no single active component failure can fail the function. Supporting systems for the FAPCS include the RCCWS, standby diesel generators (SDGs), plant investment protection (PIP) buses, electrical building HVAC, fuel building HVAC, turbine building HVAC, reactor building HVAC, the nuclear island chilled water system (NICWS), and the PSWS.

22.5.1.1.3 Probabilistic Risk Assessment Initiating Event Frequency Evaluation

DCD Tier 2, Revision 9, Section 19A.4.3, describes the applicant's evaluation of the importance of the nonsafety-related systems to the initiating event frequencies used for at-power and shutdown initiating event frequencies in the ESBWR PRA. The applicant identified eight categories of initiating events for at-power and shutdown conditions.

The at-power initiating event categories include the following:

- Generic transients
- Inadvertent opening of a relief valve
- Transient with a loss of feedwater
- Loss of preferred power
- LOCA

The shutdown initiating event categories include the following:

- Shutdown loss of decay heat removal
- Shutdown loss of offsite power
- Shutdown LOCA

The evaluation of the importance of the unavailability of nonsafety-related SSCs to the initiating event frequencies is based on the following three screening criteria:

1. Does the calculation of the initiating event frequency consider the nonsafety-related SSCs?

2. Does the unavailability of the nonsafety-related SSCs significantly affect the calculation of the initiating event frequency?

3. Does the initiating event significantly affect the CDF and the LRF?

In DCD Tier 2, Revision 9, Section 19A.4.3, the applicant stated that only safety-related systems are involved in the initiation of a stuck-open relief valve event and LOCA events inside containment. Therefore, in accordance with Criterion 1 of this section, RTNSS for nonsafety-related systems associated with these initiating events does not apply.

In the case of generic transients, the initiating event frequency is an assumed bounding value based on operating experience and does not depend on the availability or reliability of any nonsafety SSCs. Consequently, in accordance with Criterion 2 of this section, no nonsafety-related systems associated with these initiating events are candidates for regulatory treatment.

In DCD Tier 2, Revision 9, Section 19A.4.3, the applicant stated that the dominant risk contributions in the loss of preferred power event category are from the loss of incoming ac power from the utility grid and weather-related faults. These faults result from the failure of components that are not controlled by the site organization. Nonsafety-related SSCs controlled by the site organization, such as substations, breakers, motor control centers, and protective relays, do not significantly affect the initiating event frequency. In addition, the applicant noted that a nonsafety-related emergency ac power system designed to mitigate the effects of a loss of preferred power (i.e., the SDGs and PIP buses) has RTNSS controls based on other criteria.

The loss of feedwater event is caused by failures in nonsafety-related components in the condensate and feedwater system, but is not a significant contributor to CDF. The first two screening criteria are met. The third screening criterion is not met because the ESBWR has improved design features that affect the operation of these systems to increase reliability and reduce initiating event frequency. The design improvements include several features in the advanced design of the new generation feedwater level control system, which adds significant reliability that leads to a lower probability of loss of feedwater initiating events. The feedwater level control system is implemented on a triplicate, fault-tolerant digital controller. Therefore, a control failure is much less likely to occur in the ESBWR than in the design of the current generation of reactors. Because of these improvements in the feedwater controller design, the dominant contributors to a total loss of feedwater are a loss of control power to the feedwater controllers and loss of ac power to the pumps.

Initiating events considered for shutdown modes of operation (i.e., Modes 5 and 6) include LOCA, loss of preferred power, and loss of decay heat removal. The applicant concluded that the unavailability of nonsafety-related systems did not affect the loss of preferred power initiating event for reasons similar to those given for the at-power version of this event. Loss of preferred power due to plant-centered and switchyard-related faults were not considered candidates because plant-centered and switchyard-related component failures are not risk significant; therefore the third screening criterion is not met. The nonsafety-related RWCU/SDC removes decay heat in Modes 5 and 6; therefore, failures in this system may affect the loss of decay heat removal initiating event frequency. However, RWCU component failures leading to loss of shutdown cooling do not meet the threshold for significane, and therefore, the third screening criterion is not met.

22.5.1.2 *Regulatory Criteria*

The NRC does not have any specific regulatory requirements governing the application of the focused PRA for determining nonsafety systems requiring regulatory treatment. SECY-94-084, SECY-95-132, and the Commission's SRM on SECY-94-084 discuss guidelines for applying the focused PRA in the RTNSS process. SRP Section 19.0, Revision 2, of NUREG–0800, which addresses use of the focused PRA in the RTNSS process in a manner acceptable to the NRC, references these documents.

22.5.1.3 *Staff Evaluation*

22.5.1.3.1 Probabilistic Risk Assessment Event Mitigation Evaluation

The applicant has performed a focused PRA and applied it in a manner consistent with NRC guidance. Using this process, the applicant determined that NRC safety goals could not be met when the focused ESBWR PRA credited only safety-related systems. It identified risk-significant functions of the nonsafety-related DPS with mitigation capability sufficient to reduce the CDF and LRF below the NRC safety goals when credited in the focused PRA. The applicant has included requirements for the availability of these nonsafety-related functions through the TS, in accordance with 10 CFR 50.36(c)(2)(ii)(D), as discussed in Section 22.5.8 of this report.

22.5.1.3.2 Uncertainty Evaluation

The applicant has identified the FAPCS and its support equipment as nonsafety-related SSCs requiring regulatory treatment to compensate for the uncertainty associated with assumptions made in the PRA models of passive systems (as discussed in DCD Tier 2, Revision 9, Section 19A.4.2). The FAPCS provides a diverse backup for the passive GDCS core injection function and passive PCCS containment heat removal function and therefore directly addresses uncertainty in the ability of passive systems to perform as designed. For this reason, the staff finds the applicant's treatment of uncertainty in the RTNSS evaluation acceptable.

22.5.1.3.3 Probabilistic Risk Assessment Initiating Event Frequency Evaluation

The nonsafety-related systems that impact the loss of feedwater initiating event are required to continuously operate to support normal plant power operation. By providing more fault-tolerant system designs that increase plant reliability and availability, these improvements directly increase plant safety by reducing the potential for plant transients or trips that could challenge the plant's normal operation. Because the regulatory oversight of the RTNSS-important nonsafety-related SSCs is intended to ensure the reliability and availability of those systems that are normally in standby operation, it is not meaningful to consider additional regulatory oversight beyond the existing operational controls for the nonsafety-related systems that are required to operate during power operation. The staff agrees with the applicant that additional regulatory oversight for the ESBWR nonsafety-related SSCs that impact the initiating event, beyond that provided by operational controls, will not provide significant benefit in reducing the initiating event frequency, the CDF, or the LRF. In addition, the staff notes that SSCs that can cause a loss of feedwater initiating event are covered under the scope of the Commission's requirements for monitoring the effectiveness of maintenance under the Maintenance Rule because such an event could result in a reactor scram or actuation of a safety-related system. Consequently, the staff agrees that no additional oversight is needed.

The staff finds the applicant's assessment of LOCA and loss of preferred power initiating events for both at-power and shutdown conditions to be acceptable. The applicant's assessment of the shutdown decay heat removal initiating event is based on the assumption that both pumps in the RWCU/SDC will be running in Modes 5 and 6. Section 19.1.6 of this report (see discussion of Request for Additional Information [RAI] 19.1-4) discusses the staff evaluation of this assumption.

22.5.1.4 *Conclusions*

Based on the above evaluation, the staff concludes that the applicant's process for using the focused PRA results to identify RTNSS-important nonsafety-related SSCs follows the process approved by the NRC and is therefore acceptable.

22.5.2 Containment Performance Consideration

22.5.2.1 *Summary of Technical Information*

DCD Tier 2, Revision 9, Section 19.2, assesses the ESBWR design for meeting the following deterministic containment performance goal described in SECY-93-087 and approved by the Commission in an SRM dated July 21, 1993:

> The containment should maintain its role as a reliable, leak-tight barrier by ensuring that containment stresses do not exceed ASME service level C limits for a minimum period of 24 hours following the onset of core damage, and that following this 24-hour period the containment should continue to provide a barrier against the uncontrolled release of fission products.

The applicant has not identified any nonsafety-related SSCs that are relied upon to meet this performance goal. The applicant has also assessed compliance of the ESBWR design with the probabilistic containment performance goal of 0.1 CCFP with and without credit for nonsafety-related SSCs. Chapter 11 of NEDO-33201 describes these studies, performed with the focused Level 2 ESBWR PRA. The applicant asserted that the NRC goals of less than 1×10^{-4} per year for CDF and less than 1×10^{-6} per year for LRF can be met by crediting the DPS. No additional systems are required to meet the containment performance goal.

The basemat-internal melt arrest and coolability (BiMAC) device provides an engineered method to ensure heat transfer between a core debris bed and cooling water in the lower drywell during severe accident scenarios. The BiMAC device is not safety-related. It is included in the ESBWR design to reduce the uncertainties involved with severe accident phenomenology. Thus, the scope for RTNSS includes the BiMAC device, the nonsafety-related GDCS deluge squib valves, and the associated actuation logic.

Igniters (glow plugs) in the lower drums of the PCCS condensers recombine the hydrogen and oxygen at low concentrations, thereby keeping the resultant internal pressure of the PCCS condensers within acceptable limits to ensure there is no plastic deformation during a detonation under severe accident conditions. The igniters are activated by the existing GDCS deluges (BiMAC) control system implemented in a nonsafety-related technology programmable logic controller. Like the BiMAC device, the ignitors are a nonsafety-related feature that helps protect the containment during severe core damage accidents and reduce the uncertainties involved with severe accident phenomenology. As such, the ignitors have been included in the scope of RTNSS.

The applicant has addressed the potential for steam bypass of the suppression pool and potential failure of the PCCS heat exchanger tubes in the design of the ESBWR. The applicant has not identified any nonsafety-related SSCs that are relied upon to address these issues. DCD Tier 2, Revision 9, Section 6.2.1.1.5, addresses steam bypass of the suppression pool. DCD Tier 2, Revision 9, Section 6.2.2.3, discusses the design of the PCCS heat exchanger tubes.

22.5.2.2 *Regulatory Criteria*

The objective of the assessment is to identify any nonsafety-related SSC functions needed to meet the containment performance goals, including those related to containment bypass during severe accidents. The containment bypass issue from SECY-93-087, Issue II.G, is concerned with potential sources of steam bypassing the suppression pool and failure of heat exchanger tubes in the PCCS.

For the ESBWR, the probabilistic criterion for assessing containment performance is the degree to which the design comports with the Commission's probabilistic containment performance goal of 0.1 CCFP when no credit is provided for the performance of the nonsafety-related, defense-in-depth systems for which there will be no regulatory oversight. SECY-93-087 discusses the following deterministic criterion:

> The containment should maintain its role as a reliable, leak-tight barrier by ensuring that containment stresses do not exceed ASME service level C limits for a minimum period of 24 hours following the onset of core damage, and that following this 24-hour period the containment should continue to provide a barrier against the uncontrolled release of fission products.

22.5.2.3 *Staff Evaluation*

Section 19.1.4.2 of this report presents the staff's evaluation of the applicant's deterministic containment performance assessment.

Section 6.2 of this report discusses the staff's review of the PCCS heat exchanger tube design and those design features incorporated to address potential suppression pool bypass.

The debris bed cooling function of the BiMAC device and the igniters (glow plugs) in the lower drums of the PCCS condensers provide defense-in-depth protection against containment failure, thereby addressing uncertainty in the ability of passive systems to perform as designed. The staff finds that inclusion of the BiMAC device, its support systems, and the ignitors in the scope of RTNSS under Criterion 4 is appropriate.

22.5.2.4 *Conclusions*

The staff finds the applicant's selection of SSCs under this RTNSS selection criterion to be acceptable.

22.5.3 Seismic Consideration

22.5.3.1 *Summary of Technical Information*

In DCD Tier 2, Revision 9, Section 19A.3.2, the applicant stated that the seismic margins analysis (SMA) described in Section 19.1.5.1 of this report assesses the seismic ruggedness of safety-related plant systems and the nonsafety systems required for long-term safety (beyond 72 hours). Based on this analysis, the applicant indicated that no accident sequence leading to core damage has a high confidence of low probability of failure (HCLPF) value less than 1.67 times the peak ground acceleration of the safe-shutdown earthquake (SSE); the design certification refers to the SSE as the certified seismic design response spectra (CSDRS). Therefore, the applicant identified no additional nonsafety-related SSCs as RTNSS candidates because of seismic events.

22.5.3.2 *Regulatory Criteria*

The NRC policy associated with RTNSS, as delineated in SECY-94-084, states that SSC functions relied upon to resolve long-term safety (beyond 72 hours) issues and to address seismic events are candidates for consideration for regulatory oversight. SECY-94-084 also states that seismic events can be evaluated by a margins approach.

22.5.3.3 *Staff Evaluation*

The staff reviewed DCD Tier 2, Revision 6, Sections 19A.3.2 and 19.2.3.2.4, which referred to Section 15 of NEDO-33201, Revision 4, and described the SMA. In RAI 22.5-8, the staff asked the applicant to discuss the following issues to gain a clear understanding of the details of the SMA in relation to the RTNSS components:

- The basis for the assertion that RTNSS SSCs designed to the requirements of the 2003 International Building Code (IBC) (also referred to as IBC-2003) will satisfy the minimum HCLPF value of 1.67 times the SSE

- The technical basis for applying generic fragility and capacity data in judging the seismic ruggedness of the systems that qualify for RTNSS

- The available ESBWR-specific component test-based or design-experience-based seismic capacity data that would further support the validity of the seismic capacity, fragility, and HCLPF values obtained in the SMA

In response, the applicant stated the following:

- The minimum HCLPF value has been revised to 0.84g (1.67*0.5g). As shown in ESBWR DCD Tier 2, Revision 4, Table 19.2-4, only safety-related SSCs and RTNSS Criterion B1 components, which are designed as seismic Category II, are included in the SMA and, therefore, are expected to be seismically rugged. The SMA does not credit any RTNSS Criterion B2 components, which are designed to the IBC-2003 provisions.

- Component fragilities have been revised and moved from Table 15-1 to Table 15-7 in NEDO-33201, Revision 5, "ESBWR Probabilistic Risk Assessment." The only RTNSS component included in the SMA is the diesel-driven pump for the fire protection system (FPS), which is designed to seismic Category I requirements in accordance with ESBWR DCD Tier 2, Revision 4, Section 19A.4.2.4, and its fragility is therefore achievable.

- The SMA approach is a qualitative process. However, safety-related equipment is also seismically qualified in a process that is test-based following the Institute of Electrical and Electronics Engineers (IEEE) Std 323, "Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations," issued September 2003, and IEEE Std 344, Revision 4, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," issued December 2004. The qualification process in these standards is a stable process for which high confidence is afforded the qualified equipment and the ability to meet the seismic margin is achievable in practice.

The staff observed that, in DCD Tier 2, Revision 4, Table 19.2-4, the SMA credited only safety-related SSCs in addition to the diesel-driven fire protection pump (RTNSS B1[1]). The applicant committed to design RTNSS B1 SSCs as seismic Category II. In DCD Tier 2, Revision 4, Section 19A.4.2.4, the applicant stated that piping and components associated with the connection of the fire protection pump are designed to meet Quality Group C and seismic Category I. Accordingly, all SSCs included in the SMA are designed to withstand the SSE.

1 The term "RTNSS B" has been defined by the applicant and refers to SSCs that meet selection Criterion 2 in Section 22.2 of this report. The terms "RTNSS B1" and "RTNSS B2" have been defined by the applicant and refer to categories of SSCs that meet RTNSS selection Criterion 2 in Section 22.2 of this report, but receive different regulatory treatment. The diesel-driven fire protection pump falls into the B1 category.

Furthermore, the seismic qualification process, in accordance with IEEE standards, is acceptable to the staff and provides reasonable assurance that the qualified equipment will achieve the seismic margin. On this basis, the staff considers RAI 22.5-8 to be resolved.

The staff has reviewed the SMA described in Section 19.2.3.24 of DCD Tier 2, Revision 9, and confirmed that it credits only safety-related SSCs and the diesel fire pump, which are designed to the seismic Category I standard.

22.5.3.4 *Conclusions*

The SMA used to perform the seismic assessment of the ESBWR standard plant design credits only safety-related SSCs and the diesel-driven fire protection pump. This pump is designed to seismic Category I requirements. All SSCs relied upon to address a design-basis seismic event are designed to withstand the effects of the SSE, in accordance with the requirements of DCD Tier 2, Revision 9, Section 3.7, which provides reasonable assurance that these SSCs will achieve the stated seismic margin. On this basis, the staff finds the results of the SMA, with regard to RTNSS components, acceptable.

22.5.4 Deterministic Anticipated Transient without Scram and Station Blackout Evaluation

22.5.4.1 *Station Blackout Assessment*

22.5.4.1.1 Summary of Technical Information

The ESBWR is designed to cope with an SBO event for 72 hours. The analysis in DCD Tier 2, Revision 9, Section 15.5.5, demonstrates that reactor water level is maintained above the top of active fuel by operation of the ICS, which is safety-related. Operation of the PCCS, which is also safety-related, maintains the containment and suppression pool pressures and temperatures within their design limits. Therefore, the integrity of containment is maintained. The ESBWR is designed to successfully mitigate an SBO event to meet the requirements of 10 CFR 50.63 without relying on nonsafety-related systems.

22.5.4.1.2 Regulatory Criteria

The staff policy associated with RTNSS, as delineated in SECY-94-084, states that SSC functions relied upon to meet deterministic NRC performance requirements in 10 CFR 50.63 for mitigating SBO events are candidates for consideration for regulatory oversight.

22.5.4.1.3 Staff Evaluation

Section 15.5.5 of this report presents the staff’s safety evaluation of the applicant’s analysis of the SBO event. Based on this review, the staff finds that the ESBWR can successfully mitigate an SBO event to meet the requirements of 10 CFR 50.63 without relying on nonsafety-related systems.

22.5.4.2 *Anticipated Transient without Scram Assessment*

22.5.4.2.1 Summary of Technical Information

Under 10 CFR 50.62, boiling-water reactors (BWRs) must have (1) an automatic recirculation pump trip, (2) an alternate rod insertion (ARI) system, and (3) an automatically initiated SLC system for ATWS prevention and mitigation.

Unlike the current BWR fleet, the ESBWR does not use recirculation pumps, so the recirculation pump trip logic does not exist. Instead, the ESBWR uses natural circulation along with automatic feedwater control. Thus, the ESBWR has implemented an automatic feedwater runback (FWRB) feature under conditions indicative of an ATWS event. This provides a reduction in water level, core flow, and reactor power similar to the recirculation pump trip. This feature is judged to be a major contributor to preventing reactor vessel overpressure and possible short-term fuel damage for ATWS events.

The ESBWR has an ARI system with sensors and logic that are diverse and independent of the RPS. The ARI employs hydraulic pressure to scram the plant using the three sets of air header dump valves of the CRD system. The DPS implements the ARI logic.

The ESBWR has the required automatic initiation of the SLC system under conditions indicative of an ATWS. The ATWS/SLC system mitigation logic provides a diverse means of emergency shutdown using the SLC for soluble boron injection. The ESBWR design uses electrical insertion of FMCRDs with sensors and logic that are diverse and independent of the RPS.

A nonsafety system may perform this ATWS diverse automated backup function if the system is of sufficient quality to perform the necessary functions under the associated event conditions, as described in the enclosure to Generic Letter 85-06, “Quality Assurance Guidance for ATWS Equipment That Is Not Safety-Related,” dated January 16, 1985. The ATWS mitigating logic system is implemented with the safety-related and nonsafety-related DCIS. The nonsafety-related DPS processes the nonsafety-related portions of the ATWS mitigation logic and is designed to mitigate the effects of potential digital protection system common-cause failures. The DPS transmits the FWRB signal from the ATWS mitigation logic to the feedwater control system (FWCS). The applicant identified the nonsafety-related portions of the ATWS mitigation logic as requiring regulatory treatment in accordance with the RTNSS process.

22.5.4.2.2 Regulatory Criteria

The staff policy associated with RTNSS, as delineated in SECY-94-084, states that SSC functions relied upon to meet deterministic NRC performance requirements under 10 CFR 50.62 for mitigating ATWS are candidates for consideration for regulatory oversight.

22.5.4.2.3 Staff Evaluation

The applicant selected the ARI system, the FWRB logic, and the ATWS initiation controls for the SLC system as RTNSS equipment. As discussed in DCD Tier 2, Revision 9, Sections 6.3.1 and 9.3.5, the SLC system is part of the ESBWR emergency core cooling system (ECCS) and is classified as safety-related. It is only the ATWS/SLC actuation logic that is classified as an RTNSS function. This logic includes the diverse ADS inhibit logic that is required, along with the safety-related ADS inhibit logic, for SLC initiation to be successful. The applicant stated in DCD Tier 2, Revision 9, Section 19A.2.1, that the requirements for these systems and functions are consistent with those specified in the ATWS rule. Section 7 of this report presents the detailed safety evaluation of the specific physical equipment; logic; detailed design; design acceptance criteria; defense-in-depth attributes; self-testing features; and inspections, tests, analyses, and acceptance criteria (ITAAC) used to satisfy the ATWS rule. Section 15.5.4 of this report presents the staff's safety evaluation of the applicant's analysis of the ATWS event.

22.5.4.2.4 Conclusions

Based on its review, the staff concludes that the applicant has correctly identified the nonsafety equipment relied upon to meet the ATWS rule and therefore requiring regulatory treatment.

22.5.5 Evaluation of Adverse Systems Interactions

22.5.5.1 *Summary of Technical Information*

DCD Tier 2, Revision 9, Section 19A.6 states that the purpose of the Criterion E analysis is to systematically evaluate adverse interactions between the active and passive systems. Section 19A.6 states that an adverse systems interaction exists if the action or condition of an active, interfacing system causes a loss of safety function of a passive safety-related system. The section further states that a systematic process is used to analyze specific features and actions that are designed to prevent postulated adverse interactions, while taking into consideration the operating experience that has been used in the current design criteria to prevent adverse systems interactions.

During the assessment of potential adverse system interactions, the applicant identified an issue that relates to MCR habitability under certain post-LOCA containment cooling with fuel failure conditions. The potentially adverse interaction involves the need to process the contaminated air expected following fuel damage. The processing of contaminated water occurs within the reactor building. A filtered HVAC system (i.e., the contaminated area ventilation system (CONAVS)) Reactor Building HVAC Accident Exhaust Filter Unit ensures that effluent from the reactor building is controlled so that dose levels in the MCR remain within acceptable limits. Contaminated air from the reactor building must be processed following fuel damage. DCD Tier 2, Revision 5, Section 5.4.8, described post-LOCA cooling with fuel failure, during which time a CONAVS Reactor Building HVAC Accident Exhaust Filter Unit may operate to prevent exceedance of the MCR dose limits. If the CONAVS filters do not perform with adequate efficiency, the theoretical control room doses may be exceeded for certain design-basis LOCAs. Therefore, it is prudent to place increased regulatory treatment on these filters as an added measure to ensure acceptable performance.

The lower drywell provides an equipment hatch for removal of equipment during maintenance and an air lock for personnel entry. These access openings are sealed during normal operation, but may be opened when the plant is shut down. Closure of both hatches is required to maintain water level during makeup following a shutdown-LOCA that occurs in either Mode 5 or Mode 6. Open hatches would inhibit the safety-related makeup systems from performing their intended function. Therefore, the lower drywell hatches are in the scope of RTNSS.

22.5.5.2 *Regulatory Criteria*

The staff presented criteria for the evaluation of nonsafety-related SSCs in SECY-94-084. The SECY paper indicates that the functions of SSCs relied upon to prevent significant adverse system interactions should be considered candidates for regulatory oversight. The staff used the guidance in the SECY paper and associated SRM as the basis for its review of the applicant's evaluation of adverse system interactions in the ESBWR.

22.5.5.3 *Staff Evaluation*

The staff reviewed the description of the evaluation of adverse systems interactions provided in DCD Tier 2, Revision 4, using the Commission guidance in SECY-94-084. The staff considered the specific SSCs included in the scope of RTNSS under this criterion and the applicant's rationale for their inclusion.

In RAI 22.5-17, the staff requested that GEH provide additional information to explain and clarify the systematic approach used to evaluate adverse system interactions, including the manner in which potential adverse systems interactions are evaluated for nonsafety-related components. In response to RAI 22.5-17, the applicant described the systematic approach used to evaluate adverse system interactions. Passive safety functions are evaluated to identify target areas or components that could be affected by an adverse condition. The systems that interface with each passive safety function are identified to determine whether nonsafety-related SSCs could potentially cause a failure of a passive safety function. Each interface between a nonsafety-related SSC and a passive safety function is evaluated for potential adverse effects. Both functional and spatial interactions are addressed. The development of the fire and flooding portions of the PRA model further addressed spatial interactions. The result of the systematic evaluation is the identification of nonsafety-related SSCs that could cause adverse system interactions. These SSCs should then be considered for additional regulatory oversight. GEH stated that the results of the adverse systems interaction evaluation of the ESBWR did not identify any SSCs that should be considered for the RTNSS program. The staff found the GEH description of the approach used to evaluate adverse system interactions to be acceptable, but GEH did not discuss how potential adverse system interactions for nonsafety-related components from functional or spatial interactions will be identified during the engineering and construction phase of the ESBWR plant. Therefore, RAI 22.5-17 was tracked as an open item in the safety evaluation report (SER) with open items.

In RAI 22.5-17 S01, the staff requested that GEH explain how it will identify and address, during the detailed engineering and construction phase, potential adverse system interactions from functional or spatial interactions for nonsafety-related components to ensure that the functions of safety-related and RTNSS systems will not be adversely impacted. In response to RAI 22.5-17 S01, GEH stated that it performs an adverse system interactions evaluation for any changes to the ESBWR design. Design phase engineering procedures that are part of the GEH quality program address the effects of fire, flood, pipe break, missile hazard, and seismic events in terms of the potential for adverse interaction given the presence of two or more systems in proximate locations. The design input procedure contains provisions for identifying design inputs during development or modification of the design of systems such as consideration of loads (e.g., seismic, wind, thermal, and dynamic); environmental impact (e.g., temperature, humidity, radiation, and electromagnetic radiation); failure effects; and reliability requirements (including interactions that could impair important functions). The staff considers this response to be acceptable in clarifying the consideration of potential system interactions. Therefore, RAI 22.5-17 and the associated open item are resolved.

Safety-related systems are required to be protected from the effects of failures in the safety-related and nonsafety-related systems. DCD Tier 2, Revision 4, addresses those interactions in Section 3.3, Section 3.4, Section 3.5, Section 3.6, and Section 3.7. In response to RAI 22.5-5, GEH described features to be implemented during the engineering and construction phase to ensure that RTNSS systems are not adversely affected by interactions with internal flooding, external flooding, missiles generated during seismic events and high winds, and piping failures in fluid systems outside containment. GEH incorporated Tables 19A-3 and 19A-4 into DCD Tier 2, Revision 5, Section 19A to clarify the consideration of potential adverse interactions.

In addition to evaluating system interactions as part of the ESBWR design certification, COL applicants must submit a quality program for the design of their proposed ESBWR plant. In particular, DCD Tier 2, Revision 9, Section 17.2 includes COL information items that require the COL applicant to describe the quality assurance program for the construction and operations phases, as well as the quality assurance program for design activities that are necessary to adapt the certified standard plant design to a specific plant implementation. This will reduce the potential to introduce system interactions during the transition from the certified design to the plant-specific implementation.

The applicant identified the Reactor Building HVAC Accident Exhaust Filter Units and the lower drywell hatches for treatment under RTNSS and demonstrated that these SSCs need to function successfully to ensure that safety-related systems perform their intended functions. The applicant has included ACs for these SSCs in the ACM. The staff finds this treatment to be appropriate and acceptable.

Based on the information provided by GEH, including the COL information items, the staff finds that the applicant's consideration of potential system interactions for RTNSS systems satisfies the applicable Commission guidance for review of the ESBWR design certification.

22.5.6 Post-72-Hour Actions and Equipment

22.5.6.1 *Summary of Technical Information*

The ESBWR is designed so that passive systems are able to perform all safety functions for 72 hours after an initiating event without the need for active systems or operator actions. After 72 hours, nonsafety-related systems can be used to replenish the passive systems or to perform safety and postaccident recovery functions directly. In DCD Tier 2, Revision 9, Section 19.A.3.1, the applicant described the actions and equipment needed in the post-72-hour period for the ESBWR. This section of the DCD, states that the following safety functions are relied upon in the 72-hour period following an accident:

- Containment integrity
- Core cooling
- Control room habitability
- Postaccident monitoring

Section 19.A.3.1 describes the nonsafety-related equipment that is relied upon to ensure that these safety functions are successful in the post-72-hour period. The staff's regulatory criteria and evaluation of this information against those criteria are provided below.

22.5.6.2 *Regulatory Criteria*

The staff's evaluation of post-72-hour actions appears in SECY-96-128, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated June 12, 1996, which the Commission approved in a memorandum dated January 15, 1997. In SECY-96-128, the staff took the position that post-72-hour actions related to all design-basis events must be accomplished with onsite equipment and supplies in the time-frame beyond 72 hours after a design-basis event occurs. After 7 days, replenishment of consumables, such as diesel fuel oil from offsite suppliers, can be credited. The staff further stated that the equipment needed for post-72-hour support need not be in "automatic standby mode," but must be readily available for connection and protected from natural phenomena, including seismic events, as required by GDC 2, "Design bases for protection against natural phenomena." In a memorandum to the Commission dated June 23, 1997, the staff outlined the implementation of the staff position in SECY-96-128. The staff stated that, to ensure that post-72-hour SSCs can withstand the effects of an SSE without the loss of capability to perform their required functions, the SSCs should be analyzed, designed, and constructed using the method and criteria for seismic Category II building structures. The staff also stated that a COL applicant would be required to have appropriate ACs, consistent with RTNSS requirements, for nonsafety-related SSCs for post-72-hour support.

22.5.6.3 *Staff Evaluation*

22.5.6.3.1 Augmented Design Standards

In DCD Tier 2, Revision 9, Section 19A.3.1, the applicant stated that RTNSS B SSCs have redundant active components. These SSCs are designed to appropriate seismic design standards and are protected from high winds and flooding hazards. In addition, these SSCs are subject to harsh environmental conditions and are able to perform in such conditions.

In DCD Tier 2, Revision 9, Section 19A.8.3, the applicant described the augmented design standards used in the design of RTNSS systems that meet Criterion B (See footnote in Section 22.5.33 of this report). The applicant reiterated that Criterion B components are required to function following a seismic event and that they are designed to seismic Category II criteria, at a minimum. In addition, any non-RTNSS systems that can adversely interact with RTNSS B systems are designed to the same seismic requirements as the affected RTNSS system. The applicant also stated that Criterion B systems must meet design standards to withstand winds and missiles generated from Category 5 hurricanes. With regard to flood protection, the applicant stated that the plant design considers the relevant requirements of GDC 2, and meets the guidelines of RG 1.59, Revision 1, "Design-Basis Floods for Nuclear Power Plants," issued August 1977, and RG 1.102, Revision 1, "Flood Protection for Nuclear Power Plants," issued September 1976. RG 1.59 provides guidance for establishing flood design criteria. RG 1.102 provides guidance for establishing the means for protection of safety-related SSCs against flood. In addition, the applicant stated that, to ensure that RTNSS systems are protected from flood-related effects associated with fluid piping and component failures, they are located above the maximum internal flooding level discussed in DCD Tier 2, Revision 9, Section 3.4.

The staff reviewed the augmented design standards described in DCD Tier 2, Revision 9, Section 19A.8.3. The staff finds that, at a minimum, RTNSS SSCs meeting Criterion B are designed in accordance with seismic Category II requirements. This provides reasonable assurance that these SSCs can perform their function following a seismic event. Therefore, the staff finds these standards acceptable.

In RAI 22.5-6, the staff asked the applicant to confirm that the ESBWR design does not contain nonsafety-related structures that either support or surround the RTNSS systems whose failure may negatively affect the RTNSS system functions. RAI 22.5-6 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-6, the applicant stated that the structures that house the systems and components that meet RTNSS Criteria B1 and B2 are required to meet the augmented standards presented in DCD Tier 2, Revision 4, Section 19A.8.3. The applicant also provided a table showing the structures that house RTNSS components for criteria other than B and indicated that the minimum structural design classification for those structures is seismic Category II.

During its review of the response, the staff noted that some of the structures that house components that meet RTNSS Criteria B2 are designed to the standards of IBC-2003. The seismic provisions of these standards use a 2,500-year event as the maximum considered earthquake. This ground motion is then reduced by a factor of two-thirds to produce the design ground motion. Such ground motion may have a return period varying from approximately 500 to 1,500 years, depending on the regional seismicity. The design seismic demands are further modified (generally reduced) in the design calculations to account for earthquake energy absorption through nonlinear behavior (i.e., component cracking and yielding). Structures classified as IBC-2003 Occupancy Category IV are designed as Seismic Use Group III and are expected to achieve the immediate occupancy performance level at the design-level ground motion. Based on the provisions documented in Federal Emergency Management Agency (FEMA) 450, "2003 NEHRP Recommended Provisions for Seismic Regulations of New Buildings and Other Structures," issued June 2004, which forms the technical bases for the IBC-2003 seismic provisions, "immediate occupancy" is a performance level below an operational or a functional level. FEMA 450 further states that, at the immediate occupancy level, damage to the structural systems is very slight and the structure remains safe to occupy; however, some repair is probably required before the structure can be restored to normal service. Equipment housed in such structures, on the other hand, is expected to experience more damage. In particular, utilities necessary for the normal function of systems are not expected to be available. In addition, some equipment and systems may experience internal damage because of the shaking of the structure. Ultimately, minor structural repairs are required; however, significant nonstructural repair and cleanup are probably required before normal function of the structure can be restored. In light of this, the staff was concerned that the IBC-2003 seismic provisions may not be adequate to ensure that the post-72 hour systems, structures and components can withstand the effects of a (SSE) without the loss of capability to perform their required functions. Based on its understanding of the limitations of the IBC-2003 seismic provisions, the staff requested the following information in RAI 22.5-6 S01 to obtain an explanation of the applicant's approach to compensate for the limitations of the IBC-2003 provisions:

1. Identify in the DCD all nonsafety-related, nonseismic structures that house or support RTNSS systems meeting Criteria B1 and B2.

2. Provide the technical rationale to support the assertion that IBC-2003 seismic provisions will achieve functional performance under SSE conditions.

3. Given the lower hazard and performance levels of the IBC-2003 as compared to the SSE hazard with a functional performance level, explain how the availability and reliability of RTNSS Criterion B2 systems and their surrounding or supporting structures will be ensured.

4. In the event of an SSE, explain in the DCD how RTNSS Criteria B1 and B2 systems are protected against adverse interaction resulting from the failure of adjacent nonsafety-related, nonseismic structural and nonstructural components that are designed to the IBC-2003 seismic provisions.

In response to RAI 22.5-6 S01, the applicant provided a complete list of RTNSS Criterion B2 systems located in nonsafety-related, nonseismic structures. The applicant stated that the IBC-2003 seismic provisions use a 2-percent exceedance value as the maximum considered earthquake ground motion that would result in acceptable safety for most regions of the United States. However, ESBWR RTNSS SSCs are designed to SSE ground motion. When RTNSS systems are located in non-Category I structures, these structures, although categorized as nonseismic, are seismically designed using IBC-2003 to maintain structural integrity with a margin of safety equal to a seismic Category I structure under SSE conditions. A dynamic analysis method is used with the SSE ground motion input equal to two-thirds of the ESBWR CSDRS.

The applicant also identified the following additional criteria that are used for the design of RTNSS systems:

1. Importance factor of 1.5 that cancels the two-thirds reduction factor in response spectra

2. Seismic Category D/Seismic Use Group III

3. Response modification factor, R=2, which results in seismic loads 3 times larger than required by IBC-2003

4. Loads, load combinations, and performance criteria consistent with IBC-2003

RTNSS Criterion B1 equipment is qualified to IEEE Std 344-1987 to demonstrate seismic performance. The SMA does not credit RTNSS Criterion B2 components. RTNSS Criterion B2 equipment is qualified to IEEE Std 344-1987 to demonstrate structural integrity.

Subsequently, the applicant recategorized the SSCs in scope for RTNSS to address long-term safety and seismic requirements as Criterion B, thus eliminating the Criterion B1 and Criterion B2 grouping. All RTNSS Criterion B SSCs meet seismic Category II design requirements; this eliminates the need to use IBC-2003 seismic provisions for the design of RTNSS SSCs meeting Criterion B2. Non-RTNSS systems that can adversely interact with RTNSS B systems are designed to the same seismic requirements as the affected RTNSS systems. On these bases, RAI 22.5-6 and the associated open item are resolved.

In addition, in RAI 22.5-7, the staff asked the applicant to discuss its specific application of the provisions of the IBC-2003 for the design of both equipment and structures meeting RTNSS Criterion B. In response, the applicant reiterated that Criterion B1 systems are designed to seismic Category II requirements, while the IBC-2003 is applied to the design of Criterion B2 systems as described below.

The maximum earthquake ground motion response spectrum is the single-envelope ESBWR SSE design response spectrum shown in DCD Tier 2, Revision 4, Figure 2.0-1. The following requirements apply to seismic Category I and II SSCs:

1. The RTNSS design ground motion spectrum is two-thirds SSE.

2. Structures, piping, or components, according to IBC-2003 Section 1616.3, must be designed as Seismic Design Category D under Seismic Use Group III with an importance factor of 1.5.

3. Equipment seismic loads must be calculated in accordance with American Society of Civil Engineers/Structural Engineering Institute 7-02, “Minimum Design Loads for Buildings and Other Structures,” issued in 2002, Equations 9.6.1.3-1, 9.6.1.3-2, 9.6.1.3-3, and 9.5.2.7 for horizontal, maximum, minimum, and vertical loads, respectively.

The applicant also stated that the electrical building is an RTNSS structure. This building houses two nonsafety-related SDGs and provides space for the technical support center. The electrical building is nonsafety-related, nonseismic, and is designed to the Criterion B2 augmented design as described above.

Based on the staff’s understanding of the IBC-2003, the augmented seismic design criteria, as delineated in the applicant’s response, would allow Criterion B2 RTNSS SSCs to achieve the immediate occupancy performance level at two-thirds SSE. In accordance with FEMA 450, this is a state of some level of damage (lower for the structure and higher for the equipment) at two-thirds SSE. This is not sufficient to provide reasonable assurance that Criterion B2 SSCs will function after an SSE event. In RAI 22.5-7 S01, the staff therefore requested that the applicant do the following:

1. Provide a detailed explanation for the applicant’s assertion that an immediate occupancy performance level at two-thirds SSE will provide reasonable assurance that Criterion B2 SSCs will function after an SSE event.

2. If applicable, provide in the DCD specific modifications to the IBC-2003 provisions to improve the performance criteria for RTNSS Criterion B2 SSCs to a functional performance level at an SSE event.

RAI 22.5-7 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-7 S01, the applicant indicated that RTNSS buildings that house Criterion B2 systems are seismically designed in accordance with IBC-2003 using a dynamic analysis method with the SSE ground input motion equal to two-thirds of the CSDRS. An occupancy importance factor of 1.5, response modification factor of 2, and Seismic Design Category D/Seismic Use Group III apply to Criterion B2 structures.

In DCD Tier 2, Revision 5, Section 19A the applicant recategorized the SSCs in scope for RTNSS to address long-term safety and seismic requirements as Criterion B, thus eliminating the Criterion B1 and Criterion B2 groupings. All RTNSS Criterion B SSCs are designed to seismic Category II design criteria, which provides assurance that this equipment will have adequate capacity to survive an SSE and perform the required long-term safety functions. Based on this response, RAI 22.5-7 and the associated open item are resolved.

In DCD Tier 2, Revision 4, Section 19A.8.1, the applicant stated that regulatory oversight for RTNSS systems is categorized as high regulatory oversight (HRO), low regulatory oversight (LRO), or support. In Section 19A.8.3, the applicant also stated that the augmented design standards apply to HRO and LRO systems that meet Criterion B. Since the applicant designated many of the RTNSS Criterion B systems as regulatory oversight “support” in DCD Tier 2, Revision 4, Table 19A-2, the staff issued RAI 22.5-21, which requested that the applicant identify the standards used for the design of the RTNSS systems designated as “support.” RAI 22.5-21 was being tracked as an open item in the SER with open items.

In its response to RAI 22.5-21, the applicant stated that it addressed the standards used to design RTNSS systems that provide support functions and the structures that house or support them in its response to RAI 22.5-5. In its response to RAI 22.5-5, the applicant committed to add supporting information to DCD Tier 2, Revision 5, Section 19A and provided a description of the proposed changes to the DCD. Specifically the response to RAI 22.5-5 included Tables 19A-3, "Structures Housing RTNSS Functions," and 19A-4, "Capability of RTNSS Related Structures." Table 19A-3 lists the systems identified as B1 and B2, the buildings in which they are housed, and their seismic category. Table 19A-4 lists the system locations and the treatment for internal flooding, external flooding, internal missiles, and extreme winds and missiles. With respect to external flooding and external missiles, GEH indicated that seismic Category I design provides the necessary level of protection. For nonseismic class buildings, the flood design accounts for hydrostatic pressure and requires that any openings below flood level be appropriately sealed. For missile protection in nonseismic class buildings (electrical and service water), the structures are designed to withstand Category 5 hurricanes and missiles. The turbine building is designed for tornado wind speeds without missiles; this design provides the required level of protection.

The staff considered the applicant's response to RAI 22.5-21 to be incomplete because it did not address seismic design. DCD Tier 2, Revision 4, Section 19A.8.3, stated that all systems that meet RTNSS Criterion B require augmented design standards. The same section excluded some of these systems because they were classified as "support" for purposes of regulatory treatment.

In RAI 22.5-21 S01, the staff requested the applicant to do the following:

1. Confirm that the augmented seismic design standards in DCD Tier 2, Revision 4, Section 19A.8.3, are applicable to all RTNSS systems and components that meet Criterion B, including those designated as regulatory oversight "support." Otherwise, describe the alternative seismic design criteria used and justify its adequacy.

2. Confirm that the augmented seismic design standards in DCD Tier 2, Revision 4, Section 19A.8.3, are applicable to the nonseismic structures that house and support all RTNSS systems and components that meet Criterion B including those designated as regulatory oversight "support." Otherwise, describe the alternative seismic design criteria used and justify its adequacy.

In response to RAI 22.5-21 S01, the applicant indicated that systems classified as "support" in DCD Tier 2, Revision 4, Section 19A.8.3, are LRO and thus are not excluded from the augmented design requirements. DCD Tier 2, Revision 5, clarified this assertion. Specifically, Section 19.8.1 clarified that "support" systems receive LRO, and Section 19.A.8.3 clarified that all RTNSS B systems are housed in buildings that meet augmented design standards. Table 19A-3 identified all structures housing RTNSS B components; all structures in the list are either seismic Category I or II. Based on the clarifications and the table added to DCD Tier 2, Revision 5, RAI 22.5-21 S01 and the associated open item are resolved.

In DCD Tier 2, Revision 4, Section 19A.8.3, with respect to wind design for RTNSS components, the staff noted that the applicant committed to design Criterion B systems to withstand winds and missiles generated from Category 5 hurricanes. However, the applicant did not provide wind design parameters and missile characteristics. In addition, the applicant stated that the plant design for safety-related SSCs satisfies GDC 2 and meets the requirements of RG 1.59 and RG 1.102 with regard to developing flood design criteria and protection against flood. However, the applicant did not note that these design criteria and RGs are used in the flood design and protection of RTNSS systems. In RAI 22.5-9, the staff asked the applicant to discuss key examples for demonstrating how the stated deterministic evaluation requirements are implemented for the RTNSS systems. RAI 22.5-9 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-9, the applicant stated that it addressed the standards used to design RTNSS systems that provide support functions and the structures that house or support them in its response to RAI 22.5-5, in which it committed to adding supporting information to DCD Tier 2, Revision 5, Section 19A. The response to RAI 22.5-5 included Tables 19A-3 and 19A-4. Table 19A-3 lists the systems identified as B1 and B2, the buildings in which they are housed, and their seismic category. Table 19A-4 lists the system locations and the treatment for internal flooding, external flooding, internal missiles, and extreme winds and missiles. With respect to external flooding and external missiles, GEH indicated that the seismic Category I design provides the necessary level of protection. For nonseismic class buildings, the flood design accounts for hydrostatic pressure and requires that any openings below flood level be appropriately sealed. For missile protection in nonseismic class buildings (electrical and service water), the structures are designed to withstand Category 5 hurricanes and missiles. The turbine building is designed for tornado wind speeds without missiles, which provides the required level of protection.

The staff accepts the external flood design considerations for all classes and the missile protection assessment for seismic Category I structures. However, the applicant did not provide enough details regarding the impact of hurricanes and missiles on the nonseismic class structures.

In RAI 22.5-9 S01, the staff therefore requested that the applicant do the following:

1. Identify the 3-second gust wind speed used in the design for the Category 5 hurricane.

2. Confirm that the procedures used for calculating and distributing the wind pressure and all of the associated parameters that account for the physical and geometrical conditions of the structures are in accordance with DCD Tier 2, Revision 4, Section 3.3.1. Otherwise, fully describe the alternative procedure used.

3. Confirm that the hurricane missile spectrum is consistent with the tornado missile spectrum identified in DCD Tier 2, Revision 4, Table 2.0-1. Otherwise, fully describe the alternative missile spectrum used.

4. Explain how the design of the turbine building for tornado winds without missiles will envelop the demands of a Category 5 hurricane wind with missiles. If hurricane missiles are assumed to penetrate the building, describe the protection provisions implemented to protect RTNSS systems from missile damage as stated in Table 19A-4.

In reply to RAI 22.5-9 S01, the applicant stated that the design uses a wind speed of 314 kilometers (km) per hour (195 miles per hour [mph]), with a 3-second gust. The seismic Category I and II structures that house Criterion B systems are designed in accordance with provisions discussed in DCD Tier 2, Revision 5, Section 3.3.1. The standard hurricane missile used to determine impact resistance is consistent with ‘‘Design and Construction Guidance for Community Safe Rooms.’’

FEMA 361, “Design and Construction Guidance for Community Safe Rooms” was issued by the FEMA in 2000. The missile impact velocity is equal to the hurricane wind speed of 314 kilometers (km) per hour (195 mph), with a 3-second gust, multiplied by the shape factor for horizontal and vertical travel. In addition, the turbine building is designed for tornado winds, hurricane Category 5 winds, and missiles generated by hurricanes.

The staff considered the applicant’s response to RAI 22.5-9 S01, to be incomplete because GEH did not indicate that it would revise the DCD as requested. The necessary information describes design criteria and must be included in the DCD. In addition, the staff found that the applicant had not adequately justified its proposed missile spectrum. In RAI 22.5-9 S02, the staff requested that the applicant do the following:

1. Include the 314 kilometers (km) per hour (195 mph), 3-second gust wind speed associated with Category 5 hurricanes in the DCD Tier 2, Revision 5.

2. Justify the use of the FEMA 361 wood stud missile as an appropriate missile for the design of nuclear facility or assume that the hurricane missile spectrum is consistent with the tornado missile spectrum identified in DCD Tier 2, Revision 5, Table 2.0-1, which is also consistent with the staff’s implementation of SECY-96-128 delineated in the staff’s memorandum to the Commission dated June 23, 1997 and titled, “Implementation of Staff Position in SECY-96-128, ‘Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standard Pressurized Reactor Design,’ Related to Post-72 Hour Actions.”

3. Provide the design criteria associated with the hurricane missile in the DCD.

In its response to RAI 22.5-9 S02, the applicant indicated that it would change the hurricane missile spectrum to be consistent with the tornado missile spectrum identified in DCD Tier 2, Revision 5, Table 2.0-1. The applicant would revise DCD Tier 2, Revision 5, Section 19A.8.3 and Table 19A-4, to include the hurricane missile spectrum description and the design criteria associated with it. The design criteria associated with hurricane missiles follows DCD Tier 2, Revision 5, Section 3.5, for missiles generated by natural phenomenon. The tornado wind speed is substituted with the hurricane wind speed to design the concrete or steel barriers against missile impact. The staff confirmed that these changes were incorporated in DCD Tier 2, Revision 6, Section 19A.8.3 and Table 19A-4. Based on that, RAI 22.5-9 and the associated open item are resolved.

In RAI 22.5-25, with regard to the seismic design criteria for RTNSS Criterion C SSCs discussed in DCD Tier 2, Revision 4, the staff requested that the applicant do the following:

1. Provide a comparison to support the assertion that nonseismic structures that are designed to the IBC-2003 will maintain a structural integrity with a margin of safety that is equivalent to a seismic Category I structure under SSE. In this comparison, address all aspects of the two design and analysis methodologies including the design load combinations, the response modification factors (or energy absorption factors), member capacity reduction factors, construction detailing, the treatment of vertical seismic loads, and the treatment of concurrent orthogonal seismic components. Otherwise, remove this assertion from the DCD Tier 2.

2. Justify that qualifying RTNSS Criterion C equipment by using IEEE Std 344 to only demonstrate structural integrity will be sufficient to ensure the equipment functionality following an SSE event. Otherwise, if the functionality of these systems is not required after

an SSE seismic event, provide a statement in DCD Tier 2, Revision 5, to clarify that assertion.

In response, the applicant agreed to remove the phrase "with a margin of safety that is equivalent to a seismic Category I structure" to describe the design of nonseismic structures using IBC-2003. In addition, the applicant stated that RTNSS Criterion C components are not required to remain functional following a seismic event. The SMA results indicate that RTNSS Criterion C components are not required to function in order to avoid core damage following a seismic event. The staff confirmed that the applicant revised DCD Tier 2, Revision 4, Section 19A.8.3, to reflect the changes and clarified the functionality requirement for RTNSS Criterion C. Therefore, RAI 22.5-25 is resolved.

In RAI 22.5-5, the staff asked the applicant to describe how RTNSS systems will be protected specifically from the following:

1. Flood-related effects associated with both high- and moderate-energy fluid piping and component failures inside and outside containment

2. Flood-related effects associated with both natural phenomena and system and component failures

3. Piping failures in fluid systems outside containment

4. Missiles

In response to RAI 22.5-5, GEH provided Tables 19A-3 and 19A-4. In Table 19A-3, GEH identified the RTNSS SSCs together with their associated RTNSS criteria, locations (buildings), and building category. In Table 19A-4, GEH identified how the structures housing RTNSS SSCs in each area are protected from internal flooding, external flooding, internal missiles, and extreme wind and missiles.

The staff found the GEH response to RAI 22.5-5 inadequate. Specifically, GEH did not provide sufficient details to demonstrate that RTNSS systems had been adequately protected from flood-related effects associated with both natural phenomena and system and component failures. Subsequently, in RAI 22.5-5 S01, the staff requested that GEH provide a detailed description of the design and installation of each RTNSS SSC and discuss how this design and installation would provide the protection against the effects of internal or external flooding or both. RAI 22.5-5 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-5 S01, GEH stated the following:

- RTNSS components are located and installed above the maximum analyzed flood levels in each of the buildings referenced. This requirement is incorporated in the design specifications and implemented during the detailed design to ensure protection of the RTNSS components against internal flooding.

- The maximum flood level for the ESBWR is one ft below the finished grade per DCD Tier 2, Revision 5, Table 2.0-1. The maximum groundwater level is two ft below the finished grade. The PSWS, located outdoors, is designed with protection from water intrusion if installed below the maximum flood and groundwater levels. This includes designing for hydrostatic loading and provision of cell enclosures. These requirements are incorporated in the design specifications and implemented during detailed design.

The staff found the GEH response to RAI 22.5-5 S01 acceptable providing that DCD Tier 1, included design descriptions and ITAAC to ensure that RTNSS systems would be protected against internal flooding, external flooding, internal missiles (inside and outside containment), and extreme wind and missiles, as stated in DCD Tier 2, Revision 5. Therefore, in RAI 22.5-5 S02, the staff requested that GEH provide ITAAC in DCD, Tier 1, Section 2.0 to ensure that RTNSS systems will be protected against the following:

- Flood-related effects associated with both high- and moderate-energy fluid piping and component failures inside and outside containment

- Flood-related effects associated with both natural phenomena and system and component failures

- Internally-generated missiles (inside and outside containment)

- Externally-generated missiles

In response to RAI 22.5-5 S02, GEH stated that it would revise DCD Tier 2, Revision 5, to include ITAAC, as marked in the response, for RTNSS to ensure that the RTNSS systems would be protected against flood-related effects associated with both high- and moderate-energy fluid piping and component failures inside and outside containment, flood-related effects associated with both natural phenomena and system and component failures, postulated piping failures in fluid systems outside containment, internally-generated missiles (inside and outside containment), and externally-generated missiles.

The staff verified that these modifications and ITAAC were added in DCD Tier 2, Revision 6. These modifications assure that the features protecting safety-related SSCs and RTNSS SSCs against internal flooding, external flooding, internal missiles (inside and outside containment), and extreme wind and missiles are designed and will perform as described in DCD Tier 2, Revision 9. Therefore, the staff concludes that the ESBWR protection provided for safety-related SSCs and RTNSS SSCs against internal flooding, external flooding, internal missiles (inside and outside containment), and extreme wind and missiles complies with the requirements of 10 CFR 52.47(b)(1). In addition, the staff considers its concerns, as described in RAI 22.5-5, RAI 22.5-5 S01, RAI 22.5-5 S02, and the associated open item to be resolved.

22.5.6.3.2 Containment Integrity

The containment integrity safety function removes reactor decay heat and controls containment pressure to maintain containment integrity for the duration of an accident. In addition, if the containment pressure approaches the design value during a LOCA, it is necessary to provide a means to rapidly reduce the pressure to an acceptably lower value and to maintain this low value.

The passive systems that remove reactor decay heat from the core and containment are the safety-related ICS and the safety-related PCCS. These systems are capable of removing decay heat for at least 72 hours without the need for active systems or operator actions.
Section 19.1.6.1 of this report discusses the ability of the ICS to perform the decay heat removal

function in Mode 5. After 72 hours, makeup water is needed to replenish the boiloff from the upper containment and spent fuel pools. Initially, makeup water is provided by opening the IC/PCCS cross-connect valves. In the longer term, the FPS provides makeup to the pools via piping in the FAPCS. In DCD Tier 2, Revision 9, Section 19A.3.1.2, the applicant identified the following equipment relied upon to accomplish this makeup function:

- Diesel-driven FPS pump
- Fire water storage tank
- Diesel-driven pump fuel storage tank
- Piping in the FPS
- Piping in the FAPCS

The applicant stated in DCD Tier 2, Revision 9, Section 9.5.1.1, that the diesel-driven pump and piping in the FPS meet the augmented design requirements listed in DCD Tier 2, Revision 9, Section 19.A.8.3. This equipment will be designed in accordance with the seismic Category I standard, which the staff finds acceptable. This equipment is protected from natural phenomena, as discussed in Section 22.5.6.3.1 of this report.

In DCD Tier 2, Revision 9, Section 9.5.1.4, the applicant stated that the fuel oil tank for the primary diesel-driven fire pump has a capacity of 3785 liters (1,000 gallons), and, with such a capacity, the diesel-driven fire pump can provide makeup water to the ICS/PCCS pools from 72 hours to seven days after an accident. To determine the capacity, the applicant assumed that the diesel-driven pump need not operate continuously to supply the required quantity of makeup water to the pools because the flow rate required for performing this function is less than the flow rate required for supplying firewater. Consequently, the fuel capacity required before tank refilling is based on fuel consumption for injecting the required makeup quantity rather than operation of the diesel engine for approximately 96 hours. The staff finds this approach acceptable because the assumptions are realistic and reasonable.

The water for makeup is stored in the FPS primary storage tanks, which are designed to the seismic Category 1 standard and, together, hold over 3.7 million liters (1 million gallons) of water. In DCD Tier 2, Revision 9, Section 9.5.1.4, the applicant stated that these tanks have sufficient capacity to meet total demand in the post-72-hour period up to seven days following an accident. After seven days, onsite or offsite makeup sources can be used. Given the expected decay heat level for the ESBWR in the 4-day, post-72-hour period, more than enough water will be available in the storage tanks to make up for boiloff in the upper containment pools.

The ACM, documented in DCD Tier 2, Revision 9, Section 19ACM, and discussed in Section 22.5.9 of this report, provides the short-term ACs for the equipment listed herein.

The equipment identified by the applicant is sufficient to perform the makeup function in the post-72-hour period for up to seven days and satisfies the regulatory criteria listed in Section 22.5.6.2 of this report.

The ability to maintain containment pressure for the first 72 hours is accomplished by removing decay heat using the PCCS. Noncondensable gas accumulation in the drywell causes containment pressure to trend upward. After 72 hours, nonsafety-related systems in the scope of RTNSS function in conjunction with PCCS to maintain containment pressure acceptably low for the long term. The passive autocatalytic recombiners (PARs) in the containment airspaces and PCCS vent fans function to mitigate the pressure increase due to noncondensable gas accumulation. The PARs remove hydrogen and oxygen generated by radiolysis. They do not require supporting power. The PCCS vent fans redistribute the noncondensable gases from the wetwell to the drywell to reduce overall containment pressure to an acceptable level. The PCCS vent fans are powered from the ancillary ac power buses and are manually aligned and operated. Section 22.5.6.3.4 of this report discusses the ancillary ac power system.

22.5.6.3.3 Core Cooling

The core cooling safety function is to provide an adequate inventory of water to ensure that the fuel remains cooled and covered, with stable and improving conditions, beyond 72 hours. For scenarios with the reactor coolant system intact, the safety-related ICS performs this function; for scenarios with the reactor coolant system open to containment, the safety-related GDCS injection function meets this requirement. As long as decay heat removal is ensured in the post-72-hour period (i.e., makeup water is provided to the upper containment pools as needed), the GDCS provides a sustainable, closed-loop method to keep the core covered. Consequently, the applicant concluded that neither nonsafety-related equipment nor operator actions are directly relied upon to support the core cooling safety function, and there are no RTNSS requirements to support post-72-hour core cooling.

Based on its review of the ICS and GDCS designs documented in Sections 5.4.6 and 6.3 of this report, respectively, the staff agrees that these systems can perform the post-72-hour core cooling function as long as makeup water is provided as described in Section 22.5.6.3.2 above. Therefore, the staff finds the applicant’s proposed treatment of the core cooling safety function to be acceptable.

22.5.6.3.4 Control Room Habitability

Safety-related portions of the control room habitability area ventilation system (CRHAVS) maintain control room habitability. This function is operated on safety-related battery power for the first 72 hours following an event. The nonsafety-related ancillary ac power system provides backup power (post-72 hours) to the safety-related control room emergency filtration unit (EFU) fans. In addition, the control room habitability area (CRHA) air-handling units (AHUs) and auxiliary cooling units maintain control room temperatures within limits in the post-72 hour period. Consequently, the applicant has identified the components of the ancillary ac power system and the CRHA AHUs as nonsafety components requiring regulatory treatment under the RTNSS process.

The components of the ancillary ac power system include redundant ancillary DGs, buses, diesel fuel storage tanks, and diesel fuel transfer pumps. These components reside in the ancillary DG building, which is a seismic Category II structure. The CRHA AHUs reside in the control building, which is a seismic Category I structure. As discussed in Section 22.5.6.3.1 of this report, the applicant has committed to applying its augmented design standards to equipment required for long term cooling, which includes this equipment, and the staff has found these standards to be acceptable.

The applicant has included ACs for the ancillary ac power system components and the CRHA AHUs in Section 19ACM of the ACM. The staff reviewed the ACs for the ancillary ac power system. In RAI 22.5-46, the staff asked the applicant to add the following availability control surveillance requirement (ACSR) for ancillary DGs:

1. Verify that each ancillary diesel generator starts and operates at rated load for ≥24 hours. This test may utilize diesel engine pre-lube prior to starting and warm-up period prior to loading. Also, verify this test is done during every refueling outage.

2. Verify the fuel oil transfer system operates to [automatically] transfer fuel oil from storage tank[s] to the day tank [and engine mounted tank]. Also, verify this test is done every 92 days.

In response, the applicant stated it would revise Availability Control Limiting Condition for Operation (ACLCO) 3.8.3 to include the requested ACSR and corresponding bases. The staff confirmed that the applicant incorporated the requested ACSR and bases into DCD Tier 2, Revision 7. The staff finds that the applicant has adequately addressed the issue, and the RAI is resolved. The staff reviewed the ACs for the CRHA AHUs and their bases and finds them acceptable because they are similar to typical surveillance requirements for this type of equipment in operating reactors.

22.5.6.3.5 Postaccident Monitoring

Postaccident monitoring safety functions include safety-related displays in the control room, emergency lighting, and control room cooling to remove heat generated by personnel and the monitoring equipment. The safety-related digital control and instrumentation system (Q-DCIS) provides postaccident monitoring (DCD Tier 2, Revision 9, Section 7.1.2.8) and is safety-related and normally powered by uninterruptible power, including dc batteries designed to function for at least 72 hours. Emergency lighting, which is normally powered by 72-hour batteries, is provided to support postaccident monitoring functions. Passive cooling, provided by the control building and reactor building structures, maintains the equipment within acceptable temperature limits for at least 72 hours.

For the post-72-hour period, the CRHA AHUs and auxiliary cooling units maintain control room temperatures within limits. Beyond 72 hours, it is necessary to provide power for the Q-DCIS components. Ancillary ac power supplies the power for the Q-DCIS and emergency lighting (DCD Tier 2, Revision 9, Section 9.5.3). The Q-DCIS cabinets and related components are either passively cooled, or if necessary, have localized cooling from the CRHAVS recirculation AHUs. Ancillary ac power also provides power for the recirculation AHUs.

The applicant has included the ancillary ac power system, the CRHA AHUs and auxiliary cooling units, and the CRHAVS in the RTNSS program. The staff reviewed the ACs for the CRHAVS and their bases, and finds them acceptable. Section 22.5.6.3.4 of this report discusses the staff's review of the CRHA and ancillary ac power system.

22.5.6.4 *Conclusions*

The staff finds that the applicant has included sufficient nonsafety-related equipment in the RTNSS program to ensure that safety functions relied upon in the post-72-hour period are successful. Further, the staff finds that the nonsafety-related equipment relied upon in the post-72-hour period has been designed in accordance with Commission policy and that the applicant has established appropriate ACs for this equipment.

22.5.7 Mission Statements and Regulatory Oversight of Important Nonsafety-Related Structures, Systems, and Components

22.5.7.1 *Summary of Technical Information*

In accordance with the RTNSS process, nonsafety-related SSCs relied upon to meet the criteria described in Section 22.2 of this report are designated as RTNSS important and are subject to regulatory oversight. As described in Sections 22.5.1 through 22.5.6 of this report, the applicant has identified the RTNSS-important SSCs. In DCD Tier 2, Revision 9, Section 19A.8.4, the applicant identified these important nonsafety systems, their missions, and recommended regulatory oversight. Table 19A-2 in DCD Tier 2, Revision 9, lists the included SSCs.

The applicant stated in DCD Tier 2, Revision 9, Section 19A.8.2, that all RTNSS systems must be in the scope of the design reliability assurance program (D-RAP), as directed by DCD Tier 2, Revision 9, Section 17. The COL applicant's Maintenance Rule program, which is regulated in accordance with 10 CFR 50.65, will incorporate the D-RAP.

In DCD Tier 2, Revision 9, Section 19A.8.1, the applicant described its method for determining whether the TS or a separate process outside of the TS will control the availability of nonsafety-related SSCs requiring regulatory oversight. The applicant's decision process relies on the results of the focused ESBWR PRAs, and in particular, on the focused PRA sensitivity studies that show the importance of SSC functions in keeping CDF and LRF below the Commission's established goals. In these focused PRA studies, each RTNSS system was failed with all other RTNSS equipment credited. In cases in which the result exceeded a CDF or LRF goal, the SSC was identified as risk significant, requiring that the TS control availability. The only RTNSS function satisfying this criterion was the diverse actuation of ECCS functions that the DPS TS controls. The ACM, discussed in Section 22.5.9 of this report, addresses the ACs of the other RTNSS systems.

22.5.7.2 *Regulatory Criteria*

The applicable regulatory criteria include (1) 10 CFR 50.36(c)(2)(ii)(D), which requires that a TS LCO of a nuclear reactor be established for an SSC that either operating experience or a PRA has shown to be significant to public health and safety, and (2) RG 1.206, which describes the scope, criteria, and process used to determine RTNSS in the passive plant designs.

22.5.7.3 *Staff Evaluation*

The mission of the DPS is to provide diverse actuation functions that will enhance the plant's ability to mitigate dominant accident sequences involving the common-cause failure of actuation logic or controls. In DCD Tier 2, Revision 9, Section 19A.8.4.5, the applicant stated that it has established generic technical specification (GTS) operability, action, and surveillance requirements for the DPS. GTS 3.3.8.1 specifies the DPS instrumentation and actuation functions. The following GTSs specify the associated DPS initiators of safety-related valves for the identified system:

- GTS 3.5.1 and GTS 3.5.3 for the ADS
- GTS 3.5.2 and GTS 3.5.3 for the GDCS
- GTS 3.6.1.3 for RWCU/SDC system containment isolation
- GTS 3.7.1 for opening of the equipment pool-to-inner expansion pool cross-connect valves

In light of the results of the focused ESBWR PRA and the requirements of 10 CFR 50.36(c)(2)(ii)(D), the staff finds this acceptable.

The staff has reviewed the mission statements for SSCs provided in DCD Tier 2, Revision 9, Section 19A.8.4. These statements correctly describe the missions of RTNSS and nonsafety-related SSCs; therefore, the staff finds them acceptable.

The staff reviewed the provisions in DCD Tier 2, Revision 4, for the oversight of nonsafety-related SSCs. In RAI 22.5-16, the staff asked the applicant to provide additional information regarding the treatment of several systems and components. The applicant provided a response for each of those systems or components and referred to the ACM or other sections of the DCD. However, the treatment provisions for several SSCs were not explained in sufficient detail and consequently, RAI 22.5-16 was being tracked as an open item in the SER with open items.

In RAI 22.5-16 S01, the staff asked the applicant to clarify the treatment provisions for RTNSS SSCs. In response to RAI 22.5-16 S01, the applicant clarified the treatment provisions for the RTNSS SSCs. Based on the Commission's guidance and experience with other risk-informed industry programs, the staff considers the treatment provisions described for these RTNSS SSCs, combined with other relevant provisions in DCD Tier 2, Revision 9, to be sufficient for the ESBWR design certification review. Therefore, RAI 22.5-16 and the associated open item are resolved.

DCD Tier 2, Revision 5, Section 19A.2.1, states that most of the SLC system is safety-related and has sufficient regulatory oversight. In RAI 22.5-15, the staff asked the applicant to clarify those portions of the SLC system that are nonsafety-related, as well as the regulatory oversight specified for those components. The staff also asked the applicant to justify the basis for stating that regulatory oversight of the SLC system is sufficient, since some portions of the SLC system are categorized as nonsafety-related and not included in RTNSS. In response to RAI 22.5-15, the applicant clarified the function of the nonsafety-related portions of the SLC system. These portions include the subsystem for nitrogen charging of the accumulators and the subsystem for boron mixing and makeup of the accumulators. These systems are not required for the SLC to perform its safety-related function. They are used to maintain SLC readiness.

In RAI 22.5-15 S01, the staff requested that the applicant discuss the nonsafety-related systems or components used to monitor the operational readiness of the SLC system and explain why they are not included in the RTNSS program. In response to RAI 22.5-15 S01, the applicant stated that the TS control the operational readiness of the SLC system and supporting systems. The staff found this response to be acceptable because TS controls provide adequate oversight. Therefore, RAI 22.5-15 S01 is resolved.

In RAIs 22.5-28 and 22.5-29, the staff asked the applicant to clarify the regulatory oversight provisions for RTNSS SSCs in Section 19A.8.1 and the treatment of specific systems in Section 19A.8.4. In response to these RAIs, the applicant provided planned modifications to DCD Tier 2, to clarify the title of Section 19A.8.1, to address availability treatment, and to include Section 19A.8.4.13 and Section 19A.8.4.14, to reference the applicable regulatory treatment for these functions. DCD Tier 2, Revision 7, included these modifications, which provide an acceptable clarification of the regulatory oversight provisions for RTNSS functions and the regulatory treatment for the specified systems.

DCD Tier 2, Revision 4, Section 17.4, describes the D-RAP, which contains requirements for the treatment of risk-significant SSCs, including RTNSS systems. The D-RAP is used during the design and specific equipment selection phases to ensure that the important ESBWR reliability assumptions in the PRA are considered throughout the plant life. The D-RAP identifies relevant aspects of plant operation, maintenance, and performance monitoring of important plant SSCs for consideration in ensuring the safety of the equipment and providing for protection of the public. GEH ESBWR engineering design procedural controls are applied to the D-RAP, with specific procedures for design process, control of design changes, and storage and retrieval controls. The design control procedure defines the process for performing, documenting, and verifying design activities, including developing or modifying the design of systems, engineering evaluations, analyses, calculations, and documents. The staff has reviewed the proposed reliability assurance program and documented its review in Section 17.4 of this report. The staff finds that the reliability assurance program meets the guidance in Item E of SECY-95-132 and Section 17.4 of the SRP.

DCD, Tier 1, Revision 9, Section 3.6 includes an ITAAC for the D-RAP. As noted above, DCD Tier 2, Revision 9, Section 17.2, includes COL information items that require the COL applicant to describe the quality assurance program for the construction and operations phases and the quality assurance program for design activities that are necessary to adapt the certified standard plant design to a specific plant implementation. The NRC will conduct its evaluation of these activities as part of the COL application reviews and construction inspection programs.

In DCD, Tier 1, Revision 4, Section 2.12.2, Section 2.12.5, and Section 2.12.7 the applicant revised the ITAAC to remove large portions of information, including a system description, system drawings, a design commitment, and ITAAC scope. The staff found the removal of this ITAAC information in Tier 1 to be unacceptable. In RAIs 22.5-1 and 22.5-1 S01, the staff requested that the applicant review and revise DCD, Tier 1 to include the RCCWS, chilled water system (CWS), and the PSWS in Tier 1 for ITAAC. In response to the RAIs, the applicant provided the requested Tier 1 system description, ITAAC, and drawings for the RCCW, CWS, and PSWS in the revised DCD, Tier 1 sections. DCD, Tier 1, Revision 5 incorporated this information; therefore, the staff finds that RAIs 22.5-1 and 22.5-1 S01 are resolved. Section 9.2 of this report also discusses closure of these RAIs.

22.5.8 Technical Specifications

As discussed in Section 22.5.7.1 of this report, the applicant committed to include in DCD Tier 2, Sections 16 and 16B, the GTS and bases for the nonsafety-related functions of the DPS that have been determined to be risk significant. The applicant included TS and bases for the risk-significant nonsafety-related functions of the DPS in DCD Tier 2, Revision 6, Sections 16 and 16B. The staff reviewed the GTS and bases for these DPS functions as documented in Section 16.2.6 of this report, and finds them acceptable.

22.5.9 Short-Term Availability Controls

22.5.9.1 *Summary of Technical Information*

In DCD Tier 2, Revision 4, Section 19A.8.1, the applicant proposed a means for implementing RTNSS controls in the form of administrative ACs for the SSCs summarized in DCD Tier 2, Revision 4, Section 19A.8.4.1, and listed in Table 19A-2, except for the DPS manual controls, which are addressed by GTS 3.3.8.1, as discussed in SER Section 22.5.8. The ACM, which has been incorporated into DCD Tier 2, Revision 7, Section 19ACM, documents the ACs.

The RTNSS criteria, designated as “1” through “5” in the preceding evaluation, are designated as “A” through “E” in DCD Tier 2, Revision 9, Section 19A and in this section of the report. For each criterion, the identified associated RTNSS SSC functions are identified below. Also listed are those nonsafety-related functions or systems that are included in the GTS and those for which an explicit AC or GTS is not specified because they do not meet any of the criteria for establishing an AC or an LCO. The instrumentation and logic descriptions are taken from DCD Tier 2, Revision 9, Section 7. Table 22.5.9-1 summarizes the proposed ACs.

Criterion A: SSC functions relied upon to meet NRC deterministic performance requirements (beyond design-basis events)—10 CFR 50.62(c) and 10 CFR 50.63

Note: DCD Tier 2, Revision 9, Section 19A.2.2 states that there are no RTNSS candidates for SBO based on Criterion A.

- (**AC 3.3.1**) ARI System
  - Four ARI-associated instrumentation channels of nonsafety-related DPS, reactor pressure vessel (RPV) wide-range water-level sensors, and RPV dome pressure sensors supply the nonsafety-related DPS ARI trip logic.
  - Nonsafety-related DPS ARI trip logic function generates ARI trip signal to the three sets of ARI valves in the CRD system upon any of the following signals:
    - Two-out-of-four channels of the DPS high RPV dome pressure function are greater than or equal to the setpoint.
    - Two-out-of-four channels of the DPS low RPV water level function are less than or equal to the setpoint (i.e., Level 2).
    - Both ARI manual pushbuttons in the ATWS/SLC system actuated (causes manual actuation of ARI, SLC, and FWRB).
    - DPS diverse scram ATWS mitigation logic ARI trip signal on either of the following:
      - (GTS 3.7.6) SCRRI/SRI command with power remaining elevated (two-out-of-three logic)
      - (GTS 3.3.1.2) RPS scram command (two-out-of-four logic)

- SLC System
  - (**AC 3.3.2, Function 1**) Safety-related ATWS/SLC actuation logic automatically initiates SLC system boron injection for diverse reactor shutdown on any of the following signals:
    - Two-out-of-four channels of the safety-related high RPV dome pressure function are greater than or equal to the setpoint and two-out-of-four channels of the safety-related start-up range nuclear monitor (SRNM) ATWS permissive function are greater than or equal to the setpoint for at least three or more minutes.
    - Two-out-of-four channels of the safety-related low RPV water level function are less than or equal to the setpoint (i.e., Level 2) and two-out-of-four channels of the safety-related SRNM ATWS permissive function are greater than or equal to the setpoint for at least three or more minutes.
  - (GTS 3.1.7, GTS 3.3.5.1 Function 1, GTS 3.3.5.2 Function 4) Safety-related safety system logic and control (SSLC), SSLC/ESF actuation logic for ECCS injection for

LOCA mitigation automatically initiates the SLC system 50 seconds after receipt of the following signal:

    - ○ (GTS 3.3.5.1 Function 1) Two out of four channels of the safety-related low RPV water level function are less than or equal to the setpoint (i.e., Level 1) sustained for 10 seconds.

  - – (GTS 3.3.5.2, Function 4) Safety-related ATWS/SLC actuation logic automatically closes the normally open, redundant, in series, fail-as-is accumulator shutoff valves to prevent nitrogen entry into the RPV on the following signal:
    - ○ (GTS 3.1.7) Two-out-of-four channels of the safety-related low accumulator level function are less than the setpoint.

- (**AC 3.3.2, Function 2**) RWCU/SDC System Isolation—The SLC system logic transmits an isolation signal to the RWCU/SDC via the leak detection and isolation system (LD&IS), thus preventing dilution of boric acid in the RPV.

- ADS Inhibit
  - – (**AC 3.3.2, Function 3**) Inhibit safety-related SSLC/ESF actuation logic for ADS actuation on two-out-of-four channels of sustained low RPV level function less than or equal to the setpoint (i.e., Level 1) and sustained drywell pressure high function greater than or equal to the setpoint by either of the following safety-related ATWS signals:
    - ○ Coincident low RPV water level (i.e., Level 2) and average power range monitor (APRM) ATWS permissive signals
    - ○ Coincident high RPV pressure function greater than or equal to its setpoint and APRM ATWS permissive signals that persist for 60 seconds
  - – (No AC provided) Inhibit safety-related SSLC/ESF actuation logic for feedwater isolation on two-out-of-four channels of high-high drywell pressure function greater than or equal to the setpoint by either of the above safety-related ATWS signals.
  - – (**AC 3.3.4, Function 7**) DPS ADS Inhibit
    - ○ Inhibit nonsafety-related DPS actuation logic for diverse actuation of ADS on two-out-of-four channels of sustained DPS RPV level less than or equal to Level 1 by either of the following DPS ATWS signals:
      - o Coincident low RPV water level (i.e., Level 2) and SRNM ATWS permissive signals
      - o Coincident high RPV pressure function greater than or equal to its setpoint and SRNM ATWS permissive signals that persist for 60 seconds

- (**AC 3.3.3**) Automatic FWRB (analogous to BWR/6 recirculation pump trip) provides quick power reduction that prevents RPV overpressure and short-term fuel damage for ATWS events.
  - – Safety-related ATWS/SLC mitigation logic generates the FWRB signal when two-out-of-four channels of high RPV dome pressure function and SRNM ATWS permissive function are greater than or equal to their setpoints.
  - – Nonsafety-related DPS FWRB actuation logic function generates FWRB actuation signal to FWCS.
  - – Nonsafety-related FWCS runs feedwater demand to minimum for quick power reduction.

- (No AC provided) Diverse scram by DPS diverse scram ATWS mitigation logic on either of the following signals:
  - (GTS 3.7.6) select control rod run-in/select rod insert (SCRRI/SRI) command with power remaining elevated (two-out-of-three logic)
  - (GTS 3.3.1.1) RPS scram command (two-out-of-four logic)
- (No AC provided) Delayed FWRB if elevated power levels persist by DPS diverse scram ATWS mitigation logic on either of the following signals:
  - (GTS 3.7.6) SCRRI/SRI command with power remaining elevated (two-out-of-three logic)
  - (GTS 3.3.1.1) RPS scram command (two-out-of-four logic)

Criterion B—SSC functions relied upon to ensure long-term safety (beyond 72 hours) and address seismic events (DCD Tier 2, Revision 9, Section 19A.3.2 states that there are no seismic-related candidates for RTNSS consideration.)

- (**AC 3.7.1**) Long-term core cooling—supports ICS and PCCS operation
- (**ACs 3.6.2, 3.6.3, 3.7.1**) Long-term containment integrity—control containment pressure; support ICS and PCCS operation
- (**AC 3.7.6**) Long-term control room habitability—CRHA temperature control; occupant radiation dose mitigation
- (GTS 3.3.3.2) Postaccident monitoring instrumentation—support operator actions needed to support SSC functions of long-term core cooling, containment integrity, and control room habitability
- (**AC 3.7.1**) Long-term spent fuel pool (SFP) cooling—supply SFP makeup
- (**AC 3.7.6**) Long-term cooling for postaccident monitoring instrumentation heat loads—CRHA temperature control
- The following SSCs are relied on to support Criterion B SSC functions:
  - (**AC 3.7.1**) FPS motor-driven and diesel-driven pumps (primary); FPS fire water storage tanks; FPS connections to FAPCS; safety-related FAPCS piping to IC/PCCS pools, and SFP; supply makeup to IC/PCCS pools and SFP
  - (**AC 3.6.3**) PCCS vent fans support PCCS for long-term control of containment pressure
  - (**AC 3.6.2**) PARs for long-term control of containment pressure
  - (**AC 3.7.6**) CRHAVS AHU fans and filters for long-term control room habitability by limiting occupant radiation dose
  - (**AC 3.7.6**) CRHAVS auxiliary cooling units and recirculation AHU fans—cool DCIS cabinets; maintain long-term control room habitability by removing heat to maintain control room temperature to cool Q-DCIS
  - (**AC 3.7.6**) Q-DCIS room local coolers—cool Q-DCIS cabinets

- (No AC provided) Emergency lighting—supports postaccident monitoring instrumentation
- (GTS Section 3.3) Q-DCIS—supports postaccident monitoring instrumentation
- (**AC 3.8.3**) Ancillary DGs—supply ancillary ac electrical power distribution buses; supported by ancillary DG building HVAC and ancillary DG fuel tanks and fuel transfer pumps
- (**AC 3.8.1 and 3.8.2**) SDGs—supply PIP buses; supported by standby DG fuel storage and fuel transfer system
- (No AC provided) PIP buses—supply ancillary ac electrical power distribution buses and ac power for FAPCS pumps
- (No AC provided) Ancillary ac electrical power distribution buses—supply ac power for Q-DCIS, emergency lighting, and CRHAVS supply AHU fans; CRHAVS recirculation AHU fans and auxiliary cooling units; Q-DCIS room local coolers, PCCS vent fans, and FPS motor-driven pump

Criterion C—SSC functions relied upon to meet Commission's safety goal guidelines of CDF < 1×10^{-4} reactor-year^{-1} and LRF < 1×10^{-6} reactor-year^{-1} (focused PRA)

- (**AC 3.3.4, Function 1**) Diverse protection logics for reactor scram—provide backup to RPS scram functions when two-out-of-four channels are tripped for any of the following diverse scram instrumentation functions:
  - High RPV pressure
  - High RPV water level (i.e., Level 8) MSIV isolation
  - Low RPV water level (i.e., Level 3)
  - High drywell pressure
  - High suppression pool temperature
  - Closure of MSIVs

- (GTS 3.7.6) DPS SCRRI/SRI Logic

- Diverse ESF logics for the following isolation actuation functions, which backup LD&IS isolation actuation functions:
  - (**AC 3.3.4, Function 2**) Diverse closure of MSIVs (enabled by mode switch in run position) on two-out-of-four channels tripped for any of the following diverse isolation instrumentation functions: high steam flow rate, low RPV pressure, or low RPV water level (i.e., Level 2)
  - (**GTS 3.3.8.1, Function 3.a)** Diverse closure RWCU/SDC isolation valves on two-out-of-four channels tripped for the diverse isolation instrumentation function of high RWCU/SDC differential flow rate
  - (No AC provided) Diverse isolation of feedwater lines (trips feedwater pumps and closes feedwater containment isolation valves) on feedwater line break inside containment or LOCA conditions that pose a challenge to containment design pressure on two-out-of-four channels tripped for any of the following diverse isolation instrumentation functions: differential pressure between feedwater lines coincident with high drywell pressure, high drywell pressure coincident with high drywell water level, or high-high drywell pressure

- (No AC provided) Diverse isolation of CRD high pressure makeup water injection on two-out-of-four channels tripped for either of the following diverse isolation instrumentation functions: high drywell pressure coincident with high drywell level or low level in two-out-of-three GDCS pools

- (**AC 3.3.4, Function 3**) Diverse initiation of SRVs
  - Diverse low RPV water level (i.e., Level 1) signals, sustained for 10 seconds, are evaluated in nonsafety-related triple redundant processors with a two-out-of-four coincident logic.
  - A coincident logic trip decision is required from two-out-of-three processors for each of the three output logic devices to generate the start (i.e., SRV open) signal.
  - Each of three in-series discrete output switches is actuated by the two-out-of-three voted start signal from its associated independent output logic device.
  - A valid initiation signal from all in-series output switches is required to generate diverse ECCS actuation (i.e., ADS function of the 10 SRVs).

- (GTS 3.3.8.1, Function 1.a) Diverse automatic initiation of ADS (open depressurization valves [DPVs])
  - Diverse low RPV water level (i.e., Level 1) signals, sustained for 10 seconds, are evaluated in nonsafety-related triple redundant processors with a two-out-of-four coincident logic.

- (GTS 3.3.8.1, Function 1.b) Diverse manual initiation of ADS (open DPVs)
  - Two-out-of-four diverse high drywell pressure signals are greater than or equal to the setpoint and are sustained for at least 60 minutes or more, which permits diverse manual initiation of ADS

- (GTS 3.3.8.1, Function 2.a) Diverse automatic initiation of GDCS injection
  - Diverse low RPV water level (i.e., Level 1) signals, sustained for 10 seconds, are evaluated in nonsafety-related triple redundant processors with a two-out-of-four coincident logic.

- (GTS 3.3.8.1, Function 2.b) Diverse manual initiation of GDCS injection
  - Two-out-of-four diverse high drywell pressure signals are greater than or equal to the setpoint and are sustained for at least 60 minutes or more, which permits diverse manual initiation of GDCS injection.

- (No AC provided) Diverse manual GDCS suppression pool equalization line actuation—not required until approximately 30 minutes after a LOCA

- (**AC 3.3.4, Function 4**) FMCRD run-in—diverse control rod insertion
  - On receipt of signals initiating ARI, as described above, the DPS generates an additional signal to the rod control and instrumentation system (RC&IS) to initiate electrical insertion of all operable control rods. The ARI and FMCRD run-in logic resides in the DPS.

- (**AC 3.3.4, Function 5**) Diverse initiation of ICS to provide core cooling on two-out-of-four channels tripped for any of the following diverse instrumentation channels: high RPV dome pressure, low RPV water level (i.e., Level 2), or MSIV closure.

- (**AC 3.3.4, Function 6**) Diverse ESF actuation logic for ECCS injection for LOCA mitigation automatically initiates the SLC system 50 seconds after receipt of the following signal:

  – Two-out-of-four channels of the nonsafety-related DPS low RPV water level function are less than or equal to the setpoint (i.e., Level 1) are sustained for 10 seconds.

- (GTS 3.3.8.1, Function 4.a) Diverse opening of cross-connect valves between the equipment storage pool and the IC/PCCS expansion pools when a low-level condition is detected in either of the IC/PCCS inner expansion pools, which provides long term core and containment cooling.

  – Two-out-of-four channels of the nonsafety-related DPS low IC/PCCS expansion pool water level function are less than or equal to the setpoint.

- (**AC 3.7.2, 3.7.3**) FAPCS low-pressure injection (diverse method of core cooling)

- (**AC 3.7.2, 3.7.3**) FAPCS suppression pool cooling (diverse method of containment heat removal)

- SSC functions relied upon to support Criterion C SSC functions include the following:

  – The following support Q-DCIS, N-DCIS, and DPS:

    ○ (**AC 3.7.6**) CRHA long-term cooling

    ○ (**AC 3.8.3**) ancillary DGs

    ○ Ancillary ac power distribution

    ○ Ancillary DG building HVAC

    ○ Reactor building HVAC local cooling

  – The following support FAPCS operation (pumps):

    ○ Fuel building HVAC which provides FAPCS pump room cooling—supported by the NICWS

    ○ RCCWS

    ○ PSWS which supports the RCCWS

    ○ (**AC 3.8.1, 3.8.2**) SDGs (onsite ac electrical power source)—supported by standby DG auxiliary systems, standby DG fuel oil storage and transfer system, and electrical building HVAC

    ○ PIP buses—ac electrical power distribution

    ○ N-DCIS

    ○ Turbine building HVAC local cooling

Criterion D—SSC functions needed to meet the containment performance goal, including containment bypass, during severe accidents of less than 0.1 CCFP—used qualitatively

- (**AC 3.5.1**) GDCS deluge function
- (**AC 4.1**) BiMAC device

Criterion E—SSC functions relied upon to prevent significant adverse system interactions

- (**AC 3.6.1**) Lower drywell hatches (personnel air lock and equipment hatch)
- (**AC 3.7.5**) Reactor building HVAC accident exhaust filtration

Table 22.5.9-1. Proposed Short Term Availability Controls.

AC	TITLE	RTNSS CRITERION—MISSIONS	SER SECTION
3.3.1	ARI System	A—ATWS Rule ATWS mitigation—automatically depressurize scram header on ATWS signal to initiate hydraulic scram	22.5.4.2
3.3.2	ATWS/SLC System Actuation Functions		
3.3.2	1. SLC Actuation	A—ATWS Rule ATWS mitigation—SLC diverse reactor shutdown using ATWS/SLC logic to actuate SLC system LOCA mitigation—RCS makeup high-pressure injection using ATWS/SLC logic to actuate SLC system	N/A Safety-Related
3.3.2	2. RWCU/SDC Isolation	A—ATWS Rule ATWS mitigation—support SLC diverse reactor shutdown by preventing dilution of RCS boric acid inventory using ATWS/SLC logic to close RWCU/SDC containment isolation valves	N/A Safety-Related
3.3.2	3. ADS Inhibit	A—ATWS Rule ATWS mitigation—support SLC diverse reactor shutdown by maintaining RCS boric acid inventory using ATWS/SLC logic to prevent SRV and DPV opening by SSLC/ESF	N/A Safety-Related

AC	TITLE	RTNSS CRITERION—MISSIONS	SER SECTION
3.3.3	FWRB (logic processed by DPS)	A—ATWS Rule ATWS mitigation—run feedwater demand to minimum for quick power reduction	22.5.4.2.1 22.5.4.2.3
3.3.4	DPS backup functions not required by LCO 3.3.8.1	Not needed to meet CDF and LRF goals; included for mitigation of common-mode failure.	
3.3.4	1. Reactor Scram	C—Focused PRA Accident mitigation—initiation of hydraulic scram diverse from RPS	22.5.1.1.1
3.3.4	2. MSIV Closure	C—Focused PRA Accident mitigation—actuation of main steamline isolation diverse from SSLC	22.5.1.1.1
3.3.4	3. SRV Actuation	C—Focused PRA Accident mitigation—actuation of reactor vessel depressurization diverse from SSLC to support low-pressure injection	22.5.1.1.1
3.3.4	4. FMCRD Run-In Actuation	C—Focused PRA Accident mitigation—initiation of electrical insertion of control rods diverse from RPS	22.5.1.1.1
3.3.4	5. ICS Actuation	C—Focused PRA Accident mitigation—ICS actuation diverse from SSLC	22.5.1.1.1
3.3.4	6. SLCS Actuation (for LOCA)	C—Focused PRA LOCA mitigation—actuation of SLC system high-pressure RCS makeup diverse from SSLC	22.5.1.1.1
3.3.4	7. ADS Inhibit	A—ATWS Rule ATWS mitigation—support SLC diverse reactor shutdown by maintaining RCS boric acid inventory; diverse from SSLC	22.5.4.2.1 22.5.4.2.3
3.5.1	GDCS Deluge Function	D—Containment Performance Automatic flood of lower drywell and BiMAC device to cool and protect containment from core melt debris	22.5.2.1

AC	TITLE	RTNSS CRITERION—MISSIONS	SER SECTION
3.6.1	Lower Drywell Hatches (personnel air lock and equipment hatch)	E—Adverse System Interactions Mitigate shutdown LOCA by preventing coolant from draining out of the lower drywell	22.5.5.1 22.5.5.3
3.6.2	PARs	B—Long-Term Containment Integrity Long-term containment pressure control by recombining hydrogen and oxygen	22.5.6.3.2
3.6.3	PCCS Vent Fans	B—Long-Term Containment Integrity Forced circulation of steam and noncondensable gas in drywell and wetwell atmosphere through PCCS condensers post-72 hours	22.5.6.3.2
3.6.4	Hydrogen Mitigation – Ignitors	D—Containment Performance Ignitors (glow plugs) in the lower drums of the PCCS condensers recombine the hydrogen and oxygen while they are still at lower concentrations, thus preventing a detonation that could result from the accumulation of high concentrations of these gases.	22.5.2.1 22.5.2.3
3.7.1	Emergency Makeup Water Functions (FPS—Diesel and Motor-Driven Pumps; FPS to FAPCS Connection Piping; FPS Water and Diesel Fuel Tanks)		
3.7.1	1. IC/PCCS Pools Makeup Water—Emergency Makeup	B—Long-Term Core Cooling and Containment Integrity Maintain IC/PCCS pool inventory for passive core and containment cooling	22.5.6.3.2 22.5.6.3.3
3.7.1	2. SFP—Emergency Makeup Water	B—Long Term SFP Cooling Maintain SFP inventory for passive decay heat removal	22.5.6.3.2
3.7.2	FAPCS—Operating	C—Focused PRA (Uncertainty) Backup to passive safety system (i.e., to GDCS) for core cooling (low-pressure injection) and containment heat removal	22.5.1.1.2 22.5.1.3.2

AC	TITLE	RTNSS CRITERION—MISSIONS	SER SECTION
3.7.3	FAPCS—Shutdown	C—Focused PRA (Uncertainty) Backup to passive safety system (i.e., to GDCS) for core cooling (low-pressure injection) and containment heat removal	22.5.1.1.2 22.5.1.3.2
3.7.4	Reactor Building HVAC Accident Exhaust Filtration	E—Adverse System Interactions Filters and exhausts reactor building CONAVS area to limit CRHA occupant doses for beyond-design-basis accidents	22.5.5.1 22.5.5.3
3.7.6	CRHAVS Post-72-Hour Long-Term Cooling		
3.7.6	CRHAVS AHUs	B—Long-Term Control Room Habitability	22.5.6.3.4 22.5.6.3.5
3.7.6	CRHAVS AHU Auxiliary Heaters and Coolers	B—Long-Term Cooling for Postaccident Monitoring Heat Loads	22.5.6.3.4 22.5.6.3.5
3.8.1	SDGs—Operating	C—Supports FAPCS Operation	22.5.1.1.2 22.5.1.3.2
3.8.2	SDGs—Shutdown	C—Supports FAPCS Operation	22.5.1.1.2 22.5.1.3.2
3.8.3	Ancillary DGs	B—Supports FPS Motor-Driven Pump, PCCS Vent Fans, CRHAVS AHUs, Emergency Lighting, Q-DCIS	22.5.6.3.4 22.5.6.3.5
4.1	BiMAC Device	D—Containment Performance Design feature that protects containment from core melt debris in conjunction with GDCS deluge function	22.5.2.3

DCD Tier 2, Revision 9, Table 19A-2, lists the SSCs that meet the RTNSS significance criteria, the criteria that each SSC satisfied, the proposed level of regulatory oversight, and any system the SSC supports. Typically, the Maintenance Rule governs any support SSCs that are not explicitly required by an ACLCO. By the definition of “availability” in Section 1.0 of the ACM, when a support system is not capable of performing its support function, the supported system is considered to be unavailable. The definition of “availability,” which is modeled on the Standard Technical Specification (STS) and the GTS definition of “operability,” is the following:

> A system, subsystem, train, division, component, or device shall be AVAILABLE or have AVAILABILITY when it is capable of performing its specified risk informed function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power, cooling and seal water, lubrication, and other auxiliary equipment that are required for the system, subsystem, train,

division, component, or device to perform its specified risk informed function(s) are also capable of performing their related support function(s).

The following table lists these support SSCs.

Table 22.5.9-2. RTNSS SSCs that Perform a Support Function.

SSC	SUPPORTED SSC	RTNSS SIGNIFICANCE CATEGORY	SUPPORTED AC
Emergency lighting	Postaccident monitoring instrumentation	B—Postaccident monitoring	LCO 3.3.3.2
Ancillary ac power buses	AC power distribution from ancillary DGs to plant loads	B—AC power distribution	All RTNSS systems requiring ancillary ac power
Ancillary DG fuel oil tank	Ancillary DGs	B—Supports ancillary DGs	3.8.3
Ancillary DG fuel oil transfer pump	Ancillary DGs	B—Supports ancillary DGs	3.8.3
Ancillary DG building HVAC	Ancillary DGs	B—Supports ancillary DGs	3.8.3
N-DCIS	DPS, FAPCS, and supporting equipment	C—Supports DPS, FAPCS, and supporting equipment	3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.5.1, 3.6.3, 3.7.1, 3.7.2, 3.7.3, 3.7.5, 3.7.6, 3.8.1, 3.8.2, 3.8.3
SDGs	FAPCS	C—Supports FAPCS operation	3.7.1, 3.7.2, 3.7.3
6.9-kilovolt PIP Buses	Plant loads associated with FAPCS	C—ac power distribution from SDGs to plant loads associated with FAPCS	3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.5.1, 3.6.3, 3.7.1, 3.7.2, 3.7.3, 3.7.5, 3.7.6, 3.8.1, 3.8.2
SDG auxiliaries	SDGs	C—Supports SDGs	3.8.1, 3.8.2
RCCWS	SDGs and NICWS	C—Supports SDGs and NICWS	3.7.2, 3.7.3, 3.7.5, 3.7.6, 3.8.1, 3.8.2
NICWS	Building HVAC	C—Building HVAC	3.7.5, 3.7.6
PSWS	RCCWS	C—Supports RCCWS	3.7.5, 3.7.6, 3.8.1, 3.8.2

SSC	SUPPORTED SSC	RTNSS SIGNIFICANCE CATEGORY	SUPPORTED AC
Electrical building HVAC area cooling	PIP buses, N-DCIS for FAPCS	C—Supports PIP buses, N-DCIS for FAPCS	3.7.2, 3.7.3
Fuel building HVAC local cooling	FAPCS, N-DCIS for FAPCS	C—Supports FAPCS, N-DCIS for FAPCS	3.7.2, 3.7.3
Reactor building HVAC local cooling	N-DCIS for FAPCS	C—Supports N-DCIS for FAPCS	3.7.2, 3.7.3
Turbine building HVAC local cooling	FAPCS	C—Supports FAPCS	3.7.2, 3.7.3

22.5.9.2 *Regulatory Criteria*

The applicable criteria for establishing which RTNSS SSCs require TS are the four screening criteria specified in 10 CFR 50.36(c)(2)(ii) for establishing LCOs. RG 1.206, which describes the scope, criteria, and process used to determine RTNSS in the passive plant design, provides guidance to applicants in establishing appropriate regulatory oversight for RTNSS SSCs, including short-term ACs if necessary, as determined by risk significance.

22.5.9.3 *Staff Evaluation*

The ACM specifies ACs for RTNSS functions as completion times. The ACs are established to ensure that the availability of each function is consistent with the functional unavailability in the ESBWR PRA. The surveillance requirements are also established to provide an adequate level of support to ensure that component performance is consistent with the functional reliability in the ESBWR PRA. Support systems inherit the ACs of the systems they support. This approach is consistent with the process for establishing RTNSS described in RG 1.206 and summarized in Section 22.3.6 of this report. Therefore, the staff finds it acceptable. The ACs of RTNSS-important SSCs are formatted similarly to the GTS with availability requirements, applicability, required actions and completion times (if availability requirements are not met), surveillance requirements, and bases. There are no requirements to bring the plant to a safe-shutdown condition when availability requirements are not fulfilled and completion times for required actions are not met. The staff finds this acceptable because (1) these RTNSS-important nonsafety-related SSCs do not meet any of the regulatory criteria stated in 10 CFR 50.36(c)(2)(ii) for establishing TS LCOs, and (2) the ESBWR D-RAP, as described in DCD Tier 2, Revision 9, Section 17.4, includes these RTNSS-important SSCs, which will ensure that COL applicants monitor and control the availability and reliability of these SSCs in accordance with 10 CFR 50.65.

In RAI 22.5-22, the staff requested that GEH clarify the following ACs (as numbered in DCD Tier 2, Revision 5) to state the associated instrumentation functions and the number of required divisions:

- AC 3.3.1 (ARI)
- AC 3.3.2 (ATWS/SLC system actuation)
- AC 3.3.3 (FWRB)
- AC 3.3.5 (ADS inhibit)

- AC 3.5.1 (GDCS deluge function)

The staff also requested that the applicant describe, in the associated bases for these ACs, the minimum level of system degradation that corresponds to a function being unavailable and the number of divisions used to determine the test interval for each required division (or component) for AC surveillance requirements (e.g., logic system functional test) that specify a frequency of 24 months on a staggered test basis. RAI 22.5-22 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-22, GEH deleted AC 3.3.5 and moved the ATWS/SLC inhibit of ADS function, which inhibits the SSLC/ESF actuation of ADS (GTS 3.3.5.2) under conditions indicative of an ATWS, to AC 3.3.2, “ATWS/SLC System Actuation,” as Function 3. The applicant moved the DPS ADS inhibit function, which inhibits the diverse actuation of ADS by DPS (GTS 3.3.8.1), to AC 3.3.4 and renumbered the function as Function 8. The applicant also moved the RWCU/SDC system isolation ATWS/SLC function to AC 3.3.2 as Function 2. Grouping the ATWS/SLC functions of SLC actuation, RWCU/SDC isolation, and ADS inhibit in the same AC improved the presentation of the requirements for these functions because they are closely related to the initiation of the SLC system under conditions indicative of an ATWS. Therefore, the staff finds ACLCO 3.3.2 acceptable. The staff also believes that it is appropriate to group the DPS ADS inhibit function with the other RTNSS functions for DPS backup actuation functions for reactor scram, ECCS, ICS, and isolation functions in the renumbered AC 3.3.4. Therefore, the staff finds ACLCO 3.3.4 to be acceptable. These changes are reflected in DCD Tier 2, Revision 9.

The applicant stated that failure of components related to the subject AC functions would result in entry into Action A of the associated AC. This is a conservative approach to specifying action requirements and is acceptable. Consequently, adding a discussion to the AC bases regarding the various levels of degradation corresponding to the unavailability of an AC-required function is unnecessary; other sections of the DCD provide system design details. Therefore, the staff finds that this issue is resolved.

Regarding the request to identify the number of required divisions, the applicant explained that the ARI function and the FWRB function are actuated by nonsafety-related logic that is processed by the DPS. The DPS is a triple-redundant control system. The DPS is not a divisional instrumentation system. It is not powered by the four divisions of the safety-related dc and uninterruptible ac power distribution system. Even though the triple-redundant control systems have two or three separate nonsafety-related power sources, the action and surveillance requirements do not take advantage of any redundancies that may exist. Therefore, this issue is resolved for the ARI function of AC 3.3.1 and the FWRB function of AC 3.3.3.

The ATWS/SLC system actuation functions required by AC 3.3.2 are performed by safety-related logic processors in each of the four divisional reactor trip and isolation function (RTIF) cabinets. Although the safety-related ATWS/SLC actuation functions are based on a four-division instrumentation system, ACLCO 3.3.2 requires the function to be available. Therefore, failure of an ATWS/SLC function in any required actuation division (as explained below) would result in entry into AC 3.3.2, Action A. In DCD Tier 2, Revision 7, GEH further revised the bases to state the following:

> There are ATWS mitigation logic processors in each of four divisional RTIF cabinets. The ATWS mitigation logic processors are separate and diverse from

> RPS circuitry. Each ATWS mitigation logic processor uses discrete programmable logic devices for ATWS mitigation logic processing. The programmable logic devices provide voting logic, control logic, and time delays for evaluating the plant conditions for automatic initiation of SLC boron injection. Although there are four divisions of the ATWS/SLC platform for each Function, only two divisions are required for a Function to be considered AVAILABLE. The two required divisions are those divisions associated with the DC and Uninterruptible AC Electrical Power Distribution Divisions required by LCO 3.8.6, "Distribution Systems—Operating," and LCO 3.8.7, "Distribution Systems—Shutdown."

Requiring just two actuation divisions is acceptable because (1) only two divisions are required to cause actuation of the SLC system and related functions to mitigate an ATWS event and (2) the ATWS/SLC actuation logic is not required to withstand a single failure. Because ACLCO 3.3.2 requires just two divisions, the staff infers that ACSR 3.3.2.4, which calls for the performance of a logic system function test (LSFT) once every 24 months on a staggered test basis, requires performing an LSFT on each required division for each of the three functions once every 48 months. This is consistent with the resolution of staggered testing in GTS 3.3 as discussed in Sections 16.2.6.4.5 and 16.2.6.4.6 of the report, but contrary to the assertion in the applicant's response to RAI 22.5-22 that stated that the staggered testing for the LSFT is based on four divisions. In DCD Tier 2, Revision 7, GEH removed the allowance for staggered testing from the 24-month frequency for LSFT surveillance requirements because it lacked a technical basis. Since this change will require more frequent performance of the LSFT on each actuation division, the staff finds it acceptable. However, this change did not include the ACSR 3.3.2.4 staggered testing provision for the LSFT. The applicant corrected this oversight in DCD Tier 2, Revision 7. Also, with just two actuation divisions being required for each function, Condition A is appropriate because, with less than two divisions available, the affected function is unavailable. Therefore, the issue regarding the number of required divisions and LSFT staggered testing is resolved for the ATWS/SLC functions of AC 3.3.2. With regard to the staggered testing issue for the other ACSRs, the applicant stated the following in their response to RAI 22.5-22:

> The functions specified by AC 3.3.1, AC 3.3.3, and AC 3.5.1 are processed by nonsafety-related instrumentation systems that are non-divisional…. Therefore, ACSR 3.3.1.3, ACSR 3.3.3.2, and ACSR 3.5.1.3 are revised to delete reference to divisions. The associated Frequencies are revised to delete "on a STAGGERED TEST BASIS." With this change, the associated Logic System Functional Tests will be performed at a Frequency of 24 months.

Based on the described changes, the staggered testing issue is resolved for the actuation functions of ARI, FWRB, and GDCS deluge.

In response to RAI 22.5-22, the applicant explained that the GDCS deluge function is executed in a pair of dedicated, nonsafety-related programmable logic controllers (PLCs) and a pair of dedicated, safety-related temperature switches. Both PLC outputs and both temperature switch outputs must operate to fire the squib initiator associated with each deluge valve. The GDCS deluge function logic is nondivisional. Therefore, the issue regarding the number of required divisions is resolved for the GDCS deluge function of AC 3.5.1.

In RAI 22.5-22 S01, the staff also requested that GEH further clarify the provisions proposed for AC 3.3.2. In its response, GEH reiterated its previous explanation that ACLCO 3.3.2 requires just two divisions of each ATWS/SLC actuation function, removed the phrase “for each required SLC actuation function of the ATWS/SLC automatic actuation division” from ACSR 3.3.2.4 as inappropriate, and confirmed that ACSR 3.3.2.4 applies to all three ATWS/SLC required functions. In addition, GEH stated that ACM Table 3.3.2-1 does not include manual switches for ATWS ADS inhibit as part of Function 3 because they are not considered in the RTNSS evaluation or in the scope of the ACM. The staff finds these clarifications to be acceptable.

The applicant also clarified that two GDCS pools and six deluge squib valves perform the deluge function. This is consistent with the Level 2 ESBWR PRA success criterion for GDCS deluge valves. GEH revised ACLCO 3.5.1 and the associated bases to require 6 of the 12 deluge squib valves to be available. In addition, GEH stated that it will include all RTNSS components, including all 12 deluge valves, under the Maintenance Rule. The applicant also committed to including the deluge valves under the ESBWR D-RAP and the inservice test program. The staff finds these clarifications to be acceptable because they show that the ACs for the deluge squib valves are consistent with assumptions in the ESBWR PRA.

The applicant confirmed that AC action requirements may be exited based on an assessment that the degraded RTNSS function is still available. However, GEH does not intend that COL applicants apply the guidance of Regulatory Issue Summary 2005-20, Revision 1, “Revision to NRC Inspection Manual Part 9900 Technical Guidance, ‘Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety,’” dated April 16, 2008, regarding operability determinations for degraded equipment, to such availability assessments. Nevertheless, the staff finds this approach to resolving AC actions consistent with the operability determination guidance. Any determination that the component is available must have concluded that all applicable ACSRs are met. Further, since AC actions contain no unit shutdown requirements, continued operation with a degraded RTNSS function based on an availability assessment is not a significant risk to plant safety. Therefore, the staff find’s the applicant’s response to be acceptable.

Based on the above clarifications and changes to the ACM, RAI 22.5-22 and the associated open item are resolved.

In RAI 22.5-23, the staff requested that the applicant explain why the ACs for the FAPCS (1) did not include an ACSR for the FAPCS pumps, which serve the low-pressure injection and suppression pool cooling functions, and (2) require only one FAPCS train to be available during operation, which is inconsistent with the applicant’s focused PRA that models the availability of two trains. RAI 22.5-23 was being tracked as an open item in the SER with open items.

In its response to RAI 22.5-23 and in DCD Tier 2, Revision 5, GEH revised AC 3.7.2, “FAPCS—Operating,” to require two FAPCS trains to be available in Modes 1, 2, 3, and 4. The staff finds this acceptable. In RAI 22.5-41, the staff repeated its question regarding ACSRs for the FAPCS pumps. In its response, GEH stated that, since the FAPCS pumps associated with low-pressure injection, suppression pool cooling, and alternate shutdown cooling (during Mode 5 and Mode 6) are normally in operation for SFP cooling, ACSRs for these pumps are unnecessary to demonstrate their availability. In addition, GEH added the FAPCS pumps to the list of FAPCS mechanical components in DCD, Tier 1, Revision 7, Table 2.6.2-1. The staff finds this response acceptable. Therefore, RAI 22.5-23 and the associated open item, as well as RAI 22.5-41, are resolved.

In RAI 22.5-24, the staff asked why (1) ACLCO 3.8.1, “Standby Diesel Generators—Operating,” specifies that only one standby DG needs to be available, which is inconsistent with the applicant's focused ESBWR PRA that models the availability of two SDGs, and (2) the actions of AC 3.8.1 permit the standby DG to be unavailable for a period of 14 days, while AC 3.7.2 only allows the supported FAPCS train to be unavailable for 7 days. (In DCD Tier 2, Revision 5, GEH changed the completion time to restore a FAPCS train to available status to 14 days to be consistent with Action A of AC 3.8.1 and Action A of AC 3.8.2 for the SDGs.) RAI 22.5-24 was being tracked as an open item in the SER with open items.

In response to RAI 22.5-24, GEH stated that just one standby DG is needed during unit operation to support FAPCS and postaccident monitoring, but that two SDGs are needed during Modes 5 and 6 to support both RWCU/SDC trains for decay heat removal, since the ICS may not be available to remove decay heat in these modes. (GTS 3.5.5 requires the ICS to be operable in Mode 5 to back up the RWCU/SDC system, but requires the RCS to heat up to Mode 4 conditions to be effective.) GEH stated that "the risk significance is elevated during shutdown modes because the containment is open, thus any core damage event contributes directly to the large release frequency." To ensure that the SDGs are maintained available during refueling outages, GEH chose, in AC 3.8.2, "Standby Diesel Generators—Shutdown," a 24-hour completion time for Required Action B.1 to restore one standby DG to available status if both SDGs are unavailable.

In RAI 22.5-24 S01, the staff asked the applicant to revise AC 3.8.1 to be consistent with the availability and reliability assumptions in the PRA and require two SDGs to be available. In its response to RAI 22.5-24 S01 EH stated the following:

> FAPCS meets RTNSS Criterion C, which addresses uncertainty in passive system performance. FAPCS provides active backup functions for coolant injection and suppression pool heat removal. The at-power focused PRA sensitivity study for RTNSS Criterion C assumes that one FAPCS train is capable of backing up these passive functions. Therefore, one FAPCS train and its supporting functions, including one standby DG, are assumed to be available for normal operations.

The staff found this reasoning acceptable. Nevertheless, in DCD Tier 2, Revision 5, GEH revised AC 3.7.2 to require two FAPCS trains to be available during unit operation. In the supplement, the staff asserted that the completion times to restore RTNSS components to available status should, in general, be based on reasonable repair times, since the ACM never requires a unit shutdown for failure to restore components to available status within the specified completion time. The staff also asked GEH in RAI 22.5-24 S01 to address this point. In response, GEH stated the following:

> The PRA evaluates the functions satisfying the RTNSS criteria to determine their risk significance. Those functions with high risk significance are included in the TS. Those functions with low risk significance are included in the ACM. CDF and LRF are relatively insensitive to the availability of these low risk significant systems. As explained in DCD Tier 2 Revision 7 Section 19A, that is specifically why they are in the ACM rather than TS. To apply the same requirements as TS, then, would be inappropriate. Neither a unit shutdown requirement nor revisions to the completion time are necessary to provide reasonable assurance that the availability of low risk significant SSCs will be consistent with the availability assumed in the PRA.

The staff agrees that applying the same requirements as TS is not appropriate and accepts the applicant's reasoning. This resolved RAI 22.5-32, which raised the same issue. In the supplement, the staff also asked GEH to modify ACLCO 3.0.3 to include a requirement to assess and manage risk. In response, GEH added the following provision to ACLCO 3.0.3 to provide confirmation that there are no significant increases in risk during operation under ACLCO 3.0.3: "Assess and manage the risk of the resulting unit configuration." The staff finds this acceptable because it clearly states that risk must be assessed and managed.

Based on the above clarifications and changes to the ACM, RAI 22.5-24 and the associated open item are resolved.

In RAI 22.5-30, the staff questioned the lack of channel check and channel calibration ACSRs in AC 3.5.1 for the drywell atmosphere and lower drywell basemat thermocouples. In its response, GEH indicated that it would add such channel check and channel calibration ACSRs to AC 3.5.1. The staff has confirmed this addition in of DCD Tier 2, Revision 7. Therefore, RAI 22.5-30 is resolved.

In RAI 22.5-31, the staff questioned the appropriateness of the frequency for performing reactor building HVAC accident exhaust filtration unit testing specified in ACSR 3.7.5.2. DCD Tier 2, Revision 5, Section 9.4.6.4 states, "The Reactor Building HVAC Purge Exhaust Filter components are periodically tested in accordance with Regulatory Guide 1.140, Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants." The staff asked the applicant why it did not base the test frequency on RG 1.52, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," since the bases state that these filtration units are relied upon to provide "exhaust filtering efficiency to ensure that theoretical control room doses are not exceeded for certain beyond design-basis LOCAs." In its response, GEH stated, "Regulatory Guide (RG) 1.52 does not apply to testing these nonsafety-related units because they perform a beyond-design-basis function, which is not required to satisfy GDC 19 dose limits." Therefore, RAI 22.5-31 is resolved.

In RAI 22.5-33, the staff requested that GEH explain the basis for the following statements which appear in the bases for each AC:

> The short-term ACs for this function, which are specified as Completion Times, are acceptable to ensure that the availability of this function is consistent with the functional availability in the ESBWR PRA. The surveillance requirements also provide an adequate level of support to ensure that component performance is consistent with the functional reliability in the ESBWR PRA.

In response, GEH stated the following:

> The Bases statement about completion times and surveillance requirements being consistent with the PRA assumptions reflects the fact that the CDF and LRF are relatively insensitive to the unavailability of components identified in the RTNSS process. The statement is not intended to imply that there is some direct relational calculation used to derive availability and reliability requirements. The nonsafety-related systems meeting the RTNSS criteria that are LRO are included in the ACM. They have low risk significance, and thus, basing allowable outage times on risk significance would result in inordinately long allowable outage

times. As for support systems, the availability of support systems for a given ACM function is already required by the definition of availability under AC 1.1.

The staff finds this reasoning acceptable. In RAI 22.5-33, the staff also questioned the frequency of 24 hours specified for channel check in ACSR 3.3.4.1 and the frequency of 24 months specified in ACSR 3.3.5.2, “Channel Functional Test,” because these frequencies are not consistent with the STS. The applicant changed these frequencies to 12 hours and 92 days, respectively, in DCD Tier 2 Revision 7. Therefore, RAI 22.5-33 is resolved.

In RAI 22.5-34, the staff questioned the use of the term “required” in several ACs. In response to RAI 22.5-34, GEH removed the word “required” from Condition A of AC 3.3.2 and AC 3.3.4, but stated that it was appropriate for Condition A of AC 3.7.1 because, as indicated in DCD Tier 2, Revision 5, Section 9.5.1.4, the ACLCO do not include redundant components (e.g., secondary diesel-driven and motor-driven fire pumps). Therefore, RAI 22.5-34 is resolved.

In RAI 22.5-35 the staff noted that DCD Tier 2, Section 19A.8.4.3, was not consistent with AC 3.3.5 in that it did not list the ADS inhibit function, which is specified in AC 3.3.5, Table 3.3.5-1, Function 7. In response to RAI 22.5-35, GEH revised DCD Tier 2, Section 19A.8.4.3, Revision 5, to include the DPS ADS inhibit function specified in AC 3.3.4, Function 8. Therefore, RAI 22.5-35 is resolved.

In RAI 22.5-36, the staff questioned the applicant’s statement in DCD Tier 2, Revision 5, Section 19A.8.4.10 indicating that use of the PARs to redistribute noncondensable gas between the wetwell and drywell reduces overall containment pressure. In response to RAI 22.5-36, GEH revised DCD Tier 2, Section 19A.8.4.10, to replace “overall containment pressure” with “containment pressure” and to clarify that the PCCS vent fans (AC 3.6.3), by transferring noncondensable gases to the drywell, reduce the pressure in the wetwell airspace that is attributable to long-term accumulation of noncondensable gases. GEH stated the following:

> [R]edistributing the non-condensable gases from the wetwell air space to the drywell reduces the pressure in the wetwell airspace. The PARs (AC 3.6.2) recombine the hydrogen and oxygen that accumulate in the wetwell air space and drywell. The combination of the PARs and the PCCS vent fans maintains acceptable containment pressure.

The staff agrees that pressure in the wetwell air space can be reduced using the PARS and PCCS vent fans as described and that the changes to the DCD Tier 2, clarify the original statements in an acceptable way. Therefore, RAI 22.5-36 is resolved.

In RAI 22.5-37, the staff requested that the applicant confirm that instrumentation settings for Availability Control Manual Section 3.3 instrumentation functions are controlled by GTS 5.5.11, “Setpoint Control Program (SCP).” In response to RAI 22.5-37, GEH stated that GTS 5.5.11, “Setpoint Control Program,” does not control the instrumentation settings for the ACM. As discussed in the GEH response to RAI 7.1-86 S01, the SCP-specified setpoint methodology only applies to safety-related and TS instrumentation settings. The calibration of nonsafety-related instrumentation is handled by plant procedures, which are controlled as described in DCD Tier 2, Revision 5, Section 13.5. Therefore, RAI 22.5-37 is resolved.

In RAI 22.5-38, the staff questioned the completeness of the Bases for selected ACs in comparison to the Bases for most other ACs. In response to RAI 22.5-38, GEH added references to the appropriate DCD sections in the bases for the DPS functions of AC 3.3.4 and added a discussion of the DPS function of SLC system diverse actuation on a LOCA signal in the bases for AC 3.3.4. Therefore, RAI 22.5-38 is resolved.

In RAI 22.5-39 the staff requested that the applicant explain why ACSR 3.5.1.4 contains the note, "Squib actuation may be excluded," or remove the note and describe how the deluge line flow paths are verified to not be obstructed. In response to RAI 22.5-39, GEH added the following to DCD Tier 2: (1) ACSR 3.5.1.4 to verify once every 24 months that required deluge valves actuate on an actual or simulated automatic initiation signal, and (2) ACSR 3.5.1.6 to verify once every 24 months on a staggered test basis the flowpath for each deluge line is not obstructed. Therefore, RAI 22.5-39 is resolved.

In RAI 22.5-42, the staff requested that GEH revise AC 3.7.1 to provide a surveillance requirement for the electric fire pump. In response to RAI 22.5-42, GEH stated that an ACSR for the motor-driven fire pump in AC 3.7.1 is not necessary because the pump is already tested in accordance with National Fire Protection Association (NFPA) 20, "Standard for the Installation of Stationary Pumps for Fire Protection," as discussed in DCD Tier 2, Revision 5, Table 9.5-1. The staff finds this to be an acceptable basis for excluding the ACSR in AC 3.7.1. Therefore RAI 22.5-42 is resolved.

In RAI 22.5-45, the staff questioned the lack of surveillances for the standby DGs in the ACM. In response to RAI 22.5-45, GEH added (1) ACSR 3.8.1.3 and ACSR 3.8.2.3 to verify once every 92 days that the fuel oil transfer system operates to transfer fuel oil from the storage tank to the required standby DG day tank, (2) ACSR 3.8.1.4 and ACSR 3.8.2.4 to verify once every 24 months that the required standby DG starts and achieves rated speed and voltage upon receipt of an under-voltage signal and sequences its designed loads while maintaining voltage and frequency within design limits, and (3) ACSR 3.8.1.5 and ACSR 3.8.2.5 to verify once every 24 months that the required standby DG starts and operates at rated load for 24 hours or longer. GEH also revised the bases for AC 3.8.1 and 3.8.2 by changing the following statement as indicated: "DG starts required by ACSRs may be preceded by an engine pre-lube period <u>prior to starting and warm-up period prior to loading</u> to minimize wear and tear on the DGs during testing." These ACSR are consistent with typical surveillance requirements for DGs in operating reactors and are therefore acceptable. Therefore, RAI 22.5-45 is resolved.

In RAI 16.2-62 S01 and S02, the staff questioned the lack of ACs for the qualified offsite ac power circuits and the onsite ac power distribution circuits. In its responses, GEH stated that its RTNSS analysis had concluded that the offsite circuits do not meet the RTNSS significance criteria and that the onsite ac circuits (PIP buses, ancillary buses) satisfied RTNSS criteria in support roles for other RTNSS equipment. Based on the above evaluation of ESBWR nonsafety-related systems against the RTNSS criteria, the staff concludes that the applicant's response is acceptable. Therefore, RAI 16.2-62 is resolved.

22.5.9.4 *Conclusions*

Based on the preceding evaluations and RAI resolutions, the ACM is acceptable.

22.5.10 Staff Conclusions

The staff has reviewed the applicant's implementation of the RTNSS process described in DCD Tier 2, Revision 9, Section 19A, and finds that the applicant's implementation of this process satisfies the scope, criteria, and process described in SECY-94-084, SECY-94-132, and

RG 1.206 and summarized in Sections 22.2 and 22.3 of this report. Therefore, the staff finds the applicant's implementation to be acceptable.