October 9, 1992

Docket No. 52-001

Mr. Patrick W. Marriott, Manager
Licensing & Consulting Services
GE Nuclear Energy
175 Curtner Avenue
San Jose, California 95125

Dear Mr. Marriott:

SUBJECT: CONFIRMATORY AND OPEN ITEMS IN THE DRAFT FINAL SAFETY EVALUATION REPORT (DFSER), FOR GE THE NUCLEAR ENERGY (GE) ADVANCED BOILING WATER REACTOR (ABWR)

Enclosed is a summary of each confirmatory and open item identified in the DFSER for the GE ABWR. This is being forwarded to you in support of upcoming meetings between GE Nuclear Energy and NRC staff to discuss closure of these issues.

Please contact me at (301) 504-1125 if you have any questions

Sincerely,
Original Signed By:
Rebecca L. Nease, Project Manager
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ABWR DFSER OPEN & CONFIRMATORY ITEMS

CHAPTER 1

OPEN ITEMS

In its application, GE stated that it is developing the design of the ABWR to meet the requirements in the Electric Power Research Institute's (EPRI) Advanced Light Water Reactor (ALWR) Program. On June 12, 1990, GE sent the staff a summary of the differences between the ABWR design and the EPRI ALWR Utility Requirements Document. Since that time EPRI has provided several revisions to its ALWR Utility Requirements Document for Evolutionary Plants; the most recent, Revision 4, was issued in April 1992. The Commission has requested that the staff evaluate any deviations that the vendor designs have with the EPRI document. Since both the ABWR design and the EPRI document have changed since June 1990, GE needs to provide for the staff's review, a comprehensive evaluation of the current ABWR design to identify and explain all differences from the EPRI document. This is Open Item 1.1-1.

GE stated in its letter of June 16, 1992, that "the same design control procedures described above apply to both Common Engineering and GE documents issued before as well as after certification of the U.S. ABWR." The staff's position is that GE must certify to the NRC, prior to final design approval for certification, that the U.S. ABWR design Tier 1 and Tier 2 information have not been affected by any changes to the ABWR Common Engineering design documents. This is Open Item 1.2.2-1. Also, GE must provide to the staff a list of the ABWR Common Engineering design documents and DALs that apply to the U.S. ABWR design and their effective dates. This is Open Item 1.2.2-2.

Section 52.47(b)(1) of Part 52 requires an applicant for certification of an evolutionary nuclear power plant design to provide an essentially complete design scope. Therefore, the scope of the U.S. ABWR design must include all of the plant which can affect safe operation of the plant except for its site-specific elements, such as the service water intake structure and the ultimate heat sink. GE's proposed scope for the ABWR design is shown in Figure 1.2 and a list of the structures and systems in their design scope is identified in SSAR Section 1 1.2. Specifically excluded from the scope are the switchyard, the cooling tower or other source of normal cooling, and the ultimate heat sink. GE has identified the interface requirements for these site-specific elements in Section 1.9 of the SSAR. A list of the interface requirements arising from the staff's review to date of the SSAR is provided in Section 1.8 of this report. The division of the structures and systems between the certified scope and the site-specific elements is still under review by the staff. This is Open Item 1.2.6-1.

Plant-specific applicants and licensees who reference the ABWR standard design in the future will be required to satisfy the requirements and concerns resulting from the staff's technical review to date. These requirements and concerns for plant-specific applicants and licensees are identified below as COL action items. These COL action items relate to programs, procedures, and issues that are outside of the scope of the certified design review. GE needs to include this list of items in a future amendment to SSAR Chapter 1 in summary and to the specific sections of the SSAR in which each system or component is discussed. This is Open Item 1.9-1.

CONFIRMATORY ITEMS

This safety evaluation report (SER) is being issued as a draft-final SER (DFSER) to clearly identify the open and confirmatory items and to facilitate their resolution. The staff is continuing its review and plans to issue a final SER after GE submits an amended SSAR, under oath or affirmation, that resolves all of the open and confirmatory items identified in Sections 1.6 and 1.7 of this report, and revised Tier 1 Design Certification Material in accordance with the staff's letter of May 29, 1992. This is Confirmatory Item 1.1-1.

The U.S. ABWR design is similar to the international ABWR design, which is currently being designed and built at the Kashiwazaki Kariwa Nuclear Power Generation Station, Units No. 6 and No. 7 (K-6/7), by the Tokyo Electric Power Company, Inc. Differences between the U.S. ABWR design and the K-6/7 project were summarized by GE in a letter to the staff dated February 20, 1992. Since that time design changes have been made to the U.S. ABWR standard design. GE committed to updating the list of differences in their letter of February 20, 1992, and incorporating the final summary of design differences in the SSAR. This is Confirmatory Item 1.2-1.

CHAPTER 2

OPEN ITEM

The staff reviewed GE's analysis and evaluation of the ABWR design in terms of the bounding site parameters provided in SSAR Table 2.0-1. The staff concluded that the list of bounding site parameters in Table 2.0-1 should be comprehensive, including any additional items from Tier 1 of the Design Control Document. Since this document is under development, GE should ensure that the final list of site parameters in Table 5.0 of the Tier 1 Design Control Document concurs with SSAR Table 2.0-1. Since GE adopted the bounding site parameters identified in the EPRI Evolutionary ALWR Requirements Document, GE should adequately address the issues identified in Section 1.4 of the EPRI Evolutionary Plant safety evaluation report (SER) when developing its final list. This is Open Item 2.6-1.

CONFIRMATORY ITEM

GE has agreed to change the design-basis tornado characteristics for the ABWR to reflect the data included in Table 1.4-1. This will be acceptable to the staff subject to the revision of the SSAR and resolves draft safety evaluation report (DSER) Open Item 146 in SECY-91-355. This is Confirmatory Item 2.3.1-1.

CHAPTER 3

OPEN ITEMS

The commitment to dynamically analyze the above components for the SSE is contained in Note r of SSAR Table 3.2-1. The components are designed to withstand the OBE and SSE design loads in combination with other appropriate loads, within the limits specified for Class 2 pipe ASME Code Section III, by use of appropriate dynamic seismic system analyses. The mathematical model for the dynamic seismic analyses of the main steamlines and the branch line piping includes the turbine stop valves and piping to the turbine casing. The dynamic input loads for the design of the main steamlines are derived from a time history model analysis or an equivalent method as described in SSAR Section 3.7. It is the staff's understanding that the alternate equivalent method is the static analysis described in SSAR Section 3.7.3.8.1.5 of the SSAR. As noted above, to demonstrate the structural integrity of the main steam piping under SSE loading conditions, a dynamic method of analysis must be used for this portion of the main steam piping. In addition, GE should discuss how the turbine building response spectra input to the main steam piping analysis will be generated when, as discussed in the paragraph below, no dynamic analysis of the turbine building is proposed. The staff position as delineated in SRP Section 3.7.2.5 for the generation of floor response spectra is that the development of the floor response spectra is acceptable if a time history approach is used. Alternatively, the methods used for direct generation of floor response spectra shall be submitted to the staff for review and approval on a case-by-case basis. If such an approach is to be used, then it should be submitted to the staff before final design approval (FDA). The resolution of this item will be discussed in Section 3.7.2 of this report. This is Open Item 3.2.1-1.

Note f in SSAR Table 3.2-1 and SSAR Sections 3.7.2.8 and 3.7.3.13 states that equipment, structures, and piping in the ABWR that are non-seismic Category I but that could damage seismic Category I items if their structural integrity failed, are analyzed and designed to ensure their integrity is maintained under seismic loading from the SSE. At the interface between seismic and non-seismic Category I piping systems, the seismic Category I dynamic analysis will be extended to either the first anchor point in the non-seismic system or to sufficient distance in the non-seismic system so as not to degrade the validity of the seismic Category I analysis. The staff has concluded that this commitment is in conformance with RG 1.29. However, as a part of the resolution of this issue, the turbine building and any other applicable structure or equipment should be seismically analyzed for a peak ground acceleration of 0.3g (RG 1.60) to ensure that an earthquake will not adversely affect the structural integrity of the main steam piping, bypass line, valves, and instruments mounted on these pipes, and the main condenser. In a letter dated January 22, 1992, GE submitted a proposed revision to SSAR Section 3.7.3.15, which describes an analysis for the turbine building that will be used in lieu of a dynamic analysis. This proposed analysis is in accordance with the Uniform Building Code (UBC) Zone 2A, and is substantially less (0.15g static coefficient) than the 0.3g SSE ground motion for which the main steam and bypass lines must be analyzed. There must be a clear set of criteria to make a safety conclusion that the turbine building, which is designed to UBC criteria, will suffer no loss of function at the peak ground acceleration of 0.3g nor adversely affect safety-significant piping, pipe mounted equipment, or the condenser itself. The staff is reviewing the turbine building analysis method to ensure that the turbine building can withstand an SSE and remain functional. The resolution of this issue will be discussed in Section 3.7.2 of this report. This is Open Item 3.2.1-2.

The walkdowns should be performed as a part of the inspections, tests, analyses, and acceptance criteria (ITAAC) verification of non-seismic/seismic interaction. Since GE has not provided an ITAAC for non-seismic/seismic interaction, this is Open Item 3.2.1-3.

GE did not include an analysis of flooding in the turbine building and its potential effects on safety-related equipment. GE should provide to the staff an updated flood analysis which characterizes the nature of the hazard and the design features to protect safety-related equipment from flooding in the turbine building. This is Open Item 3.4.1-1.

GE has provided the ITAAC for flood protection as part of the individual building ITAACs. The results of the staff's review of these ITAACs will be provided in the FSER. This is Open Item 3.4.1-2.

GE has provided ITAAC regarding protection of structures, systems, and components from internally generated missiles. The results of the staff's review will be provided in the FSER. This is Open Item 3.5.1.1-1.

GE stated in SSAR Section 3.5.1 that missiles generated by rotating equipment will be contained by the equipment housing. GE should provide design information supporting this assertion or clearly state that this information will be provided by the COL applicant. This is Open Item 3.5.1.2-1.

Measures to protect safety-related equipment inside containment from internally generated missiles will be verified as part of the reactor building ITAAC. GE has provided this ITAAC to the staff for review. The results of the review will be provided in a supplement to this SER. This is Open Item 3.5.1.2-2.

The design will withstand an 1800-kg (4000-lb) automobile, a 125-kg (280-lb), 20-cm (8-inch) armor piercing artillery shell, and a 2.54-cm (1-in) solid steel sphere, all impacting at 35 percent of the maximum horizontal windspeed of the DBT. GE identifies these missiles as Spectrum I. GE's preliminary evaluation of the design revealed that the reactor building superstructure and roof will have to be thickened and the roof purlins strengthened. In addition, the seismic model will have to be modified. The structural design aspects of this issue are discussed in Section 3.8.4 of this report and are being tracked as Open Item 3.8.4-3.

GE has provided the ITAAC regarding protection of SSCs from missiles generated by natural phenomena. The results of the staff's review will be provided in a supplement to this report. This is Open Item 3.5.1.4-1.

In the DSER (SECY-91-153), GE identified an interface requirement regarding protection of safety-related equipment from failures of non-safety-related SSCs not housed in tornado-resistant buildings or structures (Open Item 9). As a result of staff review of interface requirements, this issue has been reclassified as an ITAAC item and will be reviewed (and protection verified) as part of the ITAAC program. This is Open Item 3.5.2-1.

GE has provided the ITAAC regarding protection of SSCs from externally-generated missiles. The results of the staff's review will be provided in a supplement to this report. This is Open Item 3.5.2-2.

Another concern expressed during meetings with the ACRS involved the ABWR design's ability to provide adequate physical separation of safety-related systems and equipment; safety-related systems must be protected from the effects of fire, flood, missiles, pipe failures, and adverse environments to ensure their ability to shutdown the reactor and mitigate the consequences of an accident. Protection is normally ensured by providing redundant safety-related systems and physical separation of the redundant systems. The ABWR provides physical separation by either spacial separation or, to the extent possible, by housing redundant train of each safety-related system in a separate compartment. Each compartment is designed to withstand the effects of the events identified above. By providing adequate physical separation for each redundant safety-related train, one train will be available to perform its safety-related function assuming a single active failure in the other train. For those trains housed in a divisional space, that space (walls, doors, and all penetrations) must be able to contain flood water, fire, smoke, jet impingement loads, pipe whip, radiation, and high temperatures and pressures which may occur as a result of a pipe or equipment failure so that only one train is rendered inoperable at any one time. The ITAAC program will ensure that each divisional space is designed and constructed to withstand the effects of postulated piping failures. Such features as 3-hour fire barriers, watertight doors, pipe restraints and shields, and barriers will be used to ensure adequate protection of the divisional space. The ITAAC will also ensure adequate spacial separation for those systems that may not be housed in a divisional space. GE has provided for staff review, the ITAAC related to protection of safety-related equipment from the effects of postulated piping failures. The results of the staff's review will be provided in the FSER. This is Open Item 3.6.1-1.

Therefore, GE should revise its SSAR to describe the computer programs to be used for pipe whip analyses and the design methodology for pipe whip restraints that are applicable to the ABWR plant design. This is Open Item 3.6.2-1.

In addition, the referenced edition of ANSI/ANS-58.2 in SSAR Section 3.6.2.2.1 was not current and the criteria in Section 3.6.2.3.1 for evaluating the effects of fluid jets on essential structures, systems, and components were not in complete agreement with the guidelines of SRP Section 3.6.2 and with the ANSI/ANS-58.2, 1988 Edition. Accordingly, GE should revise SSAR Section 3.6.2.2.1 to update its reference to the 1988 edition of the ANSI/ANS-58.2 and revise the criteria in SSAR Section 3.6.2.3.1 to be consistent with the Section 3.6.2 and ANSI/ANS-58.2 (1988). This is Open Item 3.6.2-2.

GE found the torsional effect resulting from the eccentricity between the center of mass and center of rigidity of the seismic Category I structures on the seismic responses is negligible because of the symmetry in the geometrical layout of the buildings. The staff agrees. For the seismic design of structures, GE followed the SRP guidelines and applied an accidental eccentricity equal to five percent of the maximum building dimension at each floor when the seismic shear was distributed to the lateral load resisting structural elements. GE evaluated the stability of the structure against seismic overturning by requiring a minimum factor of safety of 1.5 between the potential energy needed to overturn the structure and the maximum kinetic energy of the structure during the SSE. These approaches are acceptable. The SSAR, however, did not describe the procedure for determining the stability of the structure against seismic sliding. It is the staff's position that GE should perform an analysis against seismic sliding. This concern is Open Item 3.7.2-1.

From the review of the SSAR and the piping design audit conducted on March 23 through 27, 1992, the staff found that GE did not consider the flexibility effect of the drywell equipment and piping support structure (DEPSS) when generating the FRS for the seismic input to the design of subsystems supported by the DEPSS. According to GE, the DEPSS was not included either in the structural model of the reactor building for generating the FRS at subsystem support locations or in the subsystem model as part of the supporting system. GE indicated that the COL applicant should be responsible to account for the dynamic effect of the DEPSS. Because of the exclusion of the DEPSS' flexibility effect, which might cause additional amplification of the FRS, the staff believes that such subsystems supported on the DEPSS as piping and equipment could be underdesigned based on the existing FRS. This is Open Item 3.7.2-2.

In the SSI analysis, GE did not consider the structure-structure interaction effect between the control building and adjacent buildings such as the reactor building and turbine building. The energy feedback from the adjacent buildings during an earthquake could significantly affect the seismic response of the control building because these adjacent buildings are much heavier. GE should consider the effect of structure-structure interaction in the SSI analysis of the control building. This is Open Item 3.7.2-3.

GE used a 2D SSI model to perform the SSI analysis. As shown in the SSAR, GE's parametric studies for the reactor building indicated that the 2D SSI analysis typically underestimated both the horizontal and vertical spectral peak accelerations at higher elevations of the building for medium-stiff-soil sites and hard-rock sites. During the second design calculation audit, the staff raised this concern about the significance of the difference between 2D and 3D SSI analyses of the control building. This issue is Open Item 3.7.2-4.

From the review of Appendices 3A and 3G of SSAR Chapter 3 and GE's "Tier 1 Design Certification Material for the GE ABWR Design (Stage 2 Submittal)," dated March 1992, the staff observed that the building dimensions are inconsistently specified in these documents. For example, the dimensions of the control building are specified to be 16 meters x 45 meters (52 ft x 147 ft) in plan and 12.2 meters (40 ft) in embedment depth according to SSAR Section 3A.2, 22 meters x 56 meters (72 ft x 184 ft) in plan and 25.7 meters (85 ft) in embedment depth according to SSAR Section 3G.3.2, and 24 meters x 56 meters (79 ft x 184 ft) in plan and 23.1 meters (75 ft and 9 in) in embedment depth according to the Tier 1 design certification material. GE should verify the accuracy of all dimensions of the control building, including the embedment depth, used in the final seismic analysis of the seismic Category I structures shown in the SSAR and the Tier 1 document. This concern also applies to the dimension of all other seismic Category I building structures, including the reactor building. This is Open Item 3.7.2-5.

The staff's concerns with the seismic input to the MSL analysis and the structural integrity of the turbine building to withstand the SSE loading are Open Items 3.7.2-6 and 3.7.2-7, respectively.

For a shallow soil site, to confirm that site-specific conditions 1 and 2 are satisfied and the standard plant design is adequate for the specific site, the COL applicant may define the site-specific ground motion (ground response spectra) at the ground surface in the free field if this ground motion is developed from a statistical analysis of a sufficient number of recorded ground motions. These recorded ground motions must be chosen based on their similarity in source, path, and site characteristics as well as magnitude, fault type, and tectonic environment, and must qualify as a site-specific (shallow soil site) surface ground motion. In all cases the appropriate level of the site-specific ground response spectrum for comparison with the design certification spectrum is the 84th percentile of the statistical analysis of the recorded earthquake data. However, if the surface motion for the shallow-soil site cannot be developed according to this criteria, the COL applicant should follow the steps shown below to confirm the design adequacy of the standard plant:

- develop the site-specific ground motion (ground response spectra)
- define the site-specific ground motion as the free field motion at a level that complies with SRP Section 3.7.1 (e.g., at rock outcrop or a hypothetic rock outcrop)
- calculate the site-specific surface motion (ground response spectra) through soil layer amplification
- compare the site-specific surface motion with the standard design ground motion (i.e., 0.3g RG 1.60 response spectra, which was defined at ground surface in the free field for the standard plant design)
- determine if the site-specific surface motion exceeds the standard design ground motion

This is Open Item 3.7.2-8.

In its letter dated August 19, 1991, and the revised SSAR Section 2.3.1.2, Amendment 18, GE proposed that COL applicants consider site-specific conditions 6 and 7 as two individual evaluation parameters when confirming the adequacy of the standard plant design for a specific site. The effect of soil layer depth was not considered or included in the evaluation. The staff is concerned that to compare site-specific conditions 6 and 7 with the site-specific design parameters separately is not sufficient to confirm the design adequacy of the standard plant. It is the staff's position that these two conditions should be considered together with the depth of soil layers. In addition, the site-specific responses (structural member forces and FRS) should be compared with the response envelopes used for the standard plant design unless it can be demonstrated that the site-specific parameters (shear wave velocity, number of soil layers, and depth of soil layers) are comparable to one of the 14 generic site conditions. This is Open Item 3.7.2-9.

Buried seismic Category I piping systems and tunnels are analyzed using techniques that account for the effects of seismic wave travel, differential movements of pipe anchors, bent geometry and curvature changes, local soil settlements or soil arching. The SSAR, however, did not describe in detail the procedure for the analysis of buried piping and tunnels. Similarly, the SSAR did not provide any description of the procedure for the dynamic analysis and evaluation of above-ground tanks. For the staff to draw the final conclusion, GE should include in the SSAR a description of the procedure for the seismic analysis and evaluation of buried piping and tunnels and above-ground tanks. This is Open Item 3.7.3-1.

The containment is designed as a reinforced-concrete cylindrical shell structure with an internal steel liner made of carbon steel, except for wetted surfaces where stainless steel or carbon steel with stainless steel cladding will be used. It is divided by the diaphragm floor and the reactor pedestal into an upper and a lower drywell chamber and a suppression chamber. The containment will be surrounded by and structurally integral with the reactor building. The containment wall will be 2.0 meters (6 ft 7 in) thick with an inside radius of 14.5 meters (47 ft 7 in) and height of 29.5 meters (96 ft 9 in). The containment design pressure is 31.7 tons/m**2 [45 psig]. The containment is designed to resist various combinations of dead loads; live loads; environmental loads, including those resulting from wind, tornadoes, and earthquakes; normal operating loads; and loads generated by a postulated LOCA. According to GE, the concrete containment has been designed, and will be fabricated, constructed, and tested, in accordance with Subsection CC of ASME Code, Section III, Division 2. However, GE did not specify the edition of ASME Code. This is Open Item 3.8.1-1.

The major steel components of the concrete containment will consist of personnel air locks, equipment hatches, and the drywell head. These components will be designed for the same loads and load combinations as those used in the design of the concrete containment shell to which these components will be attached. These components will be designed, fabricated, and tested as Class MC components in accordance with Subsection NE of ASME Code, Section III, Division 1. However, GE did not specify the edition of ASME Code. This is Open Item 3.8.1-2. See paragraph below for more discussion of this open item.

In SSAR Section 3.8.1.7.1, GE agreed that the COL applicant will perform the structural integrity test (SIT) of the ABWR containments in accordance with the provisions of Article CC-6000 and Subarticle CC-6230 of the ASME Code, Section III, Division 2. However, GE did not specify which edition of this code is to be used for the design. This is also Open Item 3.8.1-2.

In the ABWR design, the internal structures inside the containment include the reinforced-concrete diaphragm, the reactor pedestal, the reactor shield wall, and other structural components. The diaphragm will separate the upper drywell from the suppression pool. The reactor pedestal will consist of a ledge on a cylindrical shell that will form the reactor cavity, extending from the bottom of the diaphragm to the top of the containment foundation slab. The space enclosed by the cylindrical shell under the reactor is the lower drywell, which will be connected to the suppression pool through a series of vertical and horizontal vents in the shell wall. A steel equipment platform will be located in the lower drywell and accessible through a steel personnel tunnel and a steel equipment tunnel from outside the containment. Other internal structures will include the DEPSS, miscellaneous floors, and the reactor shield wall stabilizer. The major code used in the design of concrete internal structures is ACI 349. GE plans to use American National Standards Institute/American Institute of Steel Construction (ANSI/AISC) N690 for the design of all steel internal structures. However, NRC staff has not approved ANSI/AISC N690, and its acceptability is conditional on a satisfactory resolution of this concern. This is Open Item 3.8.3-1.

The materials of construction and their fabrication, construction, and installation are in accordance with ACI 349 and ANSI/AISC N690 for the concrete and steel structures, respectively, with the exception of the concrete diaphragm floors, for which ASME Code, Section III, Division 2, is used. However, GE did not specify the edition of ASME Code. This is Open Item 3.8.3-2.

As discussed in Section 3.7.2 of this report, the turbine building is not seismic Category I but must be capable of withstanding the SSE so as not to impair the safety function of the portion of the MSL and condenser (when used as an alternate leakage path) housed within the turbine building. On May 21, 1992, GE submitted its justification for demonstrating that the turbine building will not fail during and after an SSE. The staff's safety evaluation of the turbine building will be included in the FSER. This is Open Item 3.8.4-1.

In the SSAR, GE did not account for the effect of the hydrodynamic load on the reactor building as a result of a safety relief valve (SRV) discharge or a LOCA in the containment. Since the reactor building encloses and is structurally integral with the containment shell, the effect of the hydrodynamic load on the reactor building as a result of a SRV discharge or a LOCA in the containment should be factored into the design. This is Open Item 3.8.4-2. Consideration of this effect for systems and components is discussed in SSAR Section 3.9.2.2.

The seismic Category I structures for the ABWR standard plant were initially designed to withstand a maximum tornado wind speed of 418 km/hour [260 mph]. The staff expressed in the DSER its concern with the acceptance of this design tornado wind speed (Outstanding Issues 4, 8, and 9). In response, GE agreed to increase the design tornado wind speed to 483 km/hour [300 mph]. GE also agreed to revise the tornado-generated missile spectrum, specified in

ANSI/ANS 2.8, to the Spectrum I specified in SRP Section 3.5.1.4. On May 29, 1992, GE informed the staff that based on its preliminary evaluation of the effect of the revised tornado loadings, the reactor building superstructure and roof design will require additional thickness and the roof purlins will require strengthening. These structural changes will affect the seismic model and hence the seismic response of the reactor building. According to GE, the revised tornado loadings will affect the seismic analysis and design results contained in several sections and appendices in Chapter 3 of the SSAR. The staff understands that GE is finalizing its evaluation of the reactor building and will inform the staff of the final structural modifications and the effect on the existing seismic analysis and design results. This is Open Item 3.8.4-3.

According to SRP Section 3.8.4, a sufficient amount of descriptive and design information for the seismic Category I structures should be provided in the SSAR and this information should meet the minimum requirements set forth in Section 3.8.4.1 of RG 1.70. This requirement typically includes such information as the floor plans, roof plan, vertical sections, structural models used in the static analysis to calculate element forces and moments, configurations of major structural components, and arrangements of reinforcements in major concrete structural members. For the reactor building structure, SSAR Figures 3.8-1 through 3.8-9 and Section 3H.3 show the required design information that meets the SRP guidelines. For the control building and radwaste building substructure, however, the SSAR did not provide the required descriptive and design information, as required by 10 CFR 52.47, similar to that provided for the reactor building. This is Open Item 3.8.4-4

In the ABWR design, GE employed separate reinforced-concrete mat foundations for major seismic Category I structures. The reactor building foundation, which is integral with the containment foundation, supports the containment structure, reactor pedestal, other internal structures, and the balance of reactor building structure. Even though the containment structure foundation is integral with the reactor building foundation, GE defines it as the portion of the foundation within the perimeter of the containment structure. Therefore, the foundation was designed as a part of the containment boundary. The concrete foundations were designed to resist various combinations of dead loads, live loads, environmental loads (including winds, tornadoes, OBE, and SSE), and loads generated by postulated ruptures of high-energy pipes. Detailed design information such as the factor of safety against sliding, overturning, and flotation (buoyancy) for the reactor building is calculated and provided in SSAR Appendix 3H. However, no such information is given in the SSAR for the control building and the radwaste building substructure. This is Open Item 3.8.5-1.

The major code used in the design of concrete mat foundations is ACI 349, except for the portion of the foundation within the containment boundary for which ASME Code, Section III, Division 2, is used. The design and analysis procedures, the materials of construction and their fabrication, construction code, and installation used for the seismic Category I foundations, are in accordance with the procedures in ACI 349 and ASME Code, Section III, Division 2. The seismic Category I foundations were designed and proportioned to remain within the limits of these design codes for the applicable load combinations, including those that were considered extreme. GE did not specify the edition of the ASME Code. This is Open Item 3.8.5-2.

The staff identified the following eleven generic ABWR concerns as Open Item 3.8.7-1:

(1) Different measuring systems (British system and metric system) were used separately in this document. For example, British system and metric system were used at different locations in the primary containment system section. GE should either use dual system with British system in the parenthesis or us the metric system along in this document.

(2) Since the "visual inspection" approach is to be applied for almost every one of the safety related items to verity the as-built construction complying with the applicable design codes and regulatory requirements, GE should develop a set of procedures for conducting the "visual inspection" and demonstrate to the staff its applicability. In addition, inspection should not be limited to "visual inspection." Dimensional measurements need also be performed and checking of concrete cracking should be required in the inspections.

(3) GE should explain how to confirm the as-built construction or installation conforms with the configuration for all items shown in the figures if there are limited or no dimensions shown in them such as Figures 2.14.1, 1.14.2a and 2.14.1b.

(4) Some structural elements shown in the figures of this document are different from those shown in the SSAR figures. For example, the cubicle wall layouts of this document are different from the layouts in the SSAR and a removable masonry wall is shown at the reactor water cleanup system heat exchanger cubicle in the reactor building, but is now shown in Figures 2.10.10e and f. GE should verify the accuracy of these figures.

(5) The purpose and scope of the so-called "plant walk through" should be provided.

(6) Minimum thickness of roof and interior walls should be provided in addition to wall, floor, and basemat thickness. The concrete pipe chase needs to be presented in appropriate figures.

(7) Minimum requirements for heating, ventilation, and air conditioning (HVAC) damper tornado missile barriers need to be provided.

(8) As discussed in FSER Section 3.7.2, site-specific seismic evaluation need be performed if the site-specific soil condition is not one of the fourteen generic site conditions.

(9) GE should provide the concrete properties (e.g., crushing strength, shear modulus, Poisson's ration, etc.) in this document because these properties are needed in developing the dynamic model for the seismic analysis.

(10) For each seismic Category I structure, GE should provide the environmental design parameters, such as design pressure, design temperature, humidity, radiation, and other environmental parameters that are necessary to perform the environmental qualification of equipment located within the subcompartment.

(11) As a result of the second design calculation audit conducted on March 30 through April 3, 1992, the staff found that the implementation of the QA program for some of the design calculations was not completed. GE should complete all QA implementation for all seismic Category I structures and finalize the thickness of the walls and floors shown in this documents.

Reactor Service Water System - this is Open Item 3.8.7-2.

(1) The ultimate heat sink pump house is classified as seismic Category I structures. GE should treat the design results of this structure as Tier 1 information and document them.

(2) The top paragraph on page 2 of Section 2.11.9 is not complete.

Primary Containment System - this is Open Item 3.8.7-3.

Figures 2.14.1a and b are mentioned in this document, but only Figure 2.14.1 is shown. Clarification is needed.

Containment Internal Structures - this is Open Item 3.8.7-4.

(1) The stabilizer truss and a large opening between the reactor shield wall and the reinforced concrete containment vessel (RCCV) top slab are shown in Figure 2.14.2a. Based on the discussion with GE during the second design calculation audit conducted at GE San Jose Office, and the revised Drawings 12-3-21 and 12-3-22 of the SSAR, because of the protection to be provided for the personnel during reactor hot standby and shutdowns for maintenance and refueling, the shield wall height was raised up to 6 inches below the RCCV top slab and the stabilizer truss was eliminated. GE should revise its documents for consistency and accuracy.

(2) For the certified design commitment in Item 12 of Table 2.14.2 that the upper drywell piping support structure is classified as a Seismic Category I structure, GE should provide a design description in this document and show the configuration and location in Figures 2.14.2a and 2.14.2b.

Reactor Pressure Vessel Pedestal - this is Open Item 3.8.7-5.

(1) In Items No. 1 and 3 of Table 2.14.3, "Figure 2.14.3a" should read, "Figure 2.14.3."

(2) The elevations of the three rows of the 10 0.7 m diameter horizontal vents shown in Figure 2.14.3 are different from those stated in Item No. 3 of Table 2.14.3. GE should verify the accuracy of these elevations.

(3) The statements made in Items 8 and 9 of Table 2.14.3 are not complete.

Reactor Building - this is Open Item 3.8.7-6.

(1) The directions f the planar dimensions (59 m x 56 m) specified in the "Design Descriptions" are different from those specified in the "Major Nominal Dimensions of Seismic Category I Structures." A resolution of this discrepancy is needed.

(2) The directions (0-180 degree direction and 90-270 degree direction) specified in this document are inconsistent with the directions (N-S direction and E-W direction) as specified in Amendment 6 of the SSAR. GE should resolve this discrepancy.

(3) The thickness of the exterior walls at the first and third through eighth levels are inconsistent with the exterior wall thickness shown in Figures 2.15.10c through 2.15.10n.

(4) The exposed exterior walls and roofs of the reactor building as well as the tornado dampers should be designed for a pressure drop of 13.8 kpa [2.0 psi] as specified in the revised SSAR Section 3.3.2 and Table 2.0-1 instead of 10.1 kPa [1.46 psi].

(5) The divisional diesel generators and supporting equipment, which are located at grade level, should also be protected from the external missiles such as aircraft, moving vehicle, etc.

(6) GE should revise the dimensions of the super-structures and roof to be consistent with GE May 29, 1992, submittal.

Control Building - this is Open Item 3.8.7-7.

(1) The planar dimensions and the soil embedment depth shown in Sections 3A.2 and 3G.3.2 of the SSAR and in this document are inconsistent with each other. This concern has previously been raised in Sections 3.7.2 and 3.8.4 of the FSER. GE should verify the accuracy of these dimensions.

(2) The building directions referenced in this document are inconsistent with those referenced in Amendment 6 of the SSAR. GE should resolve this discrepancy.

(3) The thickness of the basemat should be considered as one of the major nominal dimensions and shown in the design description section because this dimension is needed to develop the dynamic model for the seismic analysis.

(4) The design basis tornado wind loads (maximum wind speed, pressure drop, etc.) should be updated for consistency with those specified in the revised SSAR Section 3.3.2 and Table 2.0-1.

Radwaste Building - this is Open Item 3.8.7-8.

(1) The planar dimensions of 54.2 m x 41.2 m [178 ft x 135 ft] as shown in this document are different from the planar dimensions of 53 m x 40 m [174 ft x 131 ft] as specified in Amendment 7 of the SSAR. GE should verify the accuracy of these planar dimensions.

(2) GE should clarify if the building height of 13.8 m [45 ft] is measured from the top of the basemat or from the bottom of the basemat to the roof.

Yard Structure - Stack System - this is Open Item 3.8.7-9.

(1) GE should provide the analysis approach, input data, and design requirements in the SSAR prior to confirming that the design, fabrication, and installation meet the design requirements.

(2) GE should take a measurement instead of visual inspection to verify that the stack height is 76 m [249 ft] above grade.

(3) GE should provide Tier 1 information for the field-erected tanks if they are classified as seismic Category I.

The list of transients in SSAR Table 3.9.1 appear to be based on a 40-year life. For a design life of 60 years, the number of cycles for each transient shall be increased by a factor of 1.5 and be applicable to all safety-related systems and components. GE should revise the table to reflect these changes. This is Open Item 3.9.1-1.

The NRC staff is currently reviewing the adequacy of the GE computer program used in the representative ABWR piping analyses that were audited by the staff on March 23-26, 1992, at GE's offices in San Jose, California. The staff is performing an independent piping analysis to confirm the adequacy of those provided by GE. This is Open Item 3.9.1-2.

GE performed the system and subsystem analyses on an elastic basis. Modal response spectrum, multidegree-of-freedom and time history methods formed the basis for the analyses of all major seismic Category I systems and components. When the response spectrum method was used, modal responses were combined by the SRSS rule. Closely spaced modes were combined using the criteria of RG 1.92. GE considered all modes with frequencies below 33 Hz in computing equipment and component response for seismic loadings. For seismic analysis, consideration of high-frequency modes to preclude missing mass effects should also be included. The staff's guidelines for this are provided in SRP Section 3.7.2, Revision 2, Appendix A. The SSAR should be revised to reflect the above staff position or, if an alternative method is used, then the details of its basis should be submitted to the staff for review and approval before to its use. This is Open Item 3.9.2.2-1.

The effect of pipe supports on the piping response is considered in the analytical model by including its actual stiffness properties. If default or generic stiffnesses are used in the piping model, then justification should be developed to validate the stiffness values used in the piping model. The justification should include verification that the generic values are representative of the types of pipe supports used in the piping system. This alternative approach to use generic stiffness values and its bases should be submitted to the staff for review and approval before its use. Additionally, because the amplified response spectra are generally specified at discrete building node points, any additional flexibility between these points and the pipe support (e.g., supplementary steel) also should be addressed. The SSAR should be revised to incorporate the above information. This is Open Item 3.9.2.2-2.

When piping terminates at non-rigid equipment (e.g., tanks, pumps, or heat exchangers), the analytical piping model should consider the flexibility and mass effects of the equipment. The SSAR should be revised to address how the flexibility and masses of equipment attached to the piping are to be modeled. This is Open Item 3.9.2.2-3.

When analyzing piping systems, the size of the mathematical model might exceed the capacity of the computer program when large and small bore piping are included. Thus, the small bore branch lines are generally decoupled from the large bore main piping. Currently, the SSAR does not provide any criteria for the decoupling of the piping systems in the analysis model. However, in a letter from P. Marriott (GE) to the NRC dated February 24, 1992, GE provided a decoupling criteria in a GE draft document entitled "ABWR SSAR Main Steam, Feedwater and SRVDL Piping Systems Design Criteria and Analysis Methods," Revision 0, dated February 1992. In this document, GE stated that when the ratio between pipe diameters of the branch line to main line is less than one-third, the branch line can be excluded from the piping model of the main line. For GE to use this criterion for all piping systems in the ABWR plant, the basis for the 1:3 ratio will have to be to be reviewed by the staff. GE also needs to define how the mass effect of the decoupled line is accounted for in the model of the main line and how the frequency ratio effect (or resonant amplification of the main line) is accounted for in the modeling and analysis of the branch line. GE should revise its SSAR to include this information for the staff's review. This is Open Item 3.9.2.2-4.

GE has not provided the staff with any specific information about the method to be used for the structural design of small-bore piping systems and instrumentation lines in the ABWR plant. This information must be included in the SSAR for the staff to reach a final safety determination on the adequacy of the ABWR small-bore piping design. This is Open Item 3.9.2.2-5.

The staff reviewed the issue of modal damping for composite structures during the audit conducted on March 23-26, 1992, at GE's offices in San Jose, California. The GE SSAR does not describe the application of modal damping for composite structures in the analysis of piping systems. However, GE's internal document entitled, "Piping Systems Design Criteria and Analysis Methods" contained a table of damping values for various types of piping supports. The damping values for the piping supports (e.g., snubbers and struts) were higher than the damping values tabulated for the piping. GE indicated that these values were presented because modal damping for composite structures could be used in a response spectrum analysis as an option. If GE plans to use the modal damping for composite structures as an option for piping analysis, then a description and justification of the approach must be provided in the SSAR for staff review and approval before its use. This is Open Item 3.9.2.2-6.

SSAR Section 3.7.3.12 outlines criteria that will be used in the analysis of buried seismic Category I piping systems. These criteria conform to applicable guidelines in SRP Section 3.9.2 and are acceptable. However, GE has not provided any detailed information on how the criteria are to be applied in the design of buried piping. Also, it is not clear if the buried piping within the scope of design certification will be in contact with the soil or routed in tunnels. This information is necessary in the SSAR for the staff to complete its review. This is Open Item 3.9.2.2-7.

The ASME Code, Section III, requires that the cumulative damage resulting from fatigue be evaluated for all ASME Code Class 1 piping. The cumulative fatigue usage factor should take into consideration all cyclic effects caused by the plant operating transients listed in SSAR Table 3.9-1. As noted in Section 3.9.1 of this report, the ABWR is designed for a 60-year design life. Recent test data to address fatigue concerns indicates that the effects of the reactor environment could significantly reduce the fatigue resistance of certain materials. A comparison of the test data with the Code requirements indicates that the margins in the ASME Code fatigue design curves might be less than originally intended. The staff is currently developing an interim position to account for the environmental effects in the fatigue design of the affected materials; it will be available at a later date. GE should include in its SSAR the proposed approach for accounting for the environmental effects in its fatigue analysis for a 60-year lifetime. This is Open Item 3.9.3.1-1.

As stated earlier the staff believes the margins built in to the ASME fatigue design curves might not be sufficient to account for variations in the original fatigue test data as a result of various environmental effects. Therefore, it is the staff's position that environmental effects should be considered in the fatigue analysis for ASME Code Class 2 and 3 piping. GE should include in its SSAR the proposed approach for accounting for the environmental effects in these fatigue analyses. This is part of Open Item 3.9.3.1-1 for ASME Class 1 components.

The staff reviewed and discussed the thermal stratification analysis methodology with the cognizant GE engineers and found it acceptable with the exception of an apparent discrepancy in load application. GE defined the stratified temperature profile in the pipe cross section as a constant hot temperature in the top half and cold temperature in the bottom half with a step change in the temperature at the centerline. However, in the pipe stress analysis, a linear top-to-bottom temperature profile was applied. The linear temperature profile provides lower bending moments and stresses than the step change profile. The staff asked GE to justify (1) the adequacy of the piping analysis load input and (2) the omission of the high-cycle fatigue effects of thermal striping from the analysis. In addition, the staff asked GE to provide additional justification for their methodology including test information to support their thermal stratification load definition. GE should provide this information in the SSAR. This is Open Item 3.9.3.1-2.

GE has not provided information to the staff that would establish a minimum temperature at which an explicit piping thermal expansion analysis would be required. Without this information in the SSAR, the staff requires that GE perform thermal analyses for all temperature conditions above ambient. This is Open Item 3.9.3.1-3.

(1) information that addresses the types of snubbers and their characteristics (as delineated in SRP 3.9.3, Section II.3b) to be used in the ABWR standard plant.

(2) information that addresses the use of seismic restraints other than snubbers and their modeling assumptions

(3) information that addresses the pipe support stiffness values and support deflection limits used in the piping analyses

(4) information that addresses how the seismic excitation of the pipe supports (especially large frame-type structures) are to be considered in the design of the pipe support anchorage

(5) information that addresses the hot and cold gaps to be used between the pipe and the box-frame-type of support and the coefficient of friction to be used for considering friction forces between the pipes and the steel frames

(6) criteria that will ensure that the maximum deflections of the piping at support locations for static and dynamic loadings are within an allowable limit to preclude failure of the pipe supports and hangers

The above items constitute Open Item 3.9.3.3-1.

In SSAR Section 3.9.7.3, GE made an interface commitment that the concerns and issues identified in GL 89-10 for MOVs will be addressed by the applicant referencing the ABWR design before plant startup. The methods for assessing the loads, sizing the actuator, and setting torque and limit switches will be specifically addressed. However, the staff has determined that those concerns and issues identified in GL 89-10 and its supplements that relate to test, analysis, and acceptance criteria to determine the adequacy of valve design and to ensure the ability of MOVs to meet functional performance requirements under all design-basis conditions, including recovery from inadvertent valve mispositioning, must be addressed under a generic ITAAC rather than an interface commitment. The development of an acceptable generic ITAAC for demonstrating MOV capability is Open Item 3.9.6.2.3-1.

In the DSER, the staff requested that GE comply with the analysis of leakage rates and corrective action requirements of OM Part 10, paragraph 4.2.2.3, for containment isolation valves (Outstanding Item 19). In response, GE stated that leakage rate testing of containment isolation valves will be in accordance with ASME Code Section XI. However, this is not completely acceptable. OM Part 10, which is referenced in ASME Code Section XI, 1989 edition, only requires containment isolation valves to be tested in accordance with Appendix J to 10 CFR Part 50 and does not require that corrective action be based on exceeding individual valve leakage limits. The staff's position is that the analysis of leakage rates and corrective action requirements of paragraph 4.2.2.3 in OM Part 10 are applicable to containment isolation valves. GE must revise its response in accordance with the staff's position. This is Open Item 3.9.6.2.4-1.

In its letter, the staff requested GE to address the issues in the list of questions. The staff stated that those questions should not be used to determine a comprehensive list of problem areas in SSAR Table 3.9-8 and that GE should systematically review and revise its ABWR IST plan, with emphasis on the design configuration to provide assurance that its commitment regarding the ability to test pumps and valves can be met. Subsequently, a meeting with GE was held on June 8, 1992, in San Jose, California. As a result of that meeting, GE made several commitments including addressing those questions identified in the staff's letter of May 4, 1992; revising SSAR Table 3.9-8 as well as the associated piping and instrumentation drawings (P&IDs); and performing a systematic review of its IST plan. GE also indicated that some exceptions to the Code requirements may be needed after it completes a systematic review of the IST plan. For the staff review of any Code exceptions, GE has committed to identify the Code requirement, to provide a basis to justify the need for relief, and to describe its proposed alternate testing method. The development and submittal of an acceptable IST plan is Open Item 3.9.6.3-1.

The staff informed GE that it would be unacceptable to leave for the COL phase certain aspects of the final design related to testability of pumps and valves. Specifically, details of the piping configuration related to additional lines, valves, and instrumentation must be provided before FDA. Because the comprehensive pump and valve design specifications are not available as part of the design certification, GE shall establish criteria to be used by the COL applicant for developing its pump and valve design specifications to ensure that the ASME Code testing requirements can be met. This is Open Item 3.9.6.3-2.

In Section 3.9.6.2.2 of this report, the staff indicated that the MOV equipment specifications require the incorporation of the results of either in-situ or prototype testing with full flow and differential pressure to verify the proper sizing and switch settings of the valves. Similarly, in Section 3.9.6.2.1 of this report, the staff indicated that all ABWR safety-related piping systems incorporate provisions for testing to demonstrate the operability of check valves under design-basis conditions. The staff addressed these issues to ensure that these valves are verified to be capable of performing their design-basis functions. GE has not provided a similar commitment in the SSAR that the specifications for other power-operated valves will incorporate the results of either in plant or prototype testing to verify design-basis capability. On the basis of past experience with estimating thrust and torque requirements and other parameters for valve operation, the staff believes that this assurance cannot be provided by analytical approaches alone and will require that proper sizing and adjustment of other power-operated valves be verified by a generic ITAAC. The development of an acceptable generic ITAAC for demonstrating the capability of other power-operated valves is Open Item 3.9.6.4-1.

According to SSAR Section 3.8.4.2.4, the design of seismic Category I electrical raceway supports uses codes, standards, and specifications applicable to the building structures to which they are attached. These codes include AISC Steel Construction Manual and AISI SG-673. The supports are designed and located to withstand the dynamic loads in three directions by means of vertical, transverse, and longitudinal support and bracing systems. The design considers the dead loads, live loads, and seismic loads plus other RBV dynamic loads. According to SSAR Section 3.10.3.2.2, the supports, including those for the non-seismic Category I cable trays and conduits, are designed to meet seismic Category I requirements. These design criteria and procedures meet the guidelines of SRP Section 3.8.4 and are acceptable. However, GE did not provide the design procedures and criteria for the seismic Category I cable trays and conduit. This is Open Item 3.10.3-1.

In the DSER, the staff stated that the tables in Appendix 3I do not include the beta radiation dose rate and the integrated beta dose for applicable zones. Subsequently, GE stated that accurate radiation environments should include consideration of the source term and the design and location and materials of construction of the equipment in the various environmental zones. While the source term is known, the design, specific location, and materials of construction of various pieces of equipment will be determined by the COL applicant. GE also proposed an ITAAC for this issue ("Table 3.73.11C: Equipment Qualification for Radiation"). The staff reviewed the ITAAC and determined that the acceptance criteria should be modified to state: "The maximum expected lifetime exposure for each piece of equipment within the scope of 10 CFR 50.49 shall not exceed the demonstrated qualified value as determined in accordance with the requirements of 10 CFR 50.49 paragraph (f)." This is Open Item 3.11.3-1.

In the DSER, the staff stated that the Appendix 3I tables do not identify whether the subject zone is environmentally mild or harsh and also do not list the typical equipment located in each zone. GE proposed a change to SSAR Section 3.11.2 to state GE's definition of a mild environment as: "Mild environment is that which, during or after a design basis event will at no time be significantly more severe than that existing during normal and abnormal events." The NRC staff understands that inservice testing is included as a normal or abnormal condition (IST is not an environmental qualification program requirement). This proposed definition is consistent with the requirements of 10 CFR 50.49, therefore this issue is resolved. This is Confirmatory Item 3.11.3-2. However, for current generation operating reactors, the staff's definition of what constitutes a mild radiation environment for electronic components such as semi-conductors, or any electronic component containing organic materials, is different from what it is for other equipment. The staffs's position is that a mild radiation environment for electronic equipment is a total integrated dose of < 10E3 R. For other equipment it is < 10E4 R. With the expected significant increase in the quantity and variety of electronic components in newer generation plants, the staff has increasing concerns about the efforts being made to ensure that these components are environmentally qualified and the capability of the component to be environmentally qualified. GE should confirm that its position on the environmental qualification of electronic components is consistent with the staff's. This is Open Item 3.11.3-2

The staff noted in the DSER that the integrated gamma accident dose in the primary containment for the ABWR is given as 6 x 10^7 rads, which is less than the typical value of about 2 x 10^8 rads quoted in the safety analysis reports of several operating reactors (e.g., Perry: 2.7 x 10^8 rads; River Bend: 1.7 x 10^8 rads; Clinton: 2 x 10^8 rads; Nine Mile Point: 1.4 x 10^8 rads). It is not clear why the ABWR integrated gamma accident dose is lower than the corresponding doses quoted for several operating reactors. GE's position, which was provided in Section 5.3.2.1.5 of SSAR Amendment 15, did not adequately address this issue. To resolve this issue GE must fully explain why the ABWR integrated gamma accident dose is lower than the corresponding doses quoted for several operating reactors. This is Open Item 3.11.3-3.

CONFIRMATORY ITEMS

GE analyzed compartment flooding from postulated component or system failures separately for the reactor, control, radwaste, and service buildings. GE considered single failure of an active component for compartment flooding. GE analyzed rupture of moderate-energy piping larger than 1-inch diameter in accordance with ANSI/ANS 56.11 "Standard Design Criteria for Protection Against the Effects of Compartment Flooding in Light Water Reactor Plants," and Crane Co. Technical Paper 410, 1973, "Flow of Fluids Through Valves, Fittings, and Pipe." GE conservatively, did not consider the effect of drain sump pump operation. In the DSER, the staff stated that high-energy line breaks (HELBs) inside the main steam tunnel (MST) were excluded from evaluation because this area will be instrumented for detection of leaks before a line break occurred. In addition, the staff stated that a leak-before-break (LBB) analysis should use plant-specific data such as piping geometry, materials, fabrication procedures, and pipe support locations (LBB is discussed in Section 3.6.3 of this report). In a meeting with the staff on May 5, 1992, GE committed to removing references to LBB from the SSAR. This is Confirmatory Item 3.4.1-1.

GE stated that the greatest flood hazard in the MST occurs as a result of a feedwater line break. The amount of water associated with the break will be limited by closing the feedwater isolation valves. The water in the MST will collect in the large cavity at the reactor building end of the tunnel; any overflow from the cavity will flow to the turbine building. There will be no openings or penetrations between the MST and the control building to provide a path for water to enter the control building from the MST. This information ensures that the control building will be protected from flooding as the result of pipe failures in the MST. This is acceptable subject to inclusion of this information in the SSAR. This is Confirmatory Item 3.4.1-2.

GE also addressed control building flooding as a result of an RSW failure. It stated that three divisions of RSW, physically separated in rooms with watertight doors, will be located on the -8200 mm (-323 in) level (first floor) of the control building. Any flooding from sources above the first floor that could possible affect safe shutdown equipment will be directed through floor drains to the first floor. Each divisional RCW/RSW room is equipped with a sump pump and contains two sets of safety-grade level sensors in a two-out-of-four logic. The first set will be located 0.15 meters (~6 in) from the floor and will alert the control room operator of the presence of water in the room. The second set of sensors will be located 0.8 meters (~32 in) from the floor and will inform the control room operator that a serious flood situation exists in the RCW/RSW room. In addition, these high-level sensors will trip the RSW pump and close the isolation valves for the affected division. The flood analysis assumed 2000 meters (~6600 ft) of pipe between the ultimate heat sink (UHS) and the RCW/RSW divisional room. This length of piping contains 770 m^3 (~27,000 ft^3) of water that can drain to the RCW/RSW room following RSW pump trip and isolation valve closure. On a pipe break, 280 m^3 (~10000 cubic ft) of water will enter the RCW/RSW room before the high level sensor trips the RSW pumps and closes the isolation valves. This volume of water, when added to the 770 m^3 (~27,000 ft^3) of water that drains from the piping, results in a total of 1050 m^3 (~37,000 ft^3) of water inside the RCW/RSW divisional room. Each RCW/RSW room is ~1900 m^3 (~67,000 ft^3) and can contain all the water associated with the break. Water from the break cannot affect the safety-related equipment in the other divisional rooms. This analysis demonstrates that the safety-related equipment is adequately protected from the effects of a pipe break in the RSW system. This is acceptable subject to inclusion of this information in the SSAR. This is Confirmatory Item 3.4.1-3.

The design will withstand an 1800-kg (4000-lb) automobile, a 125-kg (280-lb), 20-cm (8-inch) armor piercing artillery shell, and a 2.54-cm (1-in) solid steel sphere, all impacting at 35 percent of the maximum horizontal windspeed of the DBT. GE identifies these missiles as Spectrum I. GE's preliminary evaluation of the design revealed that the reactor building superstructure and roof will have to be thickened and the roof purlins strengthened. In addition, the seismic model will have to be modified. The structural design aspects of this issue are discussed in Section 3.8.4 of this report and are being tracked as Open Item 3.8.4-3. As a result of these structural design changes, several SSAR sections and appendices will be affected. The staff expects GE's commitment to design the ABWR to withstand the aforementioned DBT and missile spectra acceptable. The staff will verify the changes to the SSAR incorporating this information. This is Confirmatory Item 3.5.1.4-1.

In the DSER (SECY-91-153), the staff identified as part of Open Item 8 regarding compliance with Positions C.1 through C.3 of RG 1.117, "Tornado Design Classification." In a subsequent amendment, GE committed to comply with Positions C.1 and C.2, GE subsequently stated that position C.3 of RG 1.117 also would be met. This open issue is resolved pending inclusion of this commitment in the SSAR. This is Confirmatory Item 3.5.1.4-2.

GE evaluated the effects of postulated pipe breaks in high-energy fluid systems with regard to pipe whip, jet impingement, flooding, room pressurization, and such environmental parameters as temperature, pressure, humidity, and radiation. However, the staff stated in the DSER (SECY-91-153) that GE excluded consideration of pipe breaks and the resulting dynamic effects in the postulation of piping failures in main steam and feedwater systems. GE justified the exclusion stating that the piping in these systems met the LBB criterion. The staff expects that a bona fide LBB analysis should use plant-specific data such as piping geometry, materials, fabrication procedures, loads, degradation mechanisms, and pipe support locations. In its evaluation of the LBB exclusion, which is discussed in Section 3.6.3 of this report, the staff concluded that LBB could not be considered in the analysis of pipe failures. GE subsequently provided an analysis of a main steam line and a main feedwater line pipe failure in SSAR Section 6.2.3; the staff's review of this analysis is found in Section 6.2.1.7 of this report. In a meeting with the staff, GE committed to removing references to LBB from the SSAR. The staff will verify that the references to LBB have been removed in a future SSAR amendment. This is Confirmatory Item 3.4.1-1, discussed in Section 3.4.1 of this chapter.

The ACRS expressed a concern regarding the pressure values in SSAR Table 31.3-15. The ACRS noted that the values appear to reflect the zone pressure which result during accident conditions, assuming that the blowout panels function properly. A more conservative scenario would assume failure of the blowout panels. GE committed to modify the table to ensure that it reflects the highest anticipated pressures resulting from accident conditions, assuming failure of the blowout panels. Revision of this table is Confirmatory Item 3.6.1-2.

The SSAR did not provide a complete description of the procedure to calculate the FRS and develop the revised FRS envelopes. During the second design calculation audit, GE indicated that the revised FRS envelopes were obtained by enveloping the FRS from the 42 cases of SASSI analyses and then multiplying an uncertainty factor of 1.33 and 1.0 to the horizontal and vertical FRS envelopes, respectively. In order for the staff to reach a final conclusion on the adequacy of the revised FRS envelopes, the SSAR should describe the procedure to develop the FRS envelopes and provide the basis for applying these uncertainty factors. During the second design audit, the staff raised a concern with the uncertainty factor of 1.0 for the vertical FRS because, when computing the vertical FRS, GE did not consider the response of the rocking mode of the structure to the horizontal earthquake component. On the basis of the staff's past review experience, the contribution of the rocking mode to the vertical FRS could be significant for a soil site. GE agreed to include in the SSAR a description of the procedure to generate the FRS and revised FRS envelopes and to provide the basis for the uncertainty factors. GE also agreed to include the seismic structural displacement profile in the SSAR. This profile is needed in the seismic design of piping systems. The issue of the procedure for FRS envelope generation, the basis for uncertainty factors, and the seismic structural displacement profile are considered Confirmatory Items 3.7.2-1, 3.7.2-2, and 3.7.2-3, respectively.

GE considered three generic site conditions to generate the envelopes of structural seismic loads and FRS. GE also applied uncertainty factors of 1.5 and 1.0, respectively, to the horizontal and vertical FRS envelopes of the control building. During the second design calculation audit, GE said a part of the uncertainty factor of 1.5 for the horizontal FRS envelope was to account for the uncertainty resulting from using only three site conditions in the standard design. The staff raised a concern with the basis of the uncertainty factors and with the sufficiency of considering only three site conditions in the standard design. GE agreed to provide the basis for the uncertainty factors. This is Confirmatory Item 3.7.2-4.

During the second design calculation audit, GE indicated that the radwaste building does not house any safety-related equipment and components and hence there is no need to generate FRS for the subsystems. To ensure that the building maintains its structural integrity during and after an SSE and to prevent unacceptable leakage of the radwaste material outside the embedded portion of the building, GE elected to design the structure for the SSE seismic loads computed by the modal response spectrum method of analysis. The seismic analysis was performed using a fixed-base freestanding stick model to represent the structure. This simplified analysis model excludes the effects of both the structural embedment and site soil conditions. The resulting fundamental horizontal frequency is within the frequency range of the maximum amplification of the input ground response spectrum. This ensures that the resulting seismic loads for the design of the structure are sufficiently conservative to preclude the need for considering the effects of structural embedment and site soil conditions. However, GE did not complete the implementation of the QA program for the seismic analysis of this building at the time of the second design audit. In addition, the SSAR did not include the analysis results such as the structural frequencies, seismic shear forces, and seismic moments. The staff considers the seismic analysis method and results acceptable provided GE completes the implementation of QA program and does not identify any deficiencies with existing calculations. This is Confirmatory Item 3.7.2-6.

When a site-specific SSI analysis is performed for the SSE case, the three components of the ground motion time history to be used must satisfy not only the PSD enveloping criterion but also the response spectrum enveloping criterion for all damping values to be applied including the damping ratios higher than 4 percent. This is Confirmatory Item 3.7.2-7.

In SSAR Section 2.3.1.2, Amendment 18, GE proposes that the FRS comparison can be made for one damping value only when confirming the seismic design adequacy of piping and equipment. The staff's position, based on the guidelines provided in RG 1.61, is that the FRS comparison should be performed for all damping values assigned to different piping systems and equipment. GE agreed to address this concern. This is Confirmatory Item 3.7.2-8.

During the first design calculation audit, the staff reviewed the preliminary design summary report for the containment and reactor buildings. During the second design calculation audit, the staff reviewed the final design summary report and found it acceptable. However, the detailed design calculations for the containment shell were not available for review during the audit. GE agreed to provide this design information to the staff for review. This is Confirmatory Item 3.8.1-1.

During the first design calculation audit, the staff reviewed the preliminary design summary report for the containment internal structures. During the second design calculation audit, the staff reviewed the final design summary report of the containment internal structures and found it acceptable. However, the detailed design calculations for these structures were not available for review during the audit. GE committed to provide such design information of the containment internal structures to the staff for review. This is Confirmatory Item 3.8.3-1.

During the second design calculation audit, the staff reviewed the static analyses which calculated the structural element forces and moments resulting from the various loads and load combinations acting on the control building and radwaste building substructure. The detailed design calculations for the reactor building, control building, and radwaste building substructure, however, were not available to the staff for review. In addition, the staff found that GE did not complete the implementation of the QA programs for the static analyses and detailed design calculations for both the control building and radwaste building substructure. GE committed to provide the detailed design calculations to the staff for review and to complete the implementation of the QA programs for the control building and radwaste building substructure. These two issues are Confirmatory Items 3.8.4-1 and 3.8.4-2, respectively.

However, in the analysis of the control building, GE did not consider the effects of winds, tornados, and tornado missiles and, in the analysis of the radwaste building, GE did not consider the effect of winds and used incorrectly calculated soil pressure loads. GE committed to address these concerns. These are Confirmatory Items 3.8.4-3 and 3.8.4-4, respectively.

The method of the static analysis and the analysis results for the element forces and moments for the control building and radwaste building are acceptable pending resolution of Confirmatory Items 3.8.4-3 and 3.8.4-4.

During the first design calculation audit, the staff reviewed the preliminary design summary report for the mat foundation supporting the containment, internal structures, and reactor building. During the second design audit, the staff found that the detailed design calculations for the foundations of all seismic Category I structures were not available for review. In addition, the staff found that GE did not complete the implementation of the QA programs for the design of the foundations of the control building and radwaste building substructure. GE committed to complete the detailed design calculations for the foundations of all seismic Category I structures and to complete the implementation of the QA programs for the foundations of the control building and radwaste building substructure. These are Confirmatory Items 3.8.5-1 and 3.8.5-2.

For the dynamic analysis of seismic Category I piping, each system is idealized as a mathematical model consisting of lumped masses connected by elastic members. The stiffness matrix for the piping system is determined using the elastic properties of the pipe. This includes the effects of torsional, bending, shear, and axial deformations as well as change in stiffness as a result of the curved members. Next, the mode shapes and the undamped natural frequencies are obtained. The dynamic response of the system is calculated by using the response spectrum method of analysis. For a piping system that is supported at points with different dynamic excitations, the response analysis is performed using an enveloped response spectrum. As an alternative to the enveloped response spectrum method, GE chose to use the multiple-support excitation analysis method. When this method is used, the staff's position is that the responses resulting from motions of supports between two or more different support groups may be combined by the SRSS method if a support group is defined by supports that have the same time history input. This usually means all supports located on the same floor, or portions of a floor in a structure. In response to RAI Q210.26 in Amendment 11 to the SSAR, GE committed to use this definition. The staff finds this alternative to the enveloped response spectrum method acceptable. GE should change the SSAR to reflect this commitment. This is Confirmatory Item 3.9.2.2-1.

The staff reviewed the method for selecting the number of masses or degrees of freedom in the mathematical piping model to determine its dynamic response. On the basis of the staff's audit conducted March 23-26, 1992, of GE's internal documents, pipe and fluid masses are lumped at nodes that are selected to coincide with the locations of large masses (e.g., valves, pumps, and tanks) and with locations of significant geometric changes (e.g., pipe elbows, reducers, and tees). Additional mass points are selected to ensure that the spacing between any two adjacent piping nodes and masses is no greater than an idealized value. This value corresponds to the length of a simply supported beam with a uniformly distributed mass whose undamped natural frequency is equal to the cut-off frequency. Because this approach, in effect, will capture all modes up to the cut-off frequency, it is acceptable. However, the SSAR should be revised to reflect the above described approach. This is Confirmatory Item 3.9.2.2-2.

SSAR Sections 3.9.2.3 through 3.9.2.6 and 3.9.7.1 provide information on vibration testing and analysis of reactor internals. In these sections, the first ABWR plant is referred to as a "prototype plant." The staff concludes that this characterization, although relevant to passive or other innovative reactor designs, is inapplicable to evolutionary light water reactor design certification applications as described in 10 CFR 52.47(b)(1). To address the staff's concern, GE agreed to delete references to "prototype" from its future revision to SSAR Sections 3.9.2.4 and 3.9.7.1. This is Confirmatory Item 3.9.2.3-1.

The staff requires that all of the GE commitments and applicable information discussed in the staff's audit summary of May 10, 1992, be included in a future revision to the SSAR. This is Confirmatory Item 3.9.2.3-2.

In the DSER, the staff identified an open item relating to justifying the use of prototype testing of MOVs as an alternative to in situ testing (Outstanding Item 16). In response to the staff's concern, GE agreed to revise the SSAR to reference Generic Letter (GL) 89-10, Supplement 1 Questions 22 and 24 through 28, which contains guidelines to justify prototype testing. The staff regards this as a GE commitment to follow this guidance. This is Confirmatory Item 3.9.6.2.2-1.

In response to the staff's concern regarding the periodic testing for MOVs, GE stated that the SSAR will be revised to require the COL applicant to periodically test MOVs. This testing would be conducted under adequate differential pressure and flow conditions that allow a justifiable demonstration of continuing MOV capability for design-basis conditions, including recovery from inadvertent valve mispositioning. This commitment is satisfactory provided the frequency and test conditions are sufficient to demonstrate continuing design-basis capability. The staff considers the 5-year interval recommended in GL 89-10 as an appropriate starting point for each valve for determining the frequency of this periodic verification moreover, it is the staff's position that MOVs in a safety-related system should either be designed to prevent mispositioning or be required to be subjected to qualification testing to demonstrate capability to recover from mispositioning. Mispositioning may occur through actions taken at any time locally (manual or electrical) at a motor control center or in the control room and includes deliberate changes of valve position for performing surveillance testing. This is Confirmatory Item 3.9.6.2.2-2.

In the draft safety evaluation report (DSER), the staff reported a concern regarding the scope of containment isolation valves (Outstanding Item 18). In response, GE stated that the scope of containment isolation valves will be in accordance with GDC 54 and agreed to amend the SSAR accordingly. The staff will verify that this change has been made in a future SSAR amendment. This is Confirmatory Item 3.9.6.2.4-1. It should be noted, however, that the staff's evaluation of compliance with GDC 54 has been found to be acceptable as discussed in Section 6.2.4 of this report.

In the DSER, the staff stated that the tables do not include the chemical environmental conditions (chemical composition and the resulting Ph) to which the applicable equipment may be exposed during accident conditions. GE responded that reactor water quality characteristics for the design-basis loss-of-coolant accident (DBLOCA) are contained in SSAR Section 3I.3.2.3. Additionally, by fax dated June 1, 1991, GE provided information indicating that SSAR Section 3I.3.2.3 would be updated to include information on water quality characteristics for normal operations. The staff has reviewed Section 3I.3.2.3 and the proposed update and finds it acceptable to resolve this issue. This is Confirmatory Item 3.11.3-1.

In the DSER, the staff stated that the Appendix 3I tables do not identify whether the subject zone is environmentally mild or harsh and also do not list the typical equipment located in each zone. GE proposed a change to SSAR Section 3.11.2 to state GE's definition of a mild environment as: "Mild environment is that which, during or after a design basis event will at no time be significantly more severe than that existing during normal and abnormal events." The NRC staff understands that inservice testing is included as a normal or abnormal condition (IST is not an environmental qualification program requirement). This proposed definition is consistent with the requirements of 10 CFR 50.49, therefore this issue is resolved. This is Confirmatory Item 3.11.3-2.

In addition, GE proposed changes to Figures 3I.3-1 through 3I.3-22 that will include references to P&ID and IED drawings that will identify typical equipment for each zone. The staff finds these proposed changes acceptable. Incorporation of the changes into the SSAR is Confirmatory Item 3.11.3-3.

In the DSER the staff stated that the Appendix 3I tables do not contain sufficient information on thermal environmental conditions (e.g., duration of different conditions) in various zones under normal plant operating conditions to develop a meaningful time-based thermal environmental profile for the zones. GE provided a proposed table (Table 3I.3-A) and a proposed amendment to all the tables in Appendix 3I that contain thermodynamic environmental conditions for both normal operating conditions and design basis accidents. The proposed information is sufficient to developed time-based profiles for the various identified zones. This is Confirmatory Item 3.11.3-4.

CHAPTER 4

OPEN ITEMS

The analysis, review, and conclusions related in discussing ABWR instability during modified ATWS transients, however, are not complete. The generic interaction of the NRC with the BWROG in this area is not completed and conclusions have not been agreed to. ATWS analyses submitted by GE for the ABWR ("GE Response to the Resolution of Outstanding Issues 140 and 144 of ABWR DSER SECY-91-355," April 24, 1992) do not explicitly address the issue. The staff does not consider the methodology used in these analyses (REDYA, discussed in Section 15.1 of this report) adequate to address the potential for large oscillations which have been considered in the NRC and BWROG interaction. Furthermore, the feedwater runback action that GE indicated as being a solution to the problem appears to be delayed too long (at least two minutes) to ensure timely mitigation. Thus, the ATWS stability problem remains an open item to be resolved either by generic demonstration or solution by the NRC and BWROG interaction or by GE providing satisfactory analyses or solutions directly related to the ABWR. This is Open Item 4.4-1.

The ABWR design, as initially presented, did not include a loose-parts monitoring system (LPMS). However, in response to the staff position that an LPMS is required, GE has provided an LPMS general description, including a design basis, system description, system operation, safety evaluation, test, and inspection and application. This system is designed in conformance with Regulatory Guide (RG) 1.133. The system will include sensors (accelerometers located at natural loose parts collection regions, e.g., steam outlet nozzle, feedwater inlet nozzle, control drive housings), signal conditioning, signal analysis, alarms, and calibration. The sensitivity is such that a sensor will be able to detect a metallic part between 0.1-14 kg (0.25 to 30 lbs) with a kinetic energy of 0.7 Joule (0.5 ft-lb) on an inside surface within 1 m (3 ft) of a sensor. There will be provisions for online channel checks and functional tests and offline calibration. The system is designed to meet the seismic and environmental operability recommendations of RG 1.133. GE has provided an ITAAC for the LPMS as part of its Tier 1 Design Certification Material submittal. It provides for design commitment for detector locations and sensitivity with appropriate accompanying inspections, tests, and criteria. The Certified Design Commitment 1 in the LPMS ITAAC should be expanded to explicitly state that the LPMS design is consistent with the requirements of RG 1.133. This is Open Item 4.4-2.

The staff is reviewing the ITAAC for control rod drive system and will provide its results in the final safety evaluation report (FSER). This is Open Item 4.6-1.

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In response to the NRC staff generic request, GE submitted Amendment 22 to GESTAR II, containing proposed fuel licensing acceptance criteria for current BWRs. These criteria consider fuel thermalmechanical, nuclear, and thermal-hydraulic aspects of design analyses. NRC staff and the Committee to Review Generic Requirements reviewed these criteria and approved them. The staff safety evaluation report (SER) accepting these criteria can be found in GESTAR II, Revision 10, Supplement for United States, Appendix C. In the future, as for current BWRs, if a GE fuel design complies with these fuel acceptance criteria it will be acceptable for licensing applications without requiring explicit staff review. However, the staff documented several deficiencies in the generic fuel licensing criteria. In its audit summary, "Audit of GG II Fuel Design Compliance with NEDE-24011-P-A," dated March 25, 1992, GE agreed to incorporate acceptable SSAR revisions to its generic fuel licensing criteria to address the deficiencies. This is Confirmatory Item 4.2-1.

GE submitted, in Appendix C to SSAR Section 4, the set of control rod licensing acceptance criteria for the ABWR. These criteria describe the safety-related functional performance requirements for the control rods. The staff reviewed GE's criteria in Appendix 4C and proposed additions and modifications necessary to provide acceptable criteria. The changes which were provided in the GE response (1) removed a statement from the General Criteria indicating that a control rod design meeting the criteria did not require specific NRC review and (2) indicated that surveillance programs are to be implemented when changes in design features could impact the control function. Also, added to the bases for the criteria were (1) inclusion of irradiation effects to the stress and strain limits, (2) further details of inspection of lead depletion rods with new design features and (3) inclusion of crudding, crevices, stress corrosion effects upon control rod material. The GE responses were responsive and satisfactory. These criteria, as revised, are acceptable. This is Confirmatory Item 4.2-2.

Currently, there are GE control rod designs that have been reviewed and approved by the NRC which are suitably adaptable for the ABWR. These designs, in current use in GE BWRs, have been documented in the GE Topical Report NEDE-31756P, "GE Control Rod Designs," January 1990 (proprietary). Control rods of these designs (suitably modified by the elimination of the velocity limiter) that have been approved by the NRC are expected to be acceptable for use in the ABWR. GE has agreed to provide a description of the reference control rod blade design by reference to a specific design in NEDE-31756P. However, GE has not officially issued and has not indicated the specific design to be used in the ABWR. This was Open Item 14 in the draft safety evaluation report (DSER), SECY-91-153. The control rod design is Confirmatory Item 4.2-3.

Core flow patterns are expected to be uniform at the core inlet in normal operations as a result of flow distributions from the downcomer through the

RIPs, into the lower plenum, up through the orifices of the lower core plate, and into the fuel assemblies. Technical specifications (TS) will require at least 9 of the 10 RIPs to be in operation with the ABWR at 100-percent power operation. With fewer pumps in operation, restrictions are required to be compatible with transient and accident analyses (SSAR chapter 15), especially loss-of-coolant accident (LOCA). TS will require lowering maximum power to 95 percent if 8 RIPs are in operation, and 90 percent for 7 pumps, reducing power to 25 percent for 6 RIPs, and 5 percent for 5 RIPs, and shutting down within 24 hours for 4 RIPs or fewer. This is Technical Specification Item 4.4-1. GE asserts that, with the allowed number of RIPs inoperable, pump operation will be close to normal and bounded by one recirculation loop operation in current jet pump BWRs (with, in effect, half the pumps out) for which there are no restrictions other than similar-type LOCA power-density restrictions. The staff, however, requested GE to provide existing flow test results for operation of fewer than 10 RIPs to demonstrate there are no significant problems. The staff has not received this information. This is Confirmatory Item 4.4-1.

CHAPTER 5

OPEN ITEMS

GE performed the overpressure protection analysis for a typical core loading pattern. GE has submitted the proposed inspections, tests, analysis, and acceptance criteria (ITAACs) for SRVs and fuel, which are under staff review. The staff's evaluation will be included in the FSER. This is Open Item 5.2.2-1.

ASME Section XI indicates that the PSI should be conducted with equipment and techniques equivalent to those that are expected to be used for subsequent ISIs. Improvements in the ultrasonic testing of RCPB components will occur in the near future, as indicated by ASME Section XI, Appendix VII, "Qualification of Nondestructive Examination Personnel for Ultrasonic Examination," and Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems." The NRC has referenced in 10 CFR 50.55a(b) the ASME Section XI edition that includes the published Appendix VII. In addition, the NRC staff has established a technical contact to coordinate the implementation of Appendix VIII. Therefore, GE should include in its SSAR PSI program provisions that ultrasonic testing be performed in accordance with Appendices VII and VIII pursuant to 10 CFR 50.55a(g)(3). This is Open Item 5.2.4-1.

GE has provided the ITAAC regarding reactor coolant pressure boundary leakage detection for staff review. The staff will provide the results of its evaluation in the FSER. This is Open Item 5.2.5-1.

The materials surveillance program will provide information on the effects of irradiation on material properties so that changes in the fracture toughness of the material in the ABWR reactor vessel beltline region can be properly assessed and adequate safety margins against the possibility of vessel failure can be provided. The surveillance program must generate sufficient information to permit the determination of conditions under which the reactor vessel will be operated with an adequate margin against rapidly propagating fracture throughout its service lifetime. Based on a 40-year design life, ASTM E-185-82 recommends three materials surveillance capsules be installed in the reactor vessel beltline. However, for the ABWR, the design life is expected to be increased to 60 years. Accordingly, the staff finds that a need exists for GE to reassess the number of materials surveillance capsules to be provided to account for the additional 20-year increase in the expected life of the vessel. GE should revise its SSAR to address changes to the material surveillance program for the ABWR reactor vessel to account for the 60-year design life of the plant. The number and location of the vessel surveillance capsules are considered to be open items that need to be resolved prior to FDA. This is Open Item 5.3.1-1.

GE predicted the neutron fluence at end of life to be 6×10^{17} n/cm^2, which is low in comparison to the existing BWR design. GE will have to submit additional information during the final design approval review to show how 6×10^{17} n/cm^2 was predicted. This is Open Item 5.3.2-1.

GE has submitted the proposed ITAAC for the recirculation flow control system. The staff will review the GE submittal and will provide its evaluation in the FSER. This is Open Item 5.4.1-1.

GE has submitted the proposed ITAAC for RCIC system. The staff will review the GE submittal and provide an evaluation in a supplement to the FSER and will ensure that the above RCIC steam line isolation valve requirements are included. This is Open Item 5.4.6-1.

The staff reviewed the draft ITAAC for RHR system and sent its comments to GE. The staff will review the GE final ITAAC submittal when available and provide its evaluation in the FSER. This is Open Item 5.4.7-1.

As a part of the high/low pressure interface design review (Generic Issue 105, "Interfacing Systems LOCA at LWRs"), GE has proposed modification to the design pressure of the RHR suction piping from 1402 to 2104 kPa (200 psig to 300 psig). GE is currently assessing other interfaces in the design. The staff will evaluate the acceptability of GE's resolution to GI 105 and provide its results in the FSER. This is Open Item 5.4.7-2.

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As a vendor-specific issue, GE designed the RPV based on the 1989 Edition of the ASME Code, which is a national standard which has been referenced by 10 CFR 50.55a(b). The NRC staff reviewed the design of the RPV using the 1989 Edition of the ASME Code for its technical acceptability. The NRC staff reached the conclusion that GE's proposal related to the examination of the RPV as discussed above will be technically acceptable, subject to written confirmation in a revision to the SSAR and the ITAAC. The revision to the SSAR will indicate the fact that GE has designed the RPV based on the 1989 Edition of the ASME Code and the PSI will be performed in accordance with that same code edition, rather than the code in effect at the time of COL issuance (as required by 10 CFR 50.55(g)). In addition, GE will be adding to the RPV ITAAC and Tier I design information, a discussion of the PSI and the 1989 edition of the code. This is Confirmatory Item 5.2.4-1.

In response to Question 430.2c, the applicant provided information regarding the detection of intersystem leakage for systems connected directly to the RCS. This information should be incorporated into SSAR Section 5.2.5. This is Confirmatory Item 5.2.5-1.

CHAPTER 6

OPEN ITEMS

The water reentering the tailpipe (reflood) after the initial actuation of the SRV has been found in experiments to be transitory because the water column within the tailpipe does not reach equilibrium quickly. In addition, the tailpipe wall has not cooled to its initial temperature before the second actuation of the SRV. If the reactor system pressure should rise again to greater than the SRV set point, the SRV would discharge. However, the noncondensable gas from the drywell atmosphere that reentered the tailpipe through the vacuum breaker would have been heated by the tailpipe wall. This discharge (commonly called SRV air-clearing loads) could produce hydrodynamic wall pressures in the pool that may be significantly different from the initial air clearing loads because of the higher noncondensable gas temperature in the tailpipe. As a result, the staff concluded that loads from both the initial and second actuation should be considered in the design of the system. GE stated in its submittal of June 1, 1992, that both the first and possible second actuation were considered and the structures will be analyzed to accommodate these second actuation loads. GE stated that these analyses are scheduled to be completed prior to final design approval. This is Open Item 6.2.1.6-1.

Therefore, to resolve DSER Open Item 10, the staff concludes that GE should address the differences in load definition using the Mark III and II test data bases and determine the effect on structural response of possible differences from frequency signatures for both CO and CH loads. The use of the ABWR SS and FS tests without correlation to the Mark III test data base has not been demonstrated to be sufficient for modeling without full-scale vent pipe configuration and is unacceptable. This is Open Item 6.2.1.6-3.

GE is based on estimated pipe lengths, fittings, elbows, valves, and other hydraulic resistance components in the pipeline. This assumed hydraulic resistance (i.e., fl/D) constitutes part of the design basis for the ABWR and must be confirmed and adhered to in the actual as-built plant since deviations in such parameters as pipe routing, and numbers and types of valves could affect the results of the subcompartment analysis. This should be included in the ITAAC for ABWR Containment. GE has approved an ITAAC submittal which is currently under staff review. The staff evaluation will be included in the FSER. This Open Item 6.2.1.7-1.

Design Certification Material

Tier 1 design information and ITAAC are required for the ABWR containment. GE has submitted Tier 1 design information and ITAAC which are under staff review. This is Open Item 6.2.1.7-1.

Design Certification Material

Tier 1 design information and ITAAC are required for the functional design of the secondary containment. GE has submitted the proposed Tier 1 design information and ITAAC which are under staff review. The results of the staff's review will be provided in a supplement to this SER. This is Open Item 6.2.3.1-1.

Design Certification Material

The staff expects that the SGTS draw-down analysis will be included in the SGTS ITAAC. The Phase 3 ITAAC is currently under review. This is Open Item 6.2.4.1-1.

RG 1.141 contains guidance on the classification of essential versus nonessential systems. Each nonessential penetration (except instrument lines) is required to meet GDC 54, 55, 56, and 57 and shall be isolated automatically by the containment isolation signal. Essential systems, such as ESF-related systems or systems needed for safe shutdown of the plant, may include remote-manual containment isolation valves. GE has provided information on a system-by-system basis with containment isolation provisions. GE did not classify the systems into essential or nonessential to address the Three Mile Island (TMI)-2 requirements (NUREG-0737, Item II.E.4.2). This is Open Item 6.2.4-2.

In addition, in response to Q430.41, GE stated that instead of meeting the requirements of GDC 56 for the HPCS and RHR test and pump miniflow bypass lines, RCIC pump miniflow bypass line, RCIC turbine exhaust and pump miniflow bypass lines, and suppression pool cleanup (SPCU) system suction and discharge lines, the ABWR will use GE Safety Standard 20, No. 8 to No. 9. In the DSER (SECY-91-355), the staff stated that these standards do not meet the requirements of GDC 56, but instead provide less conservative criteria for containment isolation and were not acceptable for the ABWR design. The ABWR design must conform to GDC 56 unless a more detailed justification is provided for this deviation. This is Open Item 6.2.4-3.

In the DSER, the staff identified a concern that closure times for these valves, including instrumentation delay, should be determined by demonstrating compliance with 10 CFR Part 100 regarding offsite radiological consequences. The 30-second closure time should be justified based on an analysis of the radiological consequences of a LOCA. However, GE did not explain how the valve open/close times were determined, or that the radiological consequences of a LOCA meeting the requirements of 10 CFR Part 100. This is Open Item 6.2.4-4, which was part of identified Open Item 17 in the DSER.

GE proposes to design the ABWR purge and vent valves with both isolation valves located outside the primary containment to avoid the harsh environment of the wetwell and drywell and to remain accessible for inspection and testing during reactor operation. The staff believes that this arrangement will improve reactor operational safety. However, GE should still justify how the isolation barrier design can protect the containment integrity. GE has agreed to provide the design information in a future SSAR amendment. This is Open Item 6.2.4.1-1.

GE has provided adequate information to address the staff's concern with the exception of simultaneous venting of the drywell and wetwell. BTP CSB 6-4 prohibits simultaneous venting of the drywell and wetwell. GE should show how this will be ensured. This is Open Item 6.2.4.1-2.

GDC 54 requires redundancy in isolation systems for piping that penetrates containment. However, SSAR Figure 6.2-39 (Amendment 20) shows common CIVs for the containment purge supply (T31-F001 from the reactor building HVAC, T31-F025 from the 40-cm [16-in] nitrogen purge line, and T31-F038 from the 5-cm [2-in] nitrogen supply line) and exhaust (T31-F009 to the reactor building HVAC and T31-F008 to SGTS). The staff believes that this valve arrangement leaves the system vulnerable to common-mode failures. Each purge and exhaust line should have redundant and independent CIVs to comply with GDC 54. This is Open Item 6.2.4.1-3, which was identified as part of Open Item 18 of the DSER (SECY-91-355).

Design Certification Material

GE has provided ITAAC for the containment isolation system. The results of the staff's review will be provided in the final safety evaluation report. This is Open Item 6.2.4.1-4.

Post-LOCA primary containment backup purging capability will be provided in accordance with RG 1.7 and as an aid in containment atmosphere cleanup following a LOCA. During normal plant operation, the purge line also functions, in conjunction with the nitrogen purge line, to maintain primary containment pressure at about 0.75 psig and oxygen concentration below 4 percent by volume. This will be accomplished by makeup of the required quantity of nitrogen in the primary containment through the makeup line or relieving pressure through the purge line. Flow through the bleed line will be directed through either the SGTS or the secondary containment HVAC and will be monitored for radiation release. However, GE provided neither the purge rate that would be required to maintain the oxygen concentration below 4 percent by volume nor the radioactive consequences analysis for the staff to review. This is Open Item 6.2.5-1, which was identified as Open Item 20 in the DSER (SECY-91-355).

In SSAR Section 6.2.6.3.1, GE states that the Type C tests will be performed on all containment isolation valves required by Appendix J. All testing is performed pneumatically, except hydraulic testing may be performed on isolation valve Type C tests using water as a sealant provided that the valves will be demonstrated to exhibit leakage rates that do not exceed those in the ABWR standard technical specification. However, it should be noted that Type C testing with water is permissible only if the system line for the valve is not a potential containment atmosphere leak path. GE should provide the above design information in a future SSAR amendment. This is Open Item 6.2.6-1, which is part of Open Item 27 in the DSER (SECY-91-153).

(3) GE did not address test methodology for ECCS isolation valves. SSAR Section 6.2.6.3 does not mention this issue. GE will provide the above design information in a future SSAR amendment. This is Open Item 6.2.6-2.

(4) GE did not provide test procedures for valves not covered by Appendix J. GE will provide the above design information in a future SSAR amendment. This is Open Item 6.2.6-3.

(6) GE did not list all the valves that will be hydrostatically tested as addressed in SSAR Section 6.2.6.3.1. This is Open Item 6.2.6-4, which is part of Open Item 27 in the DSER (SECY-91-153).

(8) GE did not specify whether lines that contain valves that do not have 30-day water-leg seals will be drained before pneumatically testing the valves. This is Open Item 6.2.6-5, which is part of Open Item 27 in the DSER (SECY-91-153). GE will provide the above design information in a future SSAR amendment.

(1) GE did not indicate whether the test, vent, and drain connections used to facilitate ILRTs and LLRTs will be kept closed and under administrative control during normal plant operations and whether they will be subject to periodic surveillance testing to ensure their integrity and to verify the effectiveness of administrative controls. The staff finds that SSAR Section 6.2.6.3.1 did not address the staff's concern. This is Open Item 6.2.6-6. GE will provide the above design information in a future SSAR amendment.

<u>Design Certification Material</u>

GE has provided for staff review, the ITAAC regarding containment leakage testing. The results of the staff's review will be provided in a supplement to this SER. This is Open Item 6.2.6-9.

6.3.6 Design Certification Material

GE submitted the ITAAC for the HPCF system for staff review. The staff reviewed the GE submittal, provided comments to GE, and will provide supplemental SER input after GE submits the final ITAAC version. This ITAAC is Open Item 6.3.6-1. The ITAAC for SRVs, RCIC, and RHR are addressed in Sections 5.2.2, 5.4.6 and 5.4.7 of this report.

The following needs to be included in ITAAC. The COL applicant will need to verify that the as-built design; the operating, maintenance, and emergency procedures and training; and the performance characteristics of the Control Room Habitability system are consistent with the licensing basis documentation. The COL applicant will also need to verify that the technical specifications and surveillance procedures are consistent with the licensing basis documentation. This ITAAC is Open Item 6.4-1.

Until the above identified issues are resolved, the staff cannot conclude that the ITAAC provide adequate assurance that the plant will be built in accordance with the certified design. This ITAAC is Open Item 6.4-2.

Appendix 6B to Chapter 6 of the ABWR SSAR addresses the compliance status of the instrumentation provided for the SGTS with the requirements identified in

Table 6.5.1-1 of SRP Section 6.5.1. In Appendix 6B, GE has identified deviations from the instrumentation requirements listed in the table and has explained that such deviations were in part due to the single filter train proposed for the SGTS. However, the staff is still concerned with deviations from the minimum instrumentation identified in SRP Table 6.5.1-1, that will not be addressed by the addition of a second filter train. As stated above, the staff requires GE to revise the Appendix 6B to reflect the redundant filter trains and justify any remaining deviations from SRP Table 6.5.1-1. This is Open Item 6.5.1-1.

During its meeting with the staff on May 5, 1992, GE committed to provide an analysis to demonstrate that the use of the system during the inerting, deinerting, pressure control, or purging of the primary containment during normal plant operation will not impair its functional capability during a DBA. This is Open Item 6.5.1-2.

Based on the above information and concerns identified in Section 6.5.1 of this report, the staff concludes that GE has demonstrated the 99 percent removal efficiency assumed for the SGTS filter train for all forms of iodine based on compliance with RG 1.52 guidelines, and further concludes that the fission product control system provided in the form of the SGTS for the ABWR design has the capability to reduce the DBA doses to within 10 CFR Part 100 limits subject to the acceptable resolutions of the Open Items 6.5.1-1 and 6.5.1-2 in Section 6.5.1 of this report.

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In its letter of March 11, 1992, GE responded to this item by revising SSAR Section 9.3.9 to state that the hydrogen water chemistry system will utilize the guidelines given in EPRI NP-5283-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry" and EPRI report NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines: 1987 Revision," October 1988. This response is acceptable; however, GE should commit to follow EPRI NP-3589-SR-LD, "BWR Water Chemistry Guidelines," April 1985. This is Confirmatory Item 6.1.1-1.

Another part of Open Item 6 from DSER (SECY-91-355) was associated with the justification used to establish the pool dynamic loads for the ABWR. The ABWR suppression pool contains structures above and below the normal level of the pool (such as SRV tailpipes, access tunnels to the lower drywell, and a walkway within the suppression pool) which would be subject to pool drag and pool swell impact loads during the initial vent clearing and pool swell phenomena. The staff requested that GE provide the specific tests used to support the methodology to establish the hydrodynamic loads for the ABWR. GE committed to provide these tests in the SSAR. Since GE has identified the general data base that will be used and methodology to develop the hydrodynamic loads, but has not provided the submittal of the actual primary or secondary loads (wall pressure, thermal, drag, impact,etc.) the methodology for hydrodynamic load definition is considered acceptable. This closes out both parts of Open Item 6, which was identified in the DSER (SECY-91-355). This is Confirmatory Item 6.2.1.6-1. GE will provide the specific load definition design information in a further SSAR amendment.

Furthermore, in a conference call of May 19, 1992, and in a facsimile dated May 22, 1991, GE has committed to, but has not yet provided, a revised SSAR Table 6.2-2. This revised table will include the values of design differential pressure for each subcompartment in order to confirm that the margin between calculated and design peak differential pressure of 40 percent required by SRP Section 6.2.1.2 (II.B.5) is achieved for the ABWR. This 40-percent design margin is acceptable subject to the SSAR revision to reflect this commitment. GE is to provide the above design information in a future SSAR amendment. This is Confirmatory Item 6.2.1.7-1.

The staff has reviewed the revised Table 6.2-7 and finds that GE still did not identify which valves are locked closed. The staff also found a discrepancy between SSAR Table 6.2-7 (p 6.2-50.39) and Figure 9.5-1 (p 9.5-11) in which valve G51-F006 is not shown in Figure 9.5-1. GE stated that valve condition is detailed on system piping and instrumentation diagram (P&ID) as locked open/closed, normally open/closed, and normally energized/de-energized. For clarity, the staff determined that the valve closure condition also should be specified in Table 6.2-7. In discussions with the staff, GE has committed to making the change. This is Confirmatory Item 6.2.4-1. This will resolve part of Open Item 17 identified in the DSER.

In response to RAI Q430.254, GE committed to providing information showing compliance with BTP CSB 6-4, "Containment Purging During Normal Plant Operation." However, GE has agreed to provide this design information. This is Confirmatory Item 6.2.5-1, and was identified as part of Open Item 21 in the DSER (SECY-91-355).

SSAR Figure 6.2-40 shows redundant dedicated hydrogen recombiner penetrations. This satisfies the intent of this TMI issue. However, GE has committed to provide the design information in a future SSAR amendment. Information concerning the penetrations should be included in SSAR Section 6.2.5.2.7. This is Confirmatory Item 6.2.5-2.

In SSAR Section 19A.2.27, GE states that during normal power operation, all large valves in the containment ventilation lines will be closed and only the 5.1-cm (2-in) nitrogen makeup valves will be open. These valves are characterized as air-operated valves with fast closure times that will prevent substantial releases from containment should containment isolation be required. However, SSAR Figure 6.2-39 shows that T31-F007 and T31-F010 (36-cm [14-in] valves) also will be open during normal operation. The SSAR should be amended to correct this discrepancy. GE has agreed to this amendment. GE will provide this design information in a future SSAR amendment. This is Confirmatory Item 6.2.5-3.

For transient and accident events that do not directly produce a high drywell pressure signal (e.g., stuck open relief valve or steam line break outside containment) and that are further complicated by the loss of all high-pressure ECCS systems, manual activation of the ADS was originally required to provide adequate core cooling. However, NUREG-0737 TMI-2 Action item II.1.18 requires ADS logic modification to eliminate operator action. GE's proposed design modification is consistent with Option 4 of the BWR owner's group response to NUREG-0737 TMI-2 Action Item II.K.3.18. This option requires the addition of a timer that bypasses the high drywell pressure permissive if the reactor water level is low for a sustained period and addition of a manual inhibit switch. An 8-minute high drywell pressure bypass timer has been added to the ABWR ADS initiation logic. (An analysis was performed to evaluate the adequacy of the 8-minute bypass timer.) This timer will initiate on a low water level-1 signal. When the timer runs out, it will bypass the need for a high drywell pressure signal to initiate the standard ADS initiation logic. The bypass timer will be tested periodically. This test will be required by the technical specifications. This is Technical Specification Item 6.3.3-1. This timer can be bypassed as indicated in the ABWR EPGs if the operator determines that water level can be maintained above TAF. The proposed GE modification to ADS logic is consistent with the staff approved solution to II.K.3.18 and is acceptable because it assures the initiation of ADS and low-pressure injection systems when high drywell pressure does not occur. In the DSFR (SECY-91-153) the staff identified concern about the ADS in Open Item 28. The above discussion on bypass timers reflects that Open Item 28 has been resolved. Assurance that the proposed modification to the ADS logic is Confirmatory Item 6.3.3-1.

The DSER stated that Appendix 6A to Chapter 6 of the ABWR SSAR demonstrates the system's compliance with each of the regulatory positions in RG 1.52, Revision 2, except one relating to the requirement for redundancy in filter train. Originally, the SGTS design included only a single filter train. The DSER (SECY-91-153) identified the use of a single filter train in the SGTS as an open item (#30). By submittal dated February 13, 1992, GE provided P&ID's for a number of systems including the SGTS. The SGTS P&ID shows provisions of two filter trains for the system. Therefore, this issue is resolved, subject to revision of: SSAR Section 6.5.1; Table 6.5.1-1; SSAR Appendices 6A and 6B to reflect the two filter trains in the system; and layout of drawings to reflect appropriate location and space requirements for the two filter trains. This is Confirmatory Item 6.5.1-1.

CHAPTER 7

OPEN ITEMS

SSAR Table 7.1-2 lists the applicable general design criteria (GDCs) for the I&C chapter. SSAR Section 3.1 discusses each GDC generally and lists references to other SSAR sections for specific system application of the GDC. GDC 3, 26, 27, 30, 37, 42, 43, 55, and 56 are listed in the SSAR Chapter 3 as being included in Chapter 7. In the Chapter 7 GDC listings, however, these GDCs do not appear but should. In addition, GDC 2, 15, 38, are listed in SSAR Chapter 7, but there is no corresponding reference to Chapter 7 in the Chapter 3 discussions. These discrepancies need to be corrected in an amendment to the SSAR. This is Open Item 7.1.3.1-1.

The staff has issued the final safety evaluation report (FSER) for the EPRI Evolutionary Plant RD and has requested that GE provide clear, detailed documentation as to how the ABWR design differs from the EPRI ALWR Evolutionary Plant RD, and how the design complies with the EPRI requirements. This is also discussed in Chapter 1 of this report as Open Item 1.1-1. This was identified in SECY-91-294 as DSER Open Item 4.

Because the design detail for the ABWR is not available, the staff has concluded that it is necessary to review both the SSAR and the ITAAC and DAC to reach design certification material safety conclusion. Because the ITAAC and DAC are still under review (as a result of their late submittal), the development of the I&C generic ITAAC (which include Instrument Setpoint Methodology, Equipment Qualification, Safety System and Logic Control, and Computer Development), and development of the DAC (which include Software Management, Configuration Management, and Verification and Validation) is considered Open Item 7.1.3.3-1 which must be resolved before the staff can reach its final safety determination.

The staff believes that the inclusion of this fourth prototype point in the ITAAC and DAC would serve two primary purposes. First, this prototype would verify that the design is being implemented as certified and that the previous requirements have been met. Second, this prototype would establish the more detailed acceptance criteria for the next step (described below). At a minimum, the staff believes that this prototype should have one full channel of the SSLC using hardware and software similar to the intended final product. However, the staff has not concluded which specific system or generic ITAAC and DAC this prototype step would be included in, since the ITAAC and DAC are still being developed and evaluated. This item is included as part of the Open Issue 7.1.3.3-1 discussed above on the ITAAC and DAC.

The ITAAC and DAC and Tier 1 description for the neutron monitoring system (NMS), including the OPRM, have not been submitted for review. Therefore, the NMS ITAAC and DAC and Tier 1 description is Open Item 7.1.4-1.

Since the DSER (SECY-91-294) was written, GE has provided some additional detail, committed to a greater number of industry standards, and submitted the ITAAC and DAC which will include the DAC design process. The staff now concludes that the improved level of design detail presented for the RPS by GE will be sufficient to permit a final safety conclusion, when evaluated in combination with the commitments to standards, and the ITAAC and DAC process discussed above (which will require extensive NRC auditing during design implementation). Therefore, this DSER (SECY-91-294) Open Item 1 is now part of Open Item 7.1.3.3-1. (Note that the safety determination will be made after all ITAAC and DAC have been reviewed and approved.)

In the DSER, the staff noted that the SSAR did not present a detailed failure modes and effects analysis (FMEA) to ensure that all postulated failures result in a known safe state if the RPS experiences conditions such as disconnection of the system, loss of energy or a postulated adverse environment. Therefore, the staff could not evaluate GE's conformance to GDC 23, "Protection System Failure Modes," and this was Open Item 3 in the DSER (SECY-91-294). Open Item 3 has since been resolved by FMEAs submitted by GE and studies performed by contractors to the staff. However, these studies indicate that some aspects of this issue relate to the issue of potential common mode failures. This FMEA issue is closed, but the potential common mode failure issue, and the required redundancy and diversity are Open Items 7.2.6-1 and 7.2.6-2, respectively, are discussed in Section 7.2.6 of this report.

The SSLC Tier 1 design description, ITAAC, and DAC, in addition to the RPS description, are part of Open Item 7.1.3.3-1. The SSLC configuration for the RPS and MSIV initiation from the Tier 1 design description is included as Figure 7.2-1. Figure 7.2-2 is the Tier 1 SSLC logic and control block diagram which shows the interconnection of the RPS and ESF systems.

The ABWR EMS uses microprocessors to control the movement of data from the sensors to the SSLC, between the individual components of the EMS, and from the SSLC logic to the actuated devices (for the ESF systems). The high-level block diagrams of the data signal paths are simple and direct. However, in a microprocessor-based system, the software implied in the blocks of the system diagram can mask much of the safety system's design complexity. Moreover, in a microprocessor-based data transport system, the software is an essential line element in the execution of the safety system functions. For this reason, the staff concluded in the DSER that the EMS design did not provide the appropriate level of detail essential to the staff's review. This was identified as an Open Item 1 in the DSER (SECY-91-294). GE has since committed to use several additional software development standards in the SSAR. This commitment, in conjunction with the proposed ITAAC and DAC for Computer Development (Open Item 7.1.3.3-1), resolves this issue. The software is addressed further in Section 7.2.8 of this report.

The staff concludes that the combination of additional information concerning information transmittal, commitment to additional standards concerning multiplexing and error handling, and the proposed ITAAC and DAC for the EMS (part of Open Item 7.1.3.3-1) provides sufficient information. Therefore, DSER Open Item 2 is closed.

MPL A32-4080, "EMS/SSLC Interface Requirements, Requirements Specification" (Revision 0, dated April 25, 1990), requires that the TLU include a watchdog timer function on all outputs to ensure constant updating. Time-out will cause outputs to assume predetermined safe states. GE has not presented these predetermined states. Therefore, these must be included in the ITAAC and DAC verifications. This is Open Item 7.2.2.3-1.

The TLUs in each of the four RPS divisions, are essentially identical, with the exception of identification and small timing differences. The TLUs are also similar to the safety system logic units (SLUs) of the ESF functions. The TLUs will have significantly different software algorithms, but the operating system, the self-diagnostics, and the input/output will be identical. Consequently, the staff is concerned that the TLUs could be vulnerable to a potential common-mode software failure similar to the DTMs. This is Open Item 7.2.6-1 in this report and is discussed further in Sections 7.2.6 and 7.2.8.

GDC 22 requires that design techniques, such as functional diversity or diversity in component design and principles of operation, be used to the extent practical to prevent loss of the protection function. NUREG-0493 provides further discussion. Although GE performed some studies during the design process, no analyses have been presented to the staff to demonstrate how the SSLC design complies with NUREG-0493 to prevent or mitigate potential common-mode failure. GE also did not present hardware design controls which conform to current criteria and standards (in particular, for hardware diversity). The common-mode failure is complicated by the fact that GE has not yet provided the design details that would allow the staff to independently assess the diversity and defense-in-depth of the design (discussed below as Open Item 7.2.6-2). As previously discussed, this is expected, given the evolution of this technology. The staff concludes that GE has not adequately addressed the common-mode failure potential of the ABWR software. This was Open Item 10 in the DSER (SECY-91-294) and is now Open Item 7.2.6-1 in this report. After determining that the ABWR SSAR and related documentation do not adequately address this concern, the staff completed a common-mode failure assessment of the ABWR based upon the guidance of NUREG-0493. This assessment resulted in some additional considerations to the original NUREG-0493 approach, such as consideration of information available to the operator, the time available for systems actuation, and the use of non-Class 1E systems to provide a diverse means of accomplishing the primary safety function if the safety system fails.

The LLNL diversity study identified several areas of concern. Two significant concerns involved the shared use of the EMS for the RPS, ESF, and operator information displays, as well as the common elements shared with the DTMs and TLUs. The study identified that the ABWR design provides information and controls to mitigate each of the transients investigated. However, as there was limited information available, the staff is concerned that there may not be time and information to manually complete the mitigation, and the use of the remote shutdown station may not be acceptable. This is an Open Item 7.2.6-3.

- GE has stated that the relative simplicity of the SSLC software will result in a high degree of assurance that the required testing will reveal virtually all of the errors. In addition, GE has stated that the EMS software is even simpler than the SSLC software. However, GE has not yet provided any supporting analyses to support these statements. This is Open Item 7.2.6-4. The staff concludes that software, even that which has been verified and validated with a high quality program, may still have undetected errors.

The results of the LLNL defense-in-depth study and the recommended staff position have been presented to GE. The recommended staff position reflects the staff's four primary concerns arising out of the review. The staff concludes that the response to the initiating event must be confined to the main control room, analysis of the time available for manual operator actions is incomplete, there is a lack of necessary system-level actuation from the control room for the ESF functions, and there is a lack of necessary Class 1E variables displayed in the main control room. The staff requested that GE complete its review of the LLNL diversity study and respond to the concerns identified in the staff position as described in the draft Commission paper. This has not been completed and is part of Open Item 7.2.6-1 concerning common-mode failure (discussed above). The staff also requested that GE prepare a list of conventionally hard-wired equipment in accordance with requirement 4 listed above. GE has completed its review using events that GE believes envelope the events identified in Chapter 15. GE has stated that they disagree with the position that the staff has taken on this issue and currently propose that the staff reconsider. GE has stated that they have adequate defense-in-depth and diversity and the staff position should consider the likelihood of the events in conjunction with the postulated common-mode failures and allow credit for the ability of the RSS to mitigate the event. This is part of Open Item 7.2.6-2.

GE submitted Tier 1 design description, ITAAC, and DAC for setpoint methodology in Chapter 3.2 of the damage control measure (DCM) which are under staff review. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.1.3.3-1, discussed earlier in this chapter. The ITAAC for setpoints will require a plant-specific setpoint analysis, in accordance with RG 1.105, which details the procedure and establishes specific setpoints. The NRC will audit and approve this analysis on a plant-specific basis.

The ABWR SSLC depends upon the proper functioning of the software to perform the safety functions. The current software-specific is standard ANSI/IEEE ANS 7-4.3.2 (1982) which the staff formally endorsed in RG 1.152. ANSI/IEEE ANS 7-4.3.2 is a high-level description of a verification and validation (V&V) process. Since it was published in 1982, several other standards have been issued which provide better guidance for V&V. In addition, software qualification involves several aspects other than V&V. ASNI/IEEE ANS 7-4.3.2 is currently undergoing significant revision and is expected to be reissued soon. The ABWR SSAR stated that software development will generally follow this standard. The staff considered this statement to be equivocal, and requested that GE provide a clear commitment to the software development process. This issue also relates to the GDC 1 issue, (closed in Section 7.1.3.2 of this report) concerning commitments to industry standards. In addition, this issue was part of Open Item 1 from the DSER (SECY-91-294) concerning level of detail. Because the SSLC software has not yet been developed, the staff has no available method to verify that the software will conform with ANSI/IEEE ANS 7-4.3.2. This is part of Open Item 7.1.3.3-1 discussed earlier in Section 7.1.3.3 of this chapter.

GE submitted in Chapter 3.2 of the DCM Tier 1 description, ITAAC and DAC for the ABWR computer development. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.1.3.3-1 discussed earlier in Section 7.1.3.3 of this chapter.

GE has agreed to provide a safety and hazards analysis, a sneak circuit analysis, and a timing analysis. In addition, the staff has requested that GE provide a description of the specifics of these analyses in the SSAR. These analyses will also be included in the computer development ITAAC and DAC. This is Open Item 7.2.8-1.

GE has submitted in the DCM, Tier 1 design description, ITAAC and DAC for equipment qualification. This is part of Open Item 7.1.3.3-1 discussed earlier in Section 7.1.3.3 of this chapter. The results of the staff's review will be provided in the FSER.

The DSER (SECY-91-294) noted an open issue (Open Item 1) concerning the level of detail provided for the ESF systems. The staff finds the level of detail available for review without appropriate ITAAC and DAC, remains inadequate. GE submitted in the DCM, Tier 1 design description, ITAAC and DAC for the SSLC. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.1.3.3-1, discussed earlier in Section 7.1.3.3 of this chapter. This closes DSER Open Item 1.

The potential for common-mode software problems may also exist with the ESF systems. This was Open Item 10 in the DSER (SECY-91-294). In the DSER, the staff noted that GE had not provided a detailed FMEA for these actuation systems to complete the conformance to the IEEE 279 requirements and the NUREG-0493 defense-in-depth analysis. This was identified as Open Item 3 in the DSER, and is now included in Open Item 7.2.6-1 discussed previously in this report, concerning the potential for common-mode failures.

GE submitted in the DCM, Tier 1 design description and ITAAC for all of the systems discussed in this section for staff review. The results of the staff's review will be provided in the FSER. This is Open Item 7.4.1-1.

As stated above, GE has submitted for staff review, Tier 1 design description and ITAAC for the ARI system. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.4.1-1.

The ARI function and SLCS instrumentation are considered part of the resolution to the potential common-mode failure of the EMS and SSLC systems as a result of EMI effects, software operational problems, or other such effects. The analysis to resolve this issue also must consider the operation of these systems during the events discussed in SSAR Chapter 15, in combination with postulated safety system failures. In addition, the analysis may also need to reconsider how the systems described in this section will operate. Specifically, RSS operation may require a reconsideration of the equipment involved. This is part of the common-mode failure analysis, which is an Open Item 7.2.6-1 discussed in Section 7.2.6 of this report.

The reviewers identified the instrumentation and controls that permit actions intended to maintain the reactor in a safe condition during shutdown. The ABWR design provides for equipment outside the control room to enable shutdown to cold shutdown conditions. Use of the remote shutdown station for additional events is under staff review, and the results will be provided in the FSER. This is Open Item 7.4.2-1.

GE has submitted for staff review in the DCM, Tier 1 design descriptions, ITAAC and DAC for the interlock systems important to safety. The results of the staff's review will be provided in the FSER. This is Open Item 7.6.1-1.

GE has submitted in Section 2.2.5 of the DCM, Tier 1 design description and ITAAC for the NMS. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.6.1-1 described above.

GE has submitted in Section 2.3.1 of the DCM, Tier 1 design description and ITAAC for the process radiation monitoring system. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.6.1-1 described above.

GE submitted in Section 2.6.2 of the DCM, Tier 1 design description and ITAAC for the fuel pool cooling and cleanup system. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.6.1-1 described above.

GE submitted in Section 2.3.4 of the DCM, Tier 1 design description and ITAAC for CAMS. The results of the staff's review will be provided in the FSER. The is part of Open Item 7.6.1-1 described above.

GE submitted in Section 2.4.9 of the DCM, Tier 1 design description and ITAAC for the SPTM system. The results of the staff's review will be provided in the FSER. This is part of Open Item 7.6.1-1 described above.

GE submitted in the DCM Tier 1 design description and ITAAC for the above listed systems. The results of the staff's review will be provided in the FSER. This is Open Item 7.7.1-1.

GE did not identify the communication systems as having a safety-related function, however these systems are used during emergencies. If the communication systems are to be used when the plant is under control of the RSS, GE must demonstrate the availability of the communications systems, assuming a main control room fire. This is Open Item 7.7.1.15-1.

GE also did not identify the EMI radiation levels or frequency range for the communication transmitters and receivers which may be installed in the plant. In addition, GE did not define the sensitivity of the safety-related computer systems, with regard to the electromagnetic fields. Therefore, a test program with field measurements and operational descriptions is required to be included in the ITAAC in order to avoid spurious effects upon safety-related equipment. This is Open Item 7.7.1.15-2.

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The DSER (SECY-91-294) identified (in Section 7.4.1.2) as Open Item 7, the lack of automatic initiation capability for the standby liquid control system (SLCS). GE has since committed in the SSAR Chapter 9 to provide automatic initiation for this system, and has included this capability as a Tier 1 design certification requirement that will be verified during the ITAAC and DAC process. However, SSAR Section 7.1.1.4.2 has not yet been revised to reflect this change. Therefore, this is Confirmatory Item 7.1.4-1.

SSAR Section 7.2.1.1.4.2 lists the initiating RPS circuits, which include the conditions listed above, as well as a reactor trip on high seismic activity. GE has stated that the latter was inadvertently included and will be deleted. GE must also make the necessary revisions to remove the seismic trip from SSAR Figures 7.2-9a, 7.2-10l through 7.2-10n, 7.2-10ai through 7.2-10al, 7.2-10au through 7.2-10az, 7.2-10ba, and 7.2-10bb (all in SSAR Amendment 5), as well as several additional sections throughout SSAR Section 7.2. This is Confirmatory Item 7.2.1-1.

The staff concludes that the SSAR states commitments concerning compliance with Institute of Electrical and Electronics Engineers (IEEE) 279-1971 for the

NMS. In addition, in response to NRC Bulletin 88-07, "Power Oscillations in Boiling Water Reactors", GE committed to implement the BWROG solution of installing an OPRM system. This is Confirmatory Item 7.2.1-2. The NMS and the OPRM are described in more detail in Section 7.6 of this report.

The second primary function of the RPS is the command function, which is implemented using the logic of the SSLC. The RPS automatically initiates rapid insertion of the control rods to shut down (scram) the reactor when warranted by any one of the predetermined conditions (listed above). The scram is initiated by means of four redundant divisions of sensor channels, trip logic, and trip actuators, and two divisions of manual scram controls and scram logic circuitry. In most instances, the EMS (described in Section 7.2.2.1) encodes the analog sensor channel output signal or contact position into a digital message, then transmits the message via an optical data link to a central decoder, which presents the signal to the DTM. In this manner, the EMS transmits data to the DTM (described in Section 7.2.2.2) from the reactor pressure transducer, reactor water level (Level 3) transducer, drywell pressure sensor, and low control rod drive charging header pressure sensor. The exceptions to this EMS-to-DTM pathway include the manual scram, which bypasses both the EMS and DTM, since it is hard-wired from the main control panel directly to the TLU. Other exceptions include the main steam isolation valve position switches, which are hard wired to the DTM, as are the main steamline radiation monitors, turbine stop valve closure, and turbine control valve fast closure inputs. (That is, they transmit their input directly to the DTM, without using the EMS.) The SSAR text and figures currently indicate that the turbine inputs are multiplexed, and GE will revise the information accordingly. This is Confirmatory Item 7.2.1-3.

The figures provided in SSAR Section 7.2 have many indications of "later" where specific details have not yet been filled in. This is Confirmatory Item 7.2.1-4 and will be resolved as the drawings are finalized.

MPL DMH-4270, "Essential Multiplexing System Design Specification" (Revision 2, dated February 3, 1989), states that the bit error rate "theoretically" shall be less than 10^{-9}. This is consistent with the FDDI requirements, and is also an ITAAC and DAC commitment. This document also states that the RMU and CMU shall have the capability to transmit the data at the rate of 1 megabit/sec (Mbps). The FDDI standard is essentially a 100-Mbps system. This is an example of an MPL revision that must be required and will be verified during the ITAAC and DAC phase. The EMS will be capable of sampling a sensor with a 10-msec sampling rate, but the actual sampling rate for each sensor has not yet been determined. The maximum transmission distance for any single multiplexing station will be 500 meters (approximately 1640 ft). The ITAAC and DAC must verify the maximum distance, and this is Confirmatory Item 7.2.2.1-1. The common-mode noise rejection must be 40 dB or greater, and the analog to digital (A/D) conversion will be with a minimum of 12-bit resolution for both the input and output. The overall accuracy of both the input and output shall be less than 1.4 percent full scale. This accuracy must be included in the setpoint methodology ITAAC and DAC and is Confirmatory Item 7.2.2.1-2.

In Section 7.2 of the SSAR, GE must clarify which sensors will use the EMS. For example, SSAR Section 7.2.1.1.4.2(6) describes the turbine stop valve closure input as using the EMS; this is not consistent with other information provided by GE. GE has committed to revising the SSAR to show the correct list of sensors which use the EMS. This is Confirmatory Item 7.2.2.1-3.

Figure 7.A.2-1 in SSAR Appendix 7A shows all sensor signals sent via the EMS. GE must revise this drawing to make it consistent with the distribution of the sensor inputs to the DTM, as described above. GE has committed to revising the SSAR to reflect the accurate listing of sensors which use the EMS. This is Confirmatory Item 7.2.2.2-1.

GE originally classified the STS as safety-associated and stated that Class 1E equipment would be used wherever the STS interfaced with safety equipment. The staff was concerned that the test features were not classified as Class 1E and identified this as an open item in the DSER. The staff was also concerned about the master/slave configuration and the potential that the STS would cause substantial problems with the SSLC and possibly violate the separation requirements of the SRP. The revised design is now substantially integrated into the SSLC, and GE has committed that all STS equipment will be qualified as part of the SSLC. The revised description has also resolved the other issues raised in the DSER. This is acceptable and the DSER open item is closed. The STS for all safety systems other than the SSLC must also be Class 1E. This has not been explicitly stated and is Confirmatory Item 7.2.2.5-1.

One significant feature of the testing described by GE is the elimination of the need to lift leads and install jumpers to perform testing. This has been a significant problem area at operating plants. This is a design feature which GE has committed to include in the Tier 1 requirements. This is Confirmatory Item 7.2.2.5-2.

The staff reviewed ABWR SSAR for commitments to RG 1.47, Position C.2, which requires that the bypassed and inoperable status of RPS auxiliary or supporting systems be automatically indicated in the main control room. The description in the SSAR indicates that adequate indication and annunciation for these systems will be provided in the main control room. The indication will be automatic at the system level when the system loses power or when it is out of service. A switch will be provided for manual initiation of bypass indication for out-of-service conditions that could not automatically be annunciated. The staff concludes that GE provides adequate commitment to RG 1.47. Verification that all bypasses are appropriately annunciated will be included in the ITAAC and DAC. This is Confirmatory Item 7.2.3-1.

SSAR Chapter 8 and the corresponding SER section discuss the plant station power. For the SSLC, the power is supplied by four independent and separate Class 1E 120 Vac sources, which are each backed up with a Class 1E, 125 Vdc battery source through an invertor. Divisions 1 and 4 are supplied from the same 480 Vac source, as indicated by SSAR Figure 8.3-6. GE must revise SSAR Figure 7.2-1 to reflect the power supply design, since that figure incorrectly shows a fourth division of 480 Vac power. GE has committed to revising

Chapter 7 of the SSAR to reflect the electrical distribution as described in Chapter 8 of the SSAR. This is Confirmatory Item 7.2.5-1.

Second, the EPAs will reduce the possibility that the scram pilot solenoid valves will stick as a result of damage by insufficient voltage supply to the solenoid coils. The ABWR design requires both coils to disengage when power is removed to initiate a scram. The EPAs will detect an undervoltage condition and should remove the power cleanly before the coils are damaged. Normal voltage drop between the EPAs and the solenoid coils must be included in the design considerations. The ITAAC and DAC for the EPAs must include a verification that the wiring to the solenoid valves is sized so that normal voltage drop in the cables will not result in insufficient voltage being supplied to the solenoid coils. The ITAAC and DAC also must include a verification that the neutral leads of the scram pilot solenoid valve coil windings are configured so that credible faults (such as hot shorts) will not prevent the valves from performing their safety function. GE has verbally committed to include the EPAs in the ABWR design. These issues are Confirmatory Item 7.2.5-2.

GE has also committed in the SSAR to the use of software metrics to track error rates during development. Inclusion of this into Tier 1 ITAAC is Confirmatory Item 7.2.8-1. However, GE has not specified a particular software metric, since this will probably be selected by the final software vendor and is an area that may change over the lifetime of the design certification. This is COL Action Item 7.2.8-1.

One area of software design which has not adequately been addressed in either the SSAR or the DCM concerns the commercial dedication of software for use in a safety system. This issue involves several concerns which need to be addressed. GE has stated a verbal commitment to these items, which are discussed below. The specific wording to be included in the SSAR and is Confirmatory Item 7.2.8-2.

A related issue involves the staff's concern that errors discovered in the suppliers' tools or software are identified to the end user. This is similar to the process required by the 10 CFR Part 21 for Class 1E vendors. GE has agreed to add a method for identifying these errors to the end user that will be included in the ITAAC and DAC. This is Confirmatory Item 7.2.8-3.

The COL applicant will select specific test categories from within the standards. The appropriate selection will be verified by the ITAAC. EMI will either be listed as part of a generic environmentally qualified (EQ) ITAAC or will have its own specific ITAAC. One specific feature that GE agreed will be included as a Tier 1 requirement is that the equipment will be tested for the low range of the EMI spectrum, as well as the middle to upper ranges. This is Confirmatory Item 7.2 8-4.

The third aspect of software design which has not adequately been addressed in the SSAR or DCM primarily concerns the qualification of the SSLC equipment for the temperature profiles that may occur. In particular, one issue concerned local hot spots that may occur as a result of higher current densities when using digital chip designs. GE has committed in the SSAR to maintain a temperature rise in the SSLC of 15 °C (27 °F). This is part of Confirmatory

Item 7.2.8-5. For qualification, the panel will be cooled with natural convection only. Fans may be used to improve long-term reliability, but no credit will be given for thermal qualification.

GE has stated that the SSLC will be constructed from electronic components purchased to military specifications and qualified by testing to a higher temperature than required in the SSAR for a given room environment. The staff agrees that it is desirable to have this additional margin built into the design. GE is evaluating the specific temperature that will be listed in the SSAR. This is part of Confirmatory Item 7.2.8-5. (See the preceding paragraph further discussion of this confirmatory item.)

The SLU architecture is arranged so that each SLU function has a dual SLU performing the same function. The component shown as SLU 1 in Division I on Figure 7.2-? actually comprises two SLUs. Both SLUs receive the same input from the DTM, manual controls, and bypasses. Both SLUs must agree before the initiation signal is processed to the actuated equipment. This two-out-of-two voting arrangement occurs at the remote multiplexing unit. A single failure of an SLU or EMS will not initiate an ESF function. With the exception of the containment isolation signals, the ESF system logic is a fail-as-is condition. Figure 1 of MPL A31-4030, "EMS/SSLC Interface Requirements, Requirements Specification" (Revision 0, dated April 25, 1990), uses the term auxiliary supporting features logic for part of the safety system logic unit SSLC. The SSAR and Tier 1 description use the term SLU for the same device. GE has committed to resolve this discrepancy, and this is Confirmatory Item 7.3.2-1.

The RCIS is not classified as a safety-related system, but it is described as a single-failure-proof, high-reliability, and high-availability design. The level 2 reactor vessel water level signal is provided through the ESF portion of the SSLC and the sensors are, therefore, classified as Class 1E. The SSLC shares the EMS with the RPS; however, the ARI description provided by GE in the SSAR does not clarify that the RPV level 2 inputs to the SSLC are hard-wired and, therefore, would not share common equipment with the RPS input. GE has committed to clearly stating this configuration in the SSAR. This is Confirmatory Item 7.4.1.1-1. The non-safety-related systems used for the ARI are discussed in SSAR Chapter 7.7 and the staff's review is discussed in Section 7.7 of this report.

10 CFR 50.62 defines the requirement for a reactor shutdown system to provide operational transients. In addition, GE has submitted a proprietary topical report (NEDE-31096-A), which the staff approved for previous, operating BWR designs. In response to the staff's questions, GE has stated its intent that the ABWR design fully conform to NEDE-31096-A. This is Confirmatory Item 7.4.1.1-2.

In Q420.15, the staff requested that GE provide additional clarification of the intended use of the RSS and the degree of its isolation and independence from the SSLC and EMS. In its response, GE stated that the RSS is totally separate and independent from the SSLC and EMS because it is hard-wired and does not use multiplexed signal interfaces. Inclusion of this clarification into the SSAR is Confirmatory Item 7.4.1.4-1. These panels play a role in the common-mode failure, which is discussed in Section 7.2.6 of this report.

Among the manual action variables required for reactor shutdown from outside the control room, SSAR Table 7.5-7 lists drywell pressure. However, the parameters listed in SSAR Section 7.4 for display on the remote shutdown panel do not include this parameter. GE has stated that this parameter is not required for shutdown using the RSS without a design-basis event, and it should, therefore, not be listed in the table. This is Confirmatory Item 7.5.2-1.

The staff finds that the Option III LPRM-based oscillation power range monitor system is the preferred method of addressing stability. The OPRM system satisfies the guidelines specified in the EPRI ALWR Utility Requirements Document. Subject to final approval of NEDO-31960 discussed above, the staff finds that GE's SSAR design commitment to implement the NRC-approved OPRM system in the ABWR design will be acceptable. This is Confirmatory Item 7.2.1-2 and is discussed in Section 7.2.1 of this report.

Separate electrical divisions power the inboard and outboard containment and pressure isolation valves for each of the three RHR trains. The valves use permissive logic, which prevents them from being opened when reactor pressure is greater than RHR design pressure, or when reactor level is less than level 3. These signals are provided by four divisional sensors in a two-out-of-four logic algorithm. These valves also receive a signal to close when the reactor vessel pressure is high or the reactor level is above level 3. The description of this interlock in SSAR Section 7.6 includes an inconsistency concerning the water level, which GE has committed to correcting. This is Confirmatory Item 7.6.1.3-1. An additional interlock is provided from the RHR area ambient temperature, and relief valves are provided to protect against overpressurizing the RHR system.

The staff has reviewed MPL C71-4010, "Reactor Protection System Design Specification" (Revision 1, dated July 2, 1990), which requires that the process computer log both the tripped and reset conditions of the RPS-related sensor instrument channels and the RPS automatic or manual trip systems. According to this MPL, the computer must identify the specific trip variable, divisional channel identity, and specific automatic or manual trip system for all conditions that cause a reactor trip. GE has agreed to add this requirement to the Tier 1 description, ITAAC and DAC for the process computer. This is Confirmatory Item 7.7.1.5-1.

The EPRI Requirements Document generally describes the operating experience necessary before equipment should be considered for use in nuclear power plants. The general guideline is approximately three years of successful experience in applications similar (but not necessarily nuclear) to the intended nuclear power plant installation. Failure to satisfy this guideline results in increased prototyping requirements. GE has committed to the EPRI guidelines and the staff finds this acceptable. Confirmation that these guidelines have been incorporated into the SSAR and ITAAC is Confirmatory Item 7.10.2-1.

One significant feature of the testing described by GE in Chapter 7 (Section 7.1) of the SSAR is the elimination of the need to lift leads and install jumpers to perform testing. This has been a significant problem area at operating plants. This feature should be included as a Tier 1 requirement, and is Confirmatory Item 7.2.2.5-2, as discussed in Section 7.2.2.5 of this report.

CHAPTER 8

OPEN ITEMS

10 CFR Part 52.47(a)(1)(viii) requires that interface requirements shall be verifiable through inspections, tests, or analyses and that the method to be used for this verification be included as part of the ITAAC. The Design Certification Material for the GE ABWR Design Stage 2 Submittal, transmitted by letter dated April 6, 1992, did not specify the appropriate interface-related ITAAC material for the offsite systems outside the ABWR scope of design. ITAAG must address this interface area. This is Open Item 8.2.1.4-1.

Design commitments relating to the physical separation of transformers should be included in the Standard Electrical ITAAC and Tier 1 information. GE has provided the Phase 3 submittal including proposed ITAAC, which is under staff review. This is Open Item 8.2.2.1-1.

Design commitments relating to the physical separation for circuit should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.1-2.

Design commitments relating to the physical separation of power, instrumentation, and control for the offsite power system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.2-1.

Design commitments relating to electrical independence should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.3-1.

The design commitments related to testing for the offsite power system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.2.4-1.

Design commitments relating to the capacity and capability of the offsite power system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.2.6-1.

Design commitments relating to the grounding and lightning protection should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.2.7-1.

Design commitments relating to the electrical independence between offsite circuits and onsite class 1E DC system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.1-1.

Design commitments relating to the electrical independence during loss of, or degraded, offsite voltage should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.2-1. Design commitments relating to LOCA during parallel operation should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-1.

Design commitments relating to LOPP during parallel operation should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-2.

Design commitments relating to the diesel generator protective relaying when the diesel generator is operating in parallel with the offsite system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.3.3-4.

Design commitments relating to the synchronizing interlocks should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-4.

Design commitments relating to the independence of safety-related systems from the influences of non-safety load during operation and/or failure, should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.4-1.

In addition, Figure 8.3.1 of the draft SSAR revision dated April 3, 1992, indicated that the offsite power connection from the reserve auxiliary transformer is normally supplied through the Division 2 Class 1E equipment areas to the Division 3 load group. Similarly, GE has indicated that the offsite connection from the unit auxiliary transformers is normally supplied through the Division 1 and Division 3 Class 1E equipment areas to the Division 1 and Division 2 load groups. To further minimize the likelihood of interaction between the offsite and onsite systems, the staff contends that the normal configuration for the connection of the offsite circuit to the onsite Class 1E distribution system should be configured with the reserve auxiliary transformer normally connected to the Division 2 load group and the unit auxiliary transformers normally connected to the Division 1 and Division 3 load groups. This is Open Item 8.2.3.4-2.

Design commitments relating to the physical separation between offsite and onsite class 1E circuits should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.4-3.

Design commitments relating to the onsite Class 1E power system design should be included in the Station Electrical ITAAC and Tier 1 Information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3-1.

Design commitments relating to the capability of performing a safe shutdown with one division should be included in the Station Electrical ITAAC and Tier 1 Information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.1.2-1.

The design commitments relating to separation between scram and other cables should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.1-1.

Design commitments relating to the separation of neutron monitoring raceways should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.2-1.

Design commitments relating to the separation of DC emergency lighting raceways should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.3-1.

Design commitments relating to the separation between Class 1E penetrations of independent divisions should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-1.

Design commitments relating to the separation between Class 1E and non-Class 1E penetrations should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-2.

Design commitments relating to the separation between Class 1E penetrations to non-Class 1E cables or to other divisional cables should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-3.

Design commitments relating to the separation/protection of cables located outside cabinets/panels should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.5-1.

Design commitments relating to the separation of cables inside cabinets/panels should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.6-1.

The design commitments relating to the separation of cables approaching and/or exiting cabinets/panels should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.7-1. Design commitments relating to the independence/physical separation of equipment should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.8-1.

Design commitments relating to the identification of power, instrumentation, and control equipment, cables, and raceways should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.9-1.

The staff concludes that the proposed identification of raceways and cables does not meet the guidelines of Section 6.1.2 of IEEE 384-1981 and position C10 of RG 1.75 (Rev. 2). The design does not include permanent, color raceway and cable markings to ensure that neutron monitoring, scram solenoid, and dc lighting cables will be installed in their associated raceways in accordance with design basic protection and independence requirements. This is Open Item 8.3.2.9-2.

Design commitments relating to the identification of neutron-monitoring, scram solenoid, and DC emergency lighting cables/raceways should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.9-3.

Design commitments relating to the protection of electric penetrations should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.1-1.

Design commitments relating to the design/qualification of Class 1E electrical equipment should be included in the Station Electrical or in the equipment qualification ITAAC, ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.2-1.

Design commitments relating to the seismic qualification of light bulbs should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.3-1.

Design commitments relating to the submergence of Class 1E electrical equipment in the suppression pool swell zone should be included in the Station

Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.4-1.

After reviewing information presented in Chapter 8 of the draft SSAR revision dated April 3, 1992, and Section 9A.5 through Amendment 20 to the SSAR, the staff is unable to reach conclusions as to the acceptability of the level of protection to be afforded Class 1E power systems due to failure of redundant Class 1E components that can be subjected to environments of the same design basis event (including fire, fire suppressant, and non-seismic structures) for which they may not be designed or qualified. Information and design commitments presented in Chapter 8 and Section 9A.5 are inconsistent. This is Open Item 8.3.3.5-1.

Design commitments relating to the protection of redundant Class 1E systems subject to common design basis environments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.5-2.

Design commitments relating to associated circuits should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.6-1.

Design commitments relating to the diesel generator protective relaying bypass should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.7-1.

Design commitments relating to the thermal overloads should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.8-1.

Design commitments relating to the protective relaying should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.10-1.

Design commitments relating to the fault interrupting capacity should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.11-1.

Design commitments relating to the control of design parameters for MOVs should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is open item 8.3.3.12-1.

Design commitments relating to separation of raceways should be included in the station electrical ITAAC and Tier 1 Information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.3.13-1.

Design commitments relating to the electrical protection for scram and MSIV solenoids should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.14-1.

Design commitments relating to safety bus grounding should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.15-1.

Design commitments relating to control of access to Class 1E power equipment should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.3.16-1.

Design commitments relating to electrical independence should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.4-1.

Design commitments relating to interconnections between redundant divisions should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.4.1-1.

Design commitments relating to constant voltage, constant frequency power supplies should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.4.2-1.

Design commitments relating to the isolation between safety buses and non-safety loads should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.4.4-1.

For other off-normal conditions, it is not clear that the design adequately considers lighting needs for essential areas and for passageways to and from these essential areas where plant operations are or may be required by emergency procedures. For example, under certain failures, it appears that the main control room may have only a portion (50 percent) of its lighting. Therefore, GE needs to further address the adequacy of the lighting in essential areas under postulated design basis event conditions. This is Open Item 8.3.5-1.

Design commitments relating to the lighting system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.5-2.

Design commitments relating to the control of the electrical design process should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.6.1-1.

Based on this information presented in the ABWR SSAR, the staff was unable to determine what constitutes an acceptable level of reliability based on results of a probability risk analysis. This is Open Item 8.3.7-1.

Design commitments relating to the testing and surveillance should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.3.7-2.

Design commitments relating to the independence between safety and non-safety dc power systems should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.1-1.

Design commitments relating to the capacity of the Class 1E 125-volt dc battery supply design parameters for motor operated valves should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.2-1.

Design commitments relating to the Class 1E ac standby power system should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.4-1.

The capacity of the CVCF power supplies should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.5-1.

Design commitments relating to the battery charger should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.6-1.

The design commitments relating to distributions systems should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.7-1.

Design commitments relating to re-establishment of ac power should be included in the Station Electrical ITAAC and Tier 1 design information. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.9.1-1.

Design commitments relating to the SBO coping capability should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.9.2-1.

Design commitments relating to the AAC should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.3.9.3-1.

CONFIRMATORY ITEMS

Section 3.1.2.2.8.2.2 and, Sections 8.2.1, 8.2.2, and 8.2.3 of SSAR Amendments 7 and 10 was inconsistent with regard to which parts of the offsite system are within (or outside) the ABWR standard design scope (DSER (SECY-91-355) Open Item 22). It is the staff's understanding, based on discussions with GE, that GE committed to revise Section 3.1.2.2.8.2.2 of SSAR Amendment 7 so that it is consistent with the above defined scope of design. This is acceptable. The staff will verify that GE has included appropriate changes to the SSAR in a future amendment to reflect the above information. This is Confirmatory Item 8.2.1.1-1.

GE's draft SSAR submittal of April 3, 1992, indicated that the offsite power system begins at the terminals on the transmission network side of the circuit breakers connecting the switching stations to the offsite transmission system. That draft also indicated that the offsite power system ends at the terminals of the plant's main generator and at the circuit breaker input terminals of the medium-voltage (6.9 kV) switchgear. This description is not consistent with the NRC SRP definition of an offsite system (DSER SECY-91-355 Open Item 27). Specifically, GE's definition appears to exclude the transmission system, as well as the plant's main generator and gas turbine generator. It is the staff's understanding, based on discussions with GE, that GE will revise the SSAR in a future amendment to be consistent with the NRC SRP definition of an offsite system. This is acceptable. The staff will verify that GE has included appropriate changes in the SSAR in a future amendment to reflect the above information. This is Confirmatory Item 8.2.1.2-1.

In the draft SSAR submittal dated April 3, 1992, GE responded to Open Item 24 from the DSER (SECY-91-355) by defining interface requirements for the offsite circuits outside the scope of design of the ABWR standard plant. Based on discussion with GE, the staff understands that GE will document similar interfaces in the SSAR in a future amendment and the staff will verify this. This is Confirmatory Item 8.2.1.3-1.

Section 8.2.3.1 of GE's draft SSAR submittal of April 3, 1992, indicated that a COL applicant "should" meet the interface requirements defined in Section 8.2.3 of the ABWR SSAR. Applicants who reference the ABWR design will be required to meet all interface requirements. Based on discussions with GE, the staff understands that GE will revise the SSAR in a future amendment to indicate that interface requirements "shall" be met by the applicant. The staff will verify this. This is Confirmatory Item 8.2.1.3-2.

The staff also understands, based on discussions with GE, that GE will revise in a future amendment the SSAR section on interface requirements to include a listing of the regulatory requirements and associated regulatory and industry guidance, which a COL applicant must address in its design scope as part of the COL application. For the offsite system, these should include, as a minimum, the requirements of General Design Criterion (GDC) 17 and 18 of 10 CFR Part 50, Appendix A as well as the guidelines of IEEE 765-1983. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.1.3-3.

Interface requirement (2) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that a COL applicant who references the ABWR design is expected to establish the size of the unit auxiliary transformers to ensure a voltage dip of no more than 20 percent during motor starting. It is the staff's understanding, based on discussions with GE, that the sizing of the unit auxiliary transformers is within the ABWR scope of design responsibility. The staff further understands that GE will revise the SSAR in a future amendment to reflect the above as part of GE's scope. This is acceptable. The staff will verify that GE has revised the SSAR in a future amendment to reflect the above information. This is Confirmatory Item 8.2.1.3-4.

Interface requirement (4) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that it is acceptable and recommended to normally power all three divisions of the Class 1E ac-distribution system from the normal preferred power source. This interface requirement is not consistent with design commitments that are currently documented in other sections of the SSAR (see Section 8.2.3.5 of this report). Based on discussions with GE, the staff understands that GE will delete this requirement (specifically, the second sentence of interface requirement (4) in Section 8.2.3.1 of the draft SSAR revision dated April 3, 1992) when the SSAR is revised in the future. This is Confirmatory Item 8.2.1.3-5.

Interface requirement (5) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that the two offsite circuits will be connected to different transmission systems. It is the staff's understanding, based on discussions with GE, that there is only one transmission system. The staff further understands that GE will clarify the interface requirement in a future amendment to indicate that the main and reserve offsite power circuits will be connected to different transmission circuits or lines (rather than systems) and that the transmission circuits or lines will be independent and separate. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.1.3-6.

Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, did not include additional interface requirements defining what is required of the COL applicant in order to have independent and separate transmission circuits and switching stations. Based on discussions with GE, the staff understands that GE will include in the SSAR in a future amendment explicit interface requirements defining independence and separation of transmission lines and switching stations or switchyards. The staff will verify that GE has revised the SSAR to reflect as a minimum the following design commitments in a future amendment. This is Confirmatory Item 8.2.1.3-7.

Interface requirement (4) in Section 8.2.3.1 of GE's draft SSAR submittal of April 3, 1992, indicated that the COL applicant will analyze incoming transmission lines to ensure that their expected availability is as good as assumed in performing the plant's probability risk analysis (PRA). Based on discussions with GE, the staff contends that the assumptions made in performing the plant's PRA are within the scope of the ABWR design. The staff understands that GE will explicitly state as part of this interface requirement, the expected availability of incoming transmission lines in a future amendment. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.1.3-8.

Design commitments documented in the SSAR indicated that the conceptual design of the ABWR offsite preferred power system will include two separate and independent switching stations (or switchyards). Given that there will be two separate and independent switchyards, the interface requirements within individual switchyards presented in GE's draft submittal of April 3, 1992, go beyond industry-recommended practice for offsite preferred circuits. The staff understands that GE will revise the SSAR as needed to describe the parts of the offsite system switchyard not subject to interface requirements specified in Section 8.2.3 of the draft submittal of April 3, 1992, in a future amendment. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.1.3-9.

The staff concludes that the 15 meters (50 ft) separation between the normal and alternate preferred power circuit transformers, together with each transformer's oil collection pit and automatic deluge water spray system, will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. Consequently, these specifications meet the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has incorporated the transformer separation information discussed above into a future Chapter 8.0 SSAR amendment. This is Confirmatory Item 8.2.2.1-1.

The staff concludes that the 15 meters (50 ft) of separation between the transformers and the normal and alternate preferred power circuits will minimize to the extent feasible the likelihood of simultaneous failure of both circuits under operating and postulated accident and environmental conditions. Consequently, these specifications meet the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has included appropriate changes to the SSAR in a future amendment to reflect the above information. This is Confirmatory Item 8.2.2.1-2.

The staff concludes that these provisions for isolating the instrumentation and control circuits will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. Consequently, these provisions meet the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has provided the above information in a future SSAR amendment. This resolves Open Item 23 of the DSER (SECY-91-355). This is Confirmatory Item 8.2.2.2-1.

The staff concludes that these provisions for electrical independence of power, instrumentation, and control circuits will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. These provisions meet the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.2.3-1.

The staff concludes that these testability requirements will ensure that electric power systems, equipment, and components important to safety are designed to permit appropriate periodic inspection and testing of important areas and features. Consequently, these provisions meet the testing requirements of GDC 18 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This resolves DSER (SECY-91-355) Open Item 25 and is Confirmatory Item 8.2.2.4-1.

Therefore, the normal and alternate preferred offsite circuits meet the requirements of GDC 17 of 10 CFR Part 50, Appendix A, and are acceptable. The staff will verify that GE has provided the noted design information in a future SSAR amendment. Providing the design information resolves DSER (SECY-91-355) Open Item 26 and is Confirmatory Item 8.2.2.6-1.

The staff concludes that plant structures, systems, and equipment will be appropriately grounded and protected from lightning and, therefore, they are acceptable. The staff will verify that GE included the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.2.7-1.

From this, the staff concludes that the offsite system circuits will derive their control, protection, and instrumentation power from a non-Class 1E dc system that is independent of the onsite Class 1E dc system. The staff also concludes that this design will ensure that failure in the offsite system will neither challenge nor possibly cause the loss of redundant, onsite Class 1E dc systems. Similarly, the design will ensure that any single failure in the Class 1E dc system will not cause loss of offsite power to redundant load groups. The staff further concludes that this design will minimize common-cause failure between offsite and onsite power sources associated with a single load group. It will also minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Therefore, the design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This resolves DSER (SECY-91-355) Open Item 28 and is Confirmatory Item 8.2.3.1-1.

Based on these commitments, the staff concludes that the proposed design will ensure independence of offsite and onsite systems during loss of or degraded voltage conditions. The staff also concludes that the design will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. This design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, for offsite and onsite power systems, equipment, and components and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.2-1.

The staff concludes that the ABWR design will include provisions for automatic switchover from system test mode to operating mode in case of either an accident signal or a loss of preferred offsite power signal, regardless of whether the test is being conducted from the local control panel or the main control room. Therefore, the staff concludes that the design meets the requirements of Section 6.2.6(2) of IEEE 308-1980, will minimize the probability of losing electric power from offsite and onsite sources due to loss of power from the nuclear power unit due to a LOCA, meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-1.

Based on GE's design commitment that interlocks to the LOPP sensing circuits will be included in the ABWR design to terminate a parallel operation test and cause the diesel generator to automatically revert to its standby mode if LOPP signal appears during a test, the staff concludes that the ABWR design meets the industry-recommended interlock practice as stated in Section 8.3.1.1.8.8 of the draft SSAR revision dated April 3, 1992. Therefore, the design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-2.

The staff concludes that the protective relaying design will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies during parallel operation of offsite and onsite supplies for testing. Consequently, this design meets the independence requirements of GDC 17 of 10 CFR rt 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-3.

The staff concludes that a design complying with these industry-recommended IEEE practices will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-3.

The staff concludes that the ABWR design minimizes the effects of non-safety-related systems causing loss of electric power to safety related systems. Consequently, this design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.4-1.

The staff concludes that the proposed ABWR design for ensuring physical independence between offsite and onsite circuits minimizes the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.4-2.

Class 1E Vital 120-volt ac Instrumentation and Control (I&C) System

The Class 1E vital 120-volt ac I&C power supply will consist of four independent and redundant vital 120-volt Class 1E ac I&C power systems (one each for Divisions I, II, III, and IV). Each of these four ac I&C power systems will include an associated Class 1E Constant Voltage Constant Frequency (CVCF) power supply, 120-volt Class 1E ac distribution system, and load group. Each of the four CVCF power supplies will consist of the power source (including the static inverter, ac and dc static transfer switches, and a regulating step down transformer as an alternate ac power supply) and its connection to the distribution supply circuit interrupting device. Each of the four Class 1E vital 120-volt ac I&C distribution systems will consist of all equipment in the distribution circuit from the power side of the constant voltage constant frequency power supply breaker to safety system I&C loads. Equipment in each of the four Class 1E vital 120-volt ac distribution circuits will include one or more 120-volt ac distribution panels and connections to vital 120-volt safety system I&C loads.

Each divisional CVCF power supply will be fed from its associated divisional dc power system. (For example, the Division I CVCF power supply will be fed from Division I 125-volt dc distribution system.) In addition, Division II and III of the 480 volt ac distribution system will feed the Division II and III CVCF power supplies, respectively. Similarly, Division I of the 480-volt ac distribution system will feed the Division I and Division IV CVCF power supplies.

The staff concludes that the above design meets the guidelines of IEEE 308-1980, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3-1.

The staff concludes that the ABWR electrical system design will comply with GDC 17 requirements discussed above and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.1-1 and resolves DSFR (SECY-91-355) Open Item 30.

In addition, IEEE has developed and issued other companion standards to provide additional guidance for certain areas. These standards include:

- IEEE 741-1986, "Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations"
- IEEE 765-1983, "Standard for Preferred Power Supply for Nuclear Power Generating Stations"
- IEEE 485-1983, "Recommended Practice for Sizing Large-Lead Storage Batteries for Generating Stations and Substations"
- IEEE 946-1985, "Recommended Practice for the Design of Safety-Related dc Auxiliary Power Systems for Nuclear Power Generating Stations"

Like the two standards cited above, these other comparison standards have not been endorsed by NRC regulatory guide. However, the staff concluded that these standards were developed to be used with IEEE 308-1980 and that they clarify and amplify current SRP criteria and guidelines. The staff therefore considered these standards the more relevant base from which to evaluate the ABWR design.

In some cases, GE has not referenced these other standards in the ABWR SSAR. The staff proceeded with its review with the understanding that GE intends to use these other standards.

The staff understands that GE will address the ABWR conformance to these standards in a future SSAR amendment. This is Confirmatory Item 8.3.1.1-1.

Therefore, the staff concludes that the electrical design meets the protection requirements of GDC 2 and 4 and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.1.2-1.

Based on the above design commitments, the staff concludes that the physical independence of the reactor protection system scram solenoid circuits meets the guidelines of RG 1.75, as well as the independence and protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. Consequently, this independence is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.1-1.

The staff concludes that the physical independence of the neutron monitoring circuits meets the guidelines of RG 1.75, as well as the independence and protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. Consequently, this independence is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.2-1.

The staff concludes that the physical independence of the dc emergency lighting circuits meets the guidelines of RG 1.75 (Rev. 2), as well as the independence and protection requirements of GDC 4 and 17 of 10 CFR Part 50,

Appendix A. Consequently, this independence is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.3-1.

The staff concludes that the proposed design for separation of penetration assemblies of different Class 1E divisions meets the guidelines of Section 6.5 of IEEE 384-1981, the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A. Consequently, this design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-1 and resolves DSER (SECY-91-355) Open Item 33.

The staff concludes that the proposed separation of penetration assemblies containing non-Class 1E circuits from those containing Class 1E or associated Class 1E circuits meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. Therefore, this design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-2.

The staff concludes that the proposed separation between penetrations containing Class 1E circuits and other divisional or non-divisional cables meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. Consequently, this design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-3.

The staff concludes that this separation reasonably ensures that failure of Class 1E (or Class 1E associated) cables in any one division (located outside of cabinets and panels and in any single raceway) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located outside of cabinets and panels and in any single raceway) will not adversely affect Class 1E (or Class 1E associated) cables. Consequently, the staff concludes that the design meets the independence and protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.5-1.

The staff concludes that these commitments reasonably ensure that failure of Class 1E (or Class 1E associated) cables in any one division (located inside of cabinets or panels) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located inside cabinets or panels) will not adversely affect Class 1E (or Class 1E associated) cables. The design therefore meets the independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.6-1.

The staff concludes that these commitments reasonably ensure that failure of Class 1E (or Class 1E associated) cables in any one division (located in a cable chase or the control room area) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located in a cable chase or the control room area) will not adversely affect Class 1E (or Class 1E associated) cables. The design therefore meets the independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.7-1.

The staff concludes that the ABWR design will provide an adequate level of independence between redundant Class 1E systems, equipment, and components and their associated load groups. This design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.8-1.[4].

The staff concludes that the ABWR proposed identification of raceways and cables meets the guidelines of Section 6.1.2 of IEEE 384-1981. The design will ensure that cables will be installed in their associated raceways in accordance with design-basis protection and independence requirements. Consequently, the design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.9-1.

The staff concludes that the proposed design for protection of containment electrical penetrations meets the guidelines of RG 1.63 (Revision 3), as well as the containment penetration requirements of GDC 50 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.1-1.

The staff concludes that Class 1E systems, equipment, and components will be protected from design-basis events. The electrical system design therefore meets the design basis requirements of GDC 2 and the design bases requirements for environmental and dynamic effects of GDC 4 and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.2-1.

The staff concludes that the proposed design of Class 1E equipment subject to submergence meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.4-1.

The staff concludes that Class 1E systems, equipment, and components will be adequately protected from associated circuits and/or non-Class 1E circuits powered through an isolation device from a Class 1E power supply. In addition, sufficient independence will be maintained between redundant Class 1E systems, equipment, and components. The design therefore meets the indepen-

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[4] Section 8.3.3.5 of this report addresses acceptable redundant circuits independence and protection from distribution system power panels to connected equipment loads which are not separated by fire and/or missile barriers.

dence and protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify and that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.6-1 and resolves DSER (SECY-91-355) Open Item 38.

The staff concludes that there is reasonable assurance that the protective relaying (to be installed on Class 1E diesel generators to protect the diesel generator from failure) will be bypassed during accident conditions so that the diesel generator will not be prevented from performing its required safety function under accident conditions due to operation or failure of the protective scheme. Consequently, this design meets the guidelines of Position C7 of RG 1.9 (Rev. 2) and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.7-1.

The staff concludes that there will be reasonable assurance that the thermal overload protection to be installed on Class 1E motor operated valves will be bypassed during accident conditions so that the Class 1E valve motor will not be prevented from performing its required safety function under accident conditions due to operation or failure of the thermal overload devices. Consequently, the design meets the guidelines of RG 1.106 (Rev. 1) and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.8-1.

The draft information provided by GE on September 4, 1991, revised the SSAR to revise the statement that tripping of the bus supply breaker is normal for faults that occur on its Class 1E loads. In discussions with the staff, GE indicated that the Class 1E load and bus supply breakers are coordinated. This design commitment is acceptable. The staff will verify that GE has provided the needed clarification in a future SSAR amendment. This is Confirmatory Item 8.3.3.9-1.

The staff concludes that when these components, equipment, or systems are used their operation or failure will not significantly reduce the capability of the Class 1E power system to perform its safety function when required. The proposed design therefore meets the protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.10-1.

The staff concludes that these design commitments will provide reasonable assurance that Class 1E equipment will have sufficient capacity and capability to interrupt the worst case fault and are acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.11-1.

The staff concludes that the proposed ABWR design, which keeps the thermal overload in force during normal plant operation as well as during test and maintenance, will provide reasonable assurance that the MOV will not be operated with excessive currents without operator knowledge (or will be operated within their design limits) and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.12-1.

In the draft SSAR revision dated April 3, 1992, GE revised Section 8.3.3.2 of SSAR Amendment 10 to indicate that separation is achieved by using totally enclosed raceways when spacial separation is less than .9 by 1.5 meter (3 by 5 ft). The use of totally enclosed raceways when spacial separation is less than .9 by 1.5 meters (3 by 5 ft) meets the separation guidelines of RG 1.75 (Rev. 2) and will provide reasonable assurance that a fire initiated in one division will not propagate to a redundant division. Consequently, this design is acceptable[5]. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.13-1.

The staff concludes that single failure of the EPA or the Class 1E CVCF power supply will not cause a non-fail-safe type failure of RPS scram or MSIV solenoid valves and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.14-1.

The staff understands that annunciation will be provided in the design to alarm in the control room whenever the breakers are racked in for service. The staff concludes that the proposed interlocks together with administrative control and annunciation of the bus grounding system will be sufficient to prevent inadvertent actuation of the grounding system. Consequently, this design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.15-1.

The staff concludes therefore that controlled access to Class 1E equipment will be included in the ABWR design in accordance with the requirements of IEEE 308-1980 and is acceptable. The staff will verify that GE provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.16-1.

Based on discussions with GE and information included in the draft SSAR revision dated April 3, 1992, the staff has the following understandings with respect to electrical independence:

- The protective actions (that is operation of equipment for the purpose of accomplishing a safety function) of each load group will be independent of the protective actions provided by redundant load groups.

- There will be no provision for automatically transferring loads from one Class 1E ac power supply (for example, the diesel generator) to a redundant supply.

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[5] For design basis event exposure fires, the adequacy of the design to prevent the spread of fire between redundant systems is addressed in the Section 9.5.1 of this SER.

- Each onsite Class 1E power supply (for example, the diesel generator) will have provisions for automatic connection to one Class 1E load group, but will have no automatic connection to any other redundant load group. If nonautomatic (manual) interconnecting means are furnished, provisions that prevent paralleling of the redundant onsite Class 1E power supplies will be included.

- The ABWR electrical system design will not include provisions for the manual connection of the onsite Class 1E power supply associated with one load group to any other redundant load group (except for the spare battery chargers)

+ The ABWR design will include provisions to allow one spare battery charger to be connected to either of two divisions and another spare battery charger to be connected to either of two other divisions.

+ The spare chargers for the dc power supply may be manually connected to either of two designated divisions, but only when their loads are switched to the same division. Key interlocks will mechanically ensure that these standby chargers can only be used in one division at a time.

+ GE modified the ABWR design to eliminate the capability to power non-Class 1E loads from more than one Class 1E division. There will be no loads in the ABWR design which can accept source power from more than one Class 1E division.

- The ABWR electrical system design will not have interconnections between redundant divisions except as noted in Sections 8.2.2.3 and 8.3.4.1 of this report.

- The divisional battery charger will normally be fed from its divisional 480-volt motor control center bus.

- Each standby power system division includes the diesel generator, its auxiliary systems, and the distribution of power to various Class 1E loads through the 6.9-kV and 480-volt systems. Each of these divisions will be segregated and separated from the other divisions. No automatic interconnection will be provided between the Class 1E divisions. Each diesel generator set will operate independently of the other sets.

- Control power (for the 480-volt auxiliaries) will be from the Class 1E 125-volt dc power system of the same division.

- Each dc system load group will have its own battery charger with no provision for automatic interconnection with other redundant load groups.

- There will be no provision for automatically interconnecting redundant dc system load groups.

- No provision will be made for automatically or manually transferring loads between Class 1E dc power sources.

- The ABWR design will not have interconnections between redundant divisions of the dc system.

- Each battery power supply will be independent of other redundant battery supplies.

- Each battery charger will be independent of other redundant battery chargers.

- The ac and dc switchgear power circuit breakers in each division will receive control power from their respective load groups to provide the following assurances:

- Loss of one 125-volt dc system will not jeopardize the Class 1E power supply to the Class 1E buses of the other load groups.

- The differential relays in one division and all the interlocks associated with these relays will be from one 125-volt dc system. There will be no cross connections between the redundant dc systems through protective relaying.

The staff concludes that the ABWR design of redundant systems meets the electrical independence requirements of GDC 17 of 10 CFR Part 50, Appendix A and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4-1.

In Section 8.3.2.1.4 and Figure 8.3-7 of the draft SSAR revision dated April 3, 1992, GE eliminated the interconnection between Division III and Division I (item 1 above), which was to be used to transfer the 250-volt dc battery charger between Class 1E divisions. In the new proposed design, power for the non-safety-related 250-volt dc battery charger is supplied from either the non-safety-related load group A or C turbine building load centers. With the elimination of the interconnection, this item is considered resolved, subject to GE providing the above design information in an SSAR amendment. This is part of Confirmatory Item 8.3.4-1.

In regard to the interconnection described in item 2 above, Section 8.3.2.1.2 and Figure 8.3-7 of the draft SSAR revision dated April 3, 1992, indicate that electrical interconnections will continue to exist between Division I and Division II and between Division I and Division III, so that two redundant divisions can share one standby charger. Incorporation of this revision into the SSAR is part of Confirmatory Item 8.3.4.1-1.

The staff concludes that the proposed design for interconnecting redundant divisions will maintain independence between redundant divisions by using two open devices. Failure of one device will not challenge or cause failure of the remaining redundant divisions. Therefore, this design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.1-1 as described above.

Based on discussions with GE and draft information provided by GE on September 4, 1991, November 26, 1991, and April 3, 1992, the staff understands that ac power to Divisions I and IV is supplied from the 6.9-kV Division I bus through a single 6.9-kV to 480-V ac transformer and motor control center to the vital ac system's CVCF power supplies and the dc system's battery charger power supplies for Division I and IV. Division I and IV ac and dc systems may be subject to a single common failure of the 6.9-kV to 480-V transformer. The staff's evaluation of this lack of independence between Divisions I and IV of I&C equipment is addressed in Chapter 7 of this SER. In addition, GE will revise the SSAR to indicate that there are four independent and redundant dc systems and three (versus four) independent and redundant ac systems. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.2-1.

The staff understands that SRVs will be powered only from Class 1E sources and that there will be no electrical interconnection between power supplies. This design will ensure electrical independence between the redundant power supplies, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.3-1.

Subsequently, in Section 8.3.1.1.1 of the draft SSAR revision dated April 3, 1992, GE eliminated automatic transfer of loads between redundant divisions by indicating that only Class 1E Division I will have a non-safety-related load and this is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.4-1.

The staff therefore concludes that this design adequately protects safety systems from the failure of the non-safety-related rod control loads, the Class 1E power system has sufficient capability and capacity to supply Class 1E loads in addition to the non safety rod control loads, and sufficient independence has been provided between redundant divisions in accordance with the capacity, capability, and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. The proposed ABWR design for isolating the non-safety fine motion control rod drive motor loads from the Class 1E power system meets the intent of IEEE 603-1980, 308-1980, and 384-1981 and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.4-2.

The staff concludes that these systems will provide adequate levels of light to permit required operation and maintenance of equipment in essential equipment areas and passageways to and from these essential areas under normal operating conditions. This design will be acceptable subject to resolution of the open item discussed below. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.5-1.

Based on information presented in Sections 8.3.4.17 and 8.3.5 in the draft SSAR revision dated April 3, 1992, the staff understands that purchase specification for both safety and non-safety related equipment will contain a list of appropriate common industrial standards to ensure quality manufacturing.

Based on this commitment, the staff concludes that this concern (DSER SECY-91-355 Open Item 60) is resolved. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.6.1-1.

GE has indicated that a formal engineering review and update of the SSAR is in progress to identify and correct inconsistencies within and between sections of the SSAR. The staff will verify that GE has revised the design bases in a future SSAR amendment. All conclusions in Section 8 of this report require the elimination of conflicting information. This is Confirmatory Item 8.3.6.2-1.

Except as noted below the staff concludes, that the electrical system design will permit sufficient testability in accordance with the testing requirements of GDC 17 and 18 of 10 CFR Part 50, Appendix A. This design is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.7-1.

Based on the design information included in the draft SSAR revision, staff concerns relating to interactions between safety and non-safety-related systems associated with the previously proposed common dc power supply have been resolved. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.1-1.

The staff concludes that the Class 1E batteries will have sufficient capacity to supply required loads following a LOCA and/or LOPP and a station blackout event. The design therefore meets the capacity requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.2-1.

In response to DSER (SECY-91-355) Open Item 66, GE provided the draft SSAR revision dated April 3, 1992, which removed the use of the silicon diode from the ABWR design and restated the commitment to design the dc system distribution equipment, component, and loads to function at 140 volts during equalization charge.

This item is therefore considered resolved. The staff will verify that GE has revised the SSAR in a future amendment, indicating the removal of the silicon diode from the ABWR design. This is Confirmatory Item 8.3.8.3-1.

The staff concludes that the diesel generators and their load sequencers meet the capacity, capability, and testability requirements of GDC 17 of 10 CFR Part 50 Appendix A. This design is therefore acceptable and resolves DSER (SECY-91-355) Open Item 67. The staff will verify that GE has revised the SSAR to include above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.4-1.

The staff concludes that the ABWR design for the CVCF power supply will have sufficient capacity to supply required loads and will be testable. This design therefore meets the capacity, capability, and testability requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.5-1.

The capacity of the CVCF power supplies should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.5-1.

The staff therefore concludes that the ABWR design for the dc system battery chargers will have sufficient capacity to supply required loads and will be testable. The design therefore meets the capacity, capability, and testability requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.6-1.

The staff concludes that the ABWR design for the Class 1E distribution systems will be capable of supplying sufficient energy to safety-related system loads for their operation, and will be capable of being tested. This design meets the capacity, capability, and testability requirement of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable. The staff will verify that GE has provided the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.7-1.

The staff therefore concludes that the ABWR design for reestablishing ac power meets the SBO rule and is acceptable. The staff will verify that GE has revised the SSAR to include the above design information. This is Confirmatory Item 8.3.9.1-1.

The staff concludes that the ABWR design will be capable of coping with the SBO event. The staff will verify that GE has revised the SSAR in a future amendment to include the above design information. This Confirmatory Item 8.3.9.2-1.

The staff concludes that the ABWR design for the Alternate ac power supply will comply with RG 1.155 and meets the SBO rule. The staff will verify that GE has revised the SSAR in a future amendment to include the above design information. This is Confirmatory Item 8.3.9.3-1.

CHAPTER 9

OPEN ITEMS

These were identified in Section 1.10 of the DSER (SECY-91-235) as Interface Information Items 28 and 29. As a result of its review of the ABWR interface requirements, the staff has determined that this information is required to be included in the inspections, tests, analysis, and acceptance criteria (ITAAC) for the fuel storage facility. This is Open Item 9.1.1-1.

GE has submitted proposed Tier 1 design information and fuel storage facility ITAAC in Section 2.5.6 of "Tier 1 Design Certification Material for the GE ABWR," (DCM) which are under staff review. The results of the staff's review will be provided in the final safety evaluation report (FSER). This is identified as an open item in Section 9.1.2 of this report.

These were identified as Interface Information Item 30 in Section 1.10 of the DSER (SECY-91-235). As a result of its review of the ABWR interface requirements, the staff has determined that analyses are required to be included in the fuel storage facility ITAAC. This is Open Item 9.1.2-1.

GE has submitted in Section 2.5.6 of the DCM proposed Tier 1 design information and fuel storage facility ITAAC in Section 2.5.6 of the DCM, which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.1.2-2. (See also Section 9.1.1 of this report).

In the DSER discussion of the system's decay heat removal capability, the staff raised the issue of the technical specification implications of the use of the RHR system as an integral part of the FPC system. The information provided by GE in response to the concerns identified in this part of DSER Open Item 46 (SECY-91-235) did not specifically address this concern. This is Open Item 9.1.3-1.

GE has submitted in Section 2.6.2 of the DCM proposed Tier 1 design information and fuel pool cooling and cleanup system ITAAC, which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.1.3-2.

GE has submitted in Sections 2.5.1, 2.5.5, and 2.15.3 of the DCM Tier 1 design information and ITAAC for refueling equipment, including the light load handling system, which is under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.1.4-1.

Note x of Table 3.2-1 (SSAR Amendment 20) indicates that the cranes are capable of holding their loads under OBE conditions but does not address the SSE. This part of DSER Open Item 48 is not resolved and is now Open Item 9.1.5-1.

The use of the steam tunnel handling equipment is limited to times when the reactor is shutdown. Failure of the handling equipment at this time would not result in the loss of safety functions (identified in SSAR Amendment 17). The rationale for not requiring this equipment to have the capability of holding its loads during an SSE is acceptable. However, sufficient justification for the lack of the application of a seismic criterion such as that identified in item 1 above has not been provided for the remaining devices in the control building, secondary containment, and clean zone of the reactor building. This part of DSER Open Item 48 is not resolved and is now Open Item 9.1.5-2.

Many of the discrepancies identified in the DSER appear to have been corrected. However, neither the jib crane nor the refueling platform crane are referred to in the text of SSAR Section 9.1, although both are listed in SSAR Table 3.2-1. Also, the term "Refueling Bridge," is used only in Table 3.2-1. Throughout all of Section 9.1, the term "Refueling Platform," is used. The text of Section 9.1 appears to be consistent within itself. References to a refueling platform are used consistently to refer to the fuel handling equipment. The remaining discrepancies in the nomenclature used in Tables 3.2-1 and Section 9.1 require clarification. This part of DSER Open Item 48 is not resolved and is now Open Item 9.1.5-3.

SSAR Amendment 20 identifies the criteria used to assess the safety impact of the failure of the load handling devices. The lower drywell equipment does not carry loads over safety-related equipment. The failure of the upper drywell equipment, used only during maintenance at shutdown, can affect only the one division of emergency core cooling system (ECCS). Safe shutdown conditions can be maintained with the failure of the one ECCS division. The main steam tunnel equipment is used only during shutdown and its failure will not impact any safety-related equipment needed to maintain shutdown conditions. Load handling equipment in the turbine and radwaste buildings are not used in the vicinity of safety-related equipment as they are restricted to use in these structures. The use of heavy load handling equipment in the control building was not addressed in this SSAR amendment. Of the items identified in this part of DSER Open Item 48, all are resolved with the information provided by SSAR Amendment 20 except for the concern regarding the control building. Identification of how safety-related equipment would be protected during all heavy load handling operations involving non-single-failures-proof load lifting devices in the control building is Open Item 9.1.5-4.

In the DSER, the staff identified that GE had not identified all the hoists for the reactor building, refueling platform, and steam tunnel cranes and any other crane, nor the load handling capacity for all the hoists, including the monorail hoist, equipment hatchway hoist, equipment platform/lower drywell RIP hoist. GE has not provided this information, therefore, this part of DSER Open Item 49 is not resolved and is now Open Item 9.1.5-5.

Section 9.1.5.5 of SSAR Amendment 20 states that the limit switches and safety interlocks are provided to prevent transporting heavy loads over any spent fuel. However, the level of detail requested by the staff in the DSER has not been provided in the SSAR, nor does it specifically identify this information as the responsibility of the COL applicant. The staff expects that GE will either provide this information or designate this as the responsibility of the COL applicant. This part of DSER Open Item 49 is not resolved and is now Open Item 9.1.5-6.

GE has not provided the information identified in the DSER, therefore, this part of DSER Open Item 49 is not resolved. GE also has not identified requirements for load lifting systems outside the scope of the ABWR (e.g., the RSW pump house). This information should include the identification of the load handling systems, the system characteristics, and the ability to meet the requirements of NUREG-0612. The provision of the previously identified information and the identification of the requirements for load lifting systems outside the ABWR scope is Open Item 9.1.5-7.

GE has submitted in the DCM Tier 1 design information and ITAAC for the overhead heavy load handling systems which are under staff review. The results of the staff's review will be included in the FSER. This is Open Item 9.1.5-8.

GE has proposed that the potable and sanitary water system be designated an interface, and that this system design be provided by the applicant referencing the ABWR design. The staff is reviewing the GE proposed interface. This is Open Item 9.2.4-1.

GE has provided in Section 4.3 of the DCM, potable and sanitary water system Tier 1 information, interface requirements, and ITAAC which are under staff review. The staff expects these ITAAC to include GE's proposal and interface verification method as required by 10 CFR Part 52. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.4-2.

GE has provided in Section 4.1 of the DCM, UHS Tier 1 information, interface requirements, and ITAAC, which are under staff review. The staff expects these ITAAC to include GE's proposed interface verification method as required by 10 CFR Part 50. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.5-1.

GE submitted in Section 4.6 of the DCM, Tier 1 design information, interface requirements, and ITAAC which are under staff review. The staff expects these ITAAC to include the GE proposed interface verification method, as required by 10 CFR Part 52. The results of this review will be provided in the FSER. This is Open Item 9.2.8-1.

GE has submitted in Section 2.11.2 of the DCM proposed Tier 1 design information and ITAAC for MUWC system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.9-1.

GE has submitted in Section 2.11.1 of the DCM proposed Tier 1 design information and ITAAC for the MUWP system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.10-2.

In the DSER, the staff indicated that an RCW system heat exchanger heat removal design capacity may be inadequate based on heat load required to be removed during suppression pool cooling following a LOCA when the post-LOCA pool temperature reaches 97 °C. They stated that a reactor shutdown at 4 hours after a blowdown to the main condenser may be the bounding case, which may require a greater heat removal rate and, consequently, a higher design capacity than that currently stated for the heat exchangers (see GE's response to RAI 440.73).

GE has not addressed this concern, therefore, this part of DSER Open Item 53 is not resolved and is now Open Item 9.2.11-1.

GE submitted in Section 2.11.3 of the DCM proposed Tier 1 design information and ITAAC for the RCW system which are under staff review. The results of the staff's review will be provided in a subsequent revision to the FSER. This is Open Item 9.2.11-2.

The staff concludes that the design of the RCW system will comply with GDC 2, 45, and 46 with respect to protection against natural phenomena and inservice inspection and testing requirements, for its safety-related portions. The staff also concludes that the system design meets the guidelines of Positions C.1 and C.2 of RG 1.29 with respect to seismic requirements for the safety-related and applicable non-safety-related portions of the system. Further, the staff concludes that the system design will comply with GDC 4 and 44 with respect to cooling water requirements and protection against internally and externally generated missiles and dynamic effects resulting from postulated piping failures, subject to satisfactory resolution of the open item identified above. The system design will meet the applicable acceptance criteria of SRP Section 9.2.2 subject to satisfactory resolution of Open Items 9.2.11-1 and 9.2.11-2 identified above.

GE has submitted in Section 2.11.5 of the DCM proposed Tier 1 design information and ITAAC for the HNCW system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.12-1.

As a result of further staff review, an additional concern was identified regarding the HECW system. Because of the properties of the refrigerant used in the HECW chiller units, unique problems may arise in the attempt to recover the units following a station blackout. GE should provide an analysis regarding the HECW system's ability to recover following a postulated station blackout condition. This is Open Item 9.2.13-1.

GE has submitted in Section 2.11.6 of the DCM proposed Tier 1 design information and HECW system ITAAC which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.13-2.

GE submitted in Section 2.11.4 of the DCM TCW system Tier 1 design information and ITAAC which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.14-1.

Subject to satisfactory resolution of Open Item 9.2.14-1 and Confirmatory Item 9.2.14-1 identified above, the TCW system will meet the requirements of SRP Section 9.2.2.

In the SSAR, GE stated that the RSW system will be able to perform its function during abnormally low or high water levels and that steps are taken to prevent organic fouling that may degrade system performance. Proposed steps include trash racks, biocide (or non- biocide where biocide treatment is not allowed) treatment, and thermal backwash capabilities. Selection of appropriate measures is site specific and, therefore, the responsibility of the COL applicant. This is COL Action Item 9.2.15-2. The staff will review those measures on a plant-specific basis. Staff review of the interface criteria in the SSAR and the DCM is Open Item 9.2.15-1.

GE has provided in Sections 2.11.9 and 4.5 of the DCM, Tier 1 design description, interface requirements, and ITAAC for the RSW system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.15-2.

The TSW system is a non-safety related system designed to transfer heat from the TCW heat exchangers to the turbine plant heat sink. The TSW includes two

100-percent capacity pumps, two 100-percent capacity duplex strainers and associated piping, valves, and instrumentation. In the DSER, (SECY-91-235) the staff stated that GE did not provide system parameters (pump flow requirements, system operating pressure) but did provide a requirement that water supplied to the TCW heat exchangers be at a temperature not to exceed 40 °C (100 °F). GE has more recently provided additional information, and committed to update the SSAR, concerning the design of the TSW system. This is Confirmatory Item 9.2.16-1. The pump flow requirements and system operating pressure have been provided. However, contradictory information was provided concerning the number of pumps in the system. The text of Section 9.2.16 still refers to two pumps and two duplex strainers. The revised Figure 9.2-8 and Table 9.2.17 both show three 50 percent capacity pumps. Resolution of this discrepancy is Open Item 9.2.16-1.

GE has provided in Sections 2.11.10 and 4.4 of the DCM, Tier 1 design description and ITAAC for the TSW system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.2.16-2.

The safety-related operation of the automatic depressurization system (ADS) valves relies on a compressed gas supply that will be provided by the HPIN under most conditions. (See Chapter 20.2 of this report for discussion of TMI item.) This nitrogen is supplied during normal operation from the ACS nitrogen storage tank. During design basis events, nitrogen is supplied by accumulators charged by either the ACS, during normal operation, or by nitrogen bottles during periods when the ACS is unavailable. In addition, stored nitrogen can be used to replenish the accumulators or to supplement their operation. In these system line-ups, unfiltered nitrogen is supplied to the accumulators and ADS/SRV valve components. As discussed in DSER Open Item 73 (SECY-91-355), this does not comply with the guidance of ANSI MC 11.1-1976, which requires clean, dry, oil-free air (or nitrogen) to safety-related components. In response to this issue, GE has indicated that the filters in the HPIN system will be able to remove particles larger than 5 microns from the system. Additionally, the nitrogen supply subsystem will provide oil-free nitrogen with a moisture content of less than 2.5 ppm. The 5-micron capacity of the filters is not in compliance with the requirements of ANSI MC 11.1-1976 and GE has not provided sufficient justification for the staff to allow deviation from the 3-micron criterion. GE should either commit to the 3-micron requirement of the standard or should provide a commitment to use equipment demonstrated to be unaffected by the use of nitrogen-containing particulates of the larger size. Compliance of the nitrogen supply system with the requirements of ANSI MC 11.1-1976 remains an open item. DSER Open Item 73 (SECY-91-355) is now Open Item 9.3.1-1.

In evaluating the IA system as a potential backup to the HPIN system, the staff stated in the DSER (SECY-91-355) that it had found that the system complies with all aspects of the ANSI MC 11.1-1976 criteria with the exception of particulate size. The ABWR design proposes a 5-micron criteria for particulate size that is contrary to the 3-micron criterion of the ANSI standard. This was identified as DSER Open Item 75. GE has not justified this aspect of the CA system design, therefore, the IA system's compliance with the requirements of GDC 1 remains an open item. DSER Open Item 75 is now Open Item 9.3.1-2.

Open Item 9.3.1-1 (formerly DSER Open Item 73): The ability of the safety-related air supply systems to meet the air quality requirements of ANSI MC 11.1-1976 has not been demonstrated in the SSAR.

Open Item 9.3.1-2 (formerly Open Item 75): Compliance of the IA system (as a potential backup to the HPIN system) with the requirements of GDC 1 regarding air quality has not been demonstrated.

GE has provided in Sections 2.11.11, 2.11.12, and 2.11.13 of the DCM Tier 1 design descriptions and ITAAC for the compressed air systems (ACS, SA, IA, and HPIN) which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.3.1-3.

GE has submitted proposed ITAAC and the Tier 1 design description in Section 2.11.20 of the DCM for the process sampling system which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.3.2.1-1.

SSAR Section 9.3.2.3.1 indicates that PASS is designed for upper limit for activity samples of 1 Ci/cm^3. All PASS systems in operating reactor plants are designed with capability of sampling liquids up to 10 Ci/ml radioactivity. GE needs to design PASS with the capability of sampling liquids up to 10 Ci/ml. This is Open Item 9.3.2.2-1.

The ABWR PASS does not have capability to obtain pressurized or unpressurized reactor water samples for dissolved gas analysis. GE needs to design PASS to be capable of obtaining reactor water samples 24 hours after the end of power generation in order to evaluate concentrations of dissolved gases and chlorides in the reactor coolant. The information on the amounts of dissolved hydrogen, oxygen and chlorides in the reactor coolant. The information on the amounts of dissolved hydrogen, oxygen and chlorides in the reactor coolant is an important factor in evaluating post-accident conditions existing in the reactor vessel. This is Open Item 9.3.2.2-2.

GE has proposed ITAAC and included Tier 1 design description of the post-accident sampling system as a part of the process sampling system in Section 2.11.20 of the DCM. The results of the staff's review of the PASS ITAAC and Tier 1 design description will be provided in the FSER. This is Open Item 9.3.2.2-3.

GE has submitted in Section 2.2.4 of the DCM, design description and ITAAC for SLCS which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.3.5-1.

GE submitted, in Sections 2.9 and 2.15.7 of the DCM, Tier 1 design information and ITAAC for the portions of the radioactive drain transfer system within the ABWR scope which are under staff review. The results of the staff's review will be provided in a supplement to this report. This is Open Item 9.3.8-1.

GE has proposed ITAAC and included Tier 1 design description of the hydrogen water chemistry system in Section 2.11.17 of the DCM. The results of the staff's review of these ITAAC and Tier 1 design description will be provided in the FSER. This is Open Item 9.3.9-1.

GE has not proposed ITAAC nor a Tier 1 design description of the oxygen injection system in Section 2.11.7 of the DCM. This is Open Item 9.3.10-1.

GE has not proposed ITAAC nor a Tier 1 design description of the zinc injection system in Section 2.11.18 of the DCM. The results of the staff's review will be provided in FSER. This is Open Item 9.3.11-1.

GE submitted in Sections 2.11.5 and 2.11.6, of the DCM Tier 1 design information and ITAAC for HVAC systems which are under staff review. The results of the staff's review will be provided in the FSER. This is Open Item 9.4-1.

After the May 5, 1992, meeting between the NRC and GE, in a telephone conversation on May 12, 1992, GE committed to provide SSAR appendices identifying the compliance of (1) the ESF-grade filter train in the system with RG 1.52 guidelines and (2) the minimum instrumentation requirements listed in SRP Table 6.5.1-1. These appendices are to be similar to those provided for the SGTS. In this context, the staff finds that SSAR Figure 9.4-1 does not show electric heaters as part of the ESF-grade filter trains as described in SSAR Subsection 9.4.1.1.3. The staff considers that these heaters are essential to maintain proper humidity conditions (less than 70-percent) to ensure proper operation of the charcoal adsorbers. This is Open item 9.4.1.1-1.

The radwaste building ventilation system complies with GDC 2 regarding protection from natural phenomena since the applicable non-essential portions of the system are designed in accordance with Position C.2 of RG 1.29, as per SSAR Table 3.2-1. The design meets the requirements of GDC 60 (regarding control of releases of radioactive materials to the environment) for select areas in the radwaste building work areas by isolating the affected areas. Since the design of the system does not include HEPAs or charcoal adsorbers, the system is not required to meet RG 1.140 guidelines. The staff, however, finds that GE has not, to date, provided the P&IDs, flow diagrams, and component description tables for the radwaste control room HVAC and the balance of the radwaste building HVAC system as committed in its letter dated August 22, 1990 (response to RAI 430.258). This is Open Item 9.4.6-1.

GE provided in Section 2.15.6 of the DCM, Tier 1 design description and ITAAC for the fire protection system. The results of the staff's review will be provided in the FSER. This is Open Item 9.5.1.3-1.

As stated in the SSAR, the ABWR automatic fire detection systems, designed and installed in accordance with National Fire Protection Association (NFPA) Standards 72D and 72E, will be provided for all significant hazards and safe-shutdown components. (Note: NFPA 72A, 72B, 72D, and 72E have been incorporated into NFPA 72, and no longer exist as separate standards. Therefore, all references to NFPA 72D and 72E should be changed to NFPA 72. This is Open Item 9.5.1.3.1-1.

Most components of the diesel generators and their auxiliary support systems are located in the seismic Category I reactor building structure that provides protection from the effects of tornadoes, missiles, and floods. The diesel generator exhaust silencer is located on top of the reactor building, well above the probable maximum flood level and designed to be able to function during design basis events such as seismic vibrations, wind, hail, tornadoes, rain, and snow storms. Fuel oil storage tanks, pump motors, valves, and piping are located underground and are of seismic Category 1 construction. The only portions of the fuel oil storage and transfer system located above ground are the fill, sample, and vent lines. In the DSER (SECY-91-355), the staff concluded that GE should provide additional information that describes provisions to minimize the effect of tornado missiles for these exposed components. (The DSER referred to DSER Section 3.5.1.4 discussion of design basis tornado for information on the staff's assessment of designed protection from tornado missiles.) In SSAR Section 9.5.4, GE states that the fuel oil storage and transfer system is protected from damage by flying debris carried by tornadoes. Subject to confirmation that the fill, vent, and sample connections are adequately protected from tornado missiles, the system designs meet the requirement of GDC 2 and 4, and RG 1.115, and RG 1.117. This was DSER Open Item 80 and is now Open Item 9.5.4.1-1.

GE has provided Tier 1 design information and ITAAC for the fuel oil storage and transfer system in Section 2.16.2 of the DCM. The remaining diesel generator auxiliaries are included as part of the Emergency Diesel Generator Tier 1 and ITAAC (DCM Section 2.12.13). This information is currently under staff review. The results of this review will be presented in the FSER. This is Open Item 9.5.4.1-2.

The staff reviewed these ABWR interface requirements and determined that this information is required to be included in the ITAAC for the diesel generator and its auxiliary systems. This is Open Item 9.5.5-1.

The combustion air intakes are located on the side of the reactor building and are protected (by vertical grills) from tornado missiles. The intakes are located 11.5 m (37.7 ft) above grade and are designed to minimize any effects from dust and debris through the use of vertical grills set into the reactor building wall with filters located behind the grills. The intakes are protected from flooding by their location. The diesel generator exhausts are partly housed within the reactor building with the exhaust silencer located on the roof of the reactor building. The design basis for the silencer requires that it be seismically qualified and able to withstand the effects of tornadoes. In DSER (SECY-91-355) Open Item 96, the staff noted that the means of protection from tornado missiles had not been adequately discussed. GE has committed to update the SSAR to indicate that the silencers are seismically mounted and bolted in a horizontal position. However, this design change does not adequately address protection of the silencers from tornado missiles. Therefore, this issue remains as Open Item 9.5.8-1.

CONFIRMATORY ITEMS

GE has subsequently committed to revise the design of the SGTS to include a second redundant filter train. Because the safety-related makeup for the pool is not totally independent but relies on the safety-related portion of the FPC system, GDC 2 and 4 are applicable for that portion of the FPC system. As stated above, the system is protected against the effects of adverse natural phenomena by virtue of its location in the reactor building. Also, SSAR Sections 3.5.1 and 3.6.1 and SSAR Table 3.6-2 include spent fuel pool cooling for protection against the effects of missiles (including those internally generated) and piping failures. GE's submittal dated June 2, 1989, further states that the major components of the FPC system are located in separately shielded rooms and that barriers, restraints, equipment compartments and the like protect fuel pool cooling components against failure of high-energy piping systems. The DSER (SECY-91-235) identified as part of Open Item 46 the need for GE to confirm that the safety-related portion of the system is protected from moderate-energy piping failures in the vicinity. (With confirmation of this item, the system would meet the requirements of GDC 2 and 4.) In SSAR Amendments 18 and 20, GE provided information indicating that the safety-related portions of the system are indeed protected from moderate-energy pipe breaks. This information resolves this part of DSER (SECY-91-235) Open Item 46. As noted in the preceding paragraph, GE has also committed to modify the design of the SGTS. This modification will resolve the part of DSER (SECY-91-235) Open Item 46 associated with the SGTS design and provide the required ventilation and filtration system required as an alternative to designing the entire fuel pool cooling and makeup system as a safety grade system. Incorporation of the identified changes to the SGTS into the SSAR is Confirmatory Item 9.1.3-1.

The DSER (SECY-91-235) stated that the FPC system design does not appear to accommodate any single active failures. (For example, the failure of a single diesel generator during a loss of offsite power results in the failure of the heat removal capability of one FPC heat exchanger owing to the failure of one train of the reactor building cooling water system.) A single heat exchanger has insufficient heat removal capability to maintain the fuel pool temperature at an acceptable level at all times. GE indicated that for some active single failures, using the RHR system may be necessary to limit the temperature of the fuel pool to less than 60 °C (140 °F). However, GE has not explained how the RHR system can be used for the maximum normal heat load removal without violating the technical specification requirements for availability of the system for other purposes in Mode 5 (refueling mode). In addition to this concern, the DSER (SECY-91-235) identified as part of Open Item 46 the staff concern with the apparent undersizing of the FPC heat exchangers for the ABWR. The staff identified as a concern sole reliance on the RHR system to supplement the FPC system's normal maximum spent fuel heat load removal capability during certain situations (e.g., all times preceding 21 days after shutdown and after 21 days when there is a single active failure coincident with a loss of all offsite power). To address this concern, GE provided additional commitments regarding the design of the RHR connection and alternative makeup capabilities. The connection will be protected from the effects of high-energy and moderate-energy pipe breaks and any other hazards to limit the likelihood of failure of the SPCU and RHR spent fuel pool makeup and cooling capability. SSAR Amendments 18 and 20 incorporated this information. GE also addressed the capability to provide alternative makeup within an acceptable time limit. Fire water makeup to the spent fuel pool will be available within

30 minutes after the failure of the fuel pool cooling capability. GE performed analyses to show that the spent fuel pool would not reach 60 °C (140 °F) under the maximum normal heat load at 21 days in less than this time. The GE analysis concluded that over 6 hours would be required for the pool to heat up to this level. (Under conditions of a full core off-load at 21 days after shutdown, the time to reach boiling was estimated to be over 16 hours.) The staff's independent calculations verify that the results are representative of the times available to provide additional makeup. The available time to realign the fire water system appears to be more than sufficient to make the configuration changes. Incorporation of this information into the SSAR is Confirmatory Item 9.1.3-2.

The system design characteristics needed to meet the requirements of GDC 61 have been described in the preceding paragraphs. The components of the FPC system are accessible and can be isolated to allow for periodic testing. The FPC system is located within the secondary containment portion of the reactor building, thus providing adequate containment. The FPC system contains design features to prevent reduction in fuel storage coolant inventory under accident conditions in accordance with Position C.6 of RG 1.13. The decay heat removal capabilities of the FPC system are designed to meet the heat load requirements of the fuel pool at 21 days after shutdown, not the requirements at 150 hours after shutdown. Use of the RHR system is required to meet the heat load requirements of the FPC system during the period between 150 hours and 21 days after shutdown. Additionally, as identified in the DSER, the FPC system is not capable of handling the decay heat load assuming both a loss of offsite power and a single active failure. Again the RHR system, in conjunction with the operable portions of the FPC system, is the system used to meet the heat load requirements. As indicated previously, GE has provided information justifying this system arrangement. The design includes measures to ensure RHR system operability in the spent fuel cooling mode and alternative makeup and cooling capabilities. The staff earlier identified incorporation of this information into the SSAR as Confirmatory Item 9.1.3-2.

As discussed in the preceding paragraph, GE's commitment to modify the design of the SGTS to incorporate two filter trains adequately addresses the staff's concern about the SGTS design, as it pertains to the need for redundant filters. However, incorporation of the information into the SSAR is Confirmatory Item 9.1.3-3.

GE has indicated that the load handling equipment located in nonseismic structures is intended to handle the equipment located in that structure (the radwaste building and the turbine building). Incorporation of this information in a future amendment to the SSAR will resolve this part of DSER Open Item 48. This is Confirmatory Item 9.1.5-1.

GE has committed to revising the response to RAI 410.43 to eliminate the contradictory statements regarding movement of the spent fuel cask. The text of SSAR Section 9.1.5.2.1 states that the reactor building crane will be interlocked to prevent movement over the spent fuel pool while carrying heavy loads. Eliminating the contradictory statements will resolve this part of DSER Open Item 48. Incorporation of the revisions to the response to RAI 410.43 is Confirmatory Item 9.1.5-2.

The rest of the system is not safety-related, as stated above, and is designed to non-seismic Category I standards. However, the non-safety-related portions of the system whose failure during a seismic event could affect any structure, system, or component important to safety, are designed to ensure their integrity under seismic loadings resulting from a SSE. Subject to GE's confirmation that the safety-related portions include the isolation valves for the secondary containment penetrations, the staff finds that the design of the HNCW system will meet Positions C.1 and C.2 of RG 1.29, as addressed by the SRP Section 9.2.2 acceptance criterion with respect to the seismic requirements for the safety-related and non-safety-related portions of the system. This was identified as Confirmatory Item 6 in Section 1.9 of the DSER (SECY-91-235), and is now Confirmatory Item 9.2.12-1.

GE has committed to provide information to reflect that Divisions "B" & "C" consist of two 50-percent capacity pumps and that Division "A" consists of one pump capable of meeting the hydraulic requirements of the train, which would be consistent with the information provided in revised SSAR Table 9.2-9. Incorporation of this information into the SSAR is now Confirmatory Item 9.2.13-1 and will resolve this part of Open Item 55.

GE has indicated that the only non-safety portions of the HECW divisions are the chemical addition tank and the piping from the tank to the safety-related valves which isolate the tank from the safety-related portions of the system. GE is to incorporate this information into the SSAR in a future amendment. This modification will resolve this part of DSER Open Item 55. Staff verification that the P&IDs are appropriately updated and the above information is incorporated into the system description in a future SSAR amendment is Confirmatory Item 9.2.13-2.

The TCW system is a non-safety-related system designed to provide heat removal capability for various turbine island auxiliary equipment. The TCW is a closed loop system consisting of three 50-percent pumps, three 50-percent heat exchangers, a surge tank, and associated piping, valves and instrumentation. In the Section 9.2.14, DSER (SECY-91-235), the staff noted that the description of the TCW SSAR Section 9.2.14 contained several inconsistencies. They noted that the component and system descriptions of SSAR Section 9.2.14.2.3, and of SSAR Figure 9.2-6a did not agree with the descriptions of SSAR Sections 9.2.14.2.1, and 9.2.14.2.2, and GE's responses to RAIs. The discrepancies (in particular, number of heat exchangers and pump capacities) required correction. GE has subsequently provided information and has committed to update the SSAR, which will eliminate the discrepancies between the figures and the text and resolves part of DSER Open Item 56[6]. The new information provided to the staff indicates that the system will be a 3 train system and the staff has incorporated this system description into this report pending its inclusion in the SSAR. Incorporation of the corrected and new information into the SSAR is Confirmatory Item 9.2.14-1.

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[6] Section 1.8 of the DSER (SECY-91-235) groupe[illegible] concerns of DSER Section 9.2.14 as Open Item 56. The other conce[illegible] addressed in a subsequent paragraph.

However, insufficient detail has been provided to ensure that this design criteria can be met. Specifically, location and design features for the RSW pump and associated equipment had not been specified prior to DSER (SECY-91-235) completion. This was identified in Section 1.8 of the DSER (SECY-91-235) as Open Item 57. GE has subsequently identified this information as an interface requirement and has established interface criteria to assure an appropriate design. Adequate guidance has been provided to insure that the RSW will comply with GDC 4 with respect to protection from dynamic effects resulting from postulated piping failures and internally and externally generated missiles. This closes the second part of DSER Open Item 57. Incorporation of this information into the SSAR is Confirmatory Item 9.2.15-1. Compliance will be reviewed on a plant-specific basis.

The TSW system is a non-safety related system designed to transfer heat from the TCW heat exchangers to the turbine plant heat sink. The TSW includes two 100-percent capacity pumps, two 100-percent capacity duplex strainers and associated piping, valves, and instrumentation. In the DSER, (SECY-91-235) the staff stated that GE did not provide system parameters (pump flow requirements, system operating pressure) but did provide a requirement that water supplied to the TCW heat exchangers be at a temperature not to exceed 40 °C (100 °F). GE has more recently provided additional information, and committed to update the SSAR, concerning the design of the TSW system. This is Confirmatory Item 9.2.16-1.

The TSW is located in the intake structure (the power cycle heat sink pump house) and the turbine building. The system does not appear to have any connections with safety-related systems. The applicant must demonstrate that all safety related components, systems, and structures are protected from flooding in the event of a pipeline break in the TSW system in order to meet position C.2 of RG 1.29 and thus comply with GDC 2. Due to the site specific nature of the location of some TSW components, the DSER (SECY-91-235) indicated that this requirement may need to be expressed as an interface requirement. This was identified in Section 1.8 of the DSER as Open Item 58. GE has subsequently identified the need to provide flood protection for safety-related structures, systems, and components from TSW component failures as an interface requirement. Incorporation of this requirement in the SSAR and the DCM will close DSER Open Item 58, but remains as Confirmatory Item 9.2.16-2.

The IA system provides dry, oil-free, compressed air for valve actuators and for non-safety-related instrument control functions and for general instrumentation and valve services outside the containment. (All instrumentation and control systems located inside the containment are supplied with nitrogen gas during normal plant operation.) The primary containment penetrations of the IA system are of seismic Category I design and are equipped with sufficient isolation valves to satisfy single failure criteria. In GE's response to RAI 430.215, the staff noted in the DSER (SECY-91-355) as an unnumbered confirmatory issue that the reference to "...containment penetrations and drywell penetrations of the instrument air system .." in SSAR Section 9.3.6.1.1 should be revised to reference primary containment penetrations only. The correction of the SSAR text is Confirmatory Item 9.3.1-1.

The staff reviewed the SSAR to identify the safety-related portions of the CA system and stated in the DSER (SECY-91-355) that the text and figures in SSAR Section 6.7 did not clearly identify which portions of the HPIN system are safety related. However, the response to an RAI and valve and instrument numbers reflected on a draft revision to SSAR Figure 6.7- provides information that identifies which portions of the system are safety related. These portions include nitrogen storage bottles and their headers up to and including F002A through F002D; piping and valves from F002 (A through D) to the accumulators for the ADS valves; and piping from the cross-tie valves F012A and B to the piping identified previously. Additional safety-related piping in the IA and AC systems include piping and valves from F200 to F209, inclusive. (The staff noted an inconsistency in the designation of the inboard isolation valve in that, GE refers to as F209 in all drawings and as F208 in responses to RAIs. In DSER Table 9.3.1-1, the staff identified (DSER Open Item 69) additional numbering inconsistencies, including valve numbers and valve operator type. Also, the staff noted (DSER Open Item 70) that information related to the safety classification of components had not been fully incorporated into the SSAR text and figures prior to DSER completion. While the information provided in response to requests for information is acceptable, the DSER (SECY-91-355) noted that this information should be fully incorporated into the SSAR. The inconsistencies and lack of information noted in the DSER were addressed in revised figures to be incorporated into the SSAR. This information closes DSER Open Items 69 and 70, however, incorporation of this information into the SSAR is Confirmatory Item 9.3.1-2.

Contrary to the guidelines of the SRP, the SSAR does not indicate the failure mode for the valves in the HPIN system. Except as noted below and assuming that the MOVs fail "as-is," the system configuration is acceptable. In the DSER, (SECY-91-355) the staff noted as Open Item 71 of the DSER (SECY-91-355) that information related to the failure mode of components should be incorporated into the SSAR text and drawings. GE has indicated in a letter dated March 11, 1992, that the motor operated valves in the air systems fail as is; air-operated valves fail open (unless otherwise indicated) in the HPIN, IA, and SA systems and fail closed in the ACS. This information resolves DSER Open Item 71, however, identification of the failure modes of the valves in the CA systems (i.e., confirmation of the failure states) in the SSAR is Confirmatory Item 9.3.1-3.

In the DSER, the staff noted that Valves AO F018A & B in SSAR Figure 6.7-1 are indicated as "NC. FO." (i.e., normally closed and fail open) and that this was inconsistent with the text of Section 19E.2.1.2.2.2(2)(b), which indicates that upon a loss of power, the operator will have to manually open these valves. The staff noted that this is also inconsistent with a design which should protect the storage bottles from inadvertent depressurization due to a postulated line break. Confirmation that these valves do not fail in the open position was identified as DSER (SECY-91-355) Open Item 72. In a letter dated March 11, 1992, GE changed these valves to motor-operated valves that are normally locked closed and as such they will fail as is, closed. This closes the DSER Open Item 72. Incorporation of this information into the SSAR is Confirmatory Item 9.3.1-4.

The staff stated in the DSER (SECY-91-355), that SSAR Section 9.3.6.1.2 indicates that the non-safety-related IA System is also used as a backup to the nitrogen system when, during normal operation, the nitrogen gas supply pressure drops below a specified setpoint. The staff noted that this conflicts with GE's earlier response to RAI 430.218 dated March 11, 1992, which states: "Instrument air system does not serve as a backup to HPIN system during normal operation...." The resolution of this discrepancy was identified as Open Item 74. In a letter dated March 11, 1992, GE committed to revise the response to RAI 430.218 to indicate that the IA system can be used as a backup to HPIN system in the event that nitrogen pressure drops below the system low pressure set point and recovery efforts have failed. IA would be used until the HPIN repairs could be completed. This information resolves DSER Open Item 74, however, incorporation of this information into the SSAR is Confirmatory Item 9.3.1-5.

To assure the availability of the SLCS, two sets of the components required to actuate the system (pumps and injection valves) are provided in parallel redundancy. The injection portion of the system can be functionally tested by injecting demineralized water from a test tank into the reactor. Because of the importance of valve reliability for the storage tank discharge valves, the staff requires GE to confirm that the valves will have adequate testing requirements and the valves be incorporated into the Reliability Assurance Program. This issue is Confirmatory Item 9.3.5-1.

All system piping is designed to remain intact following a seismic event. The drain system is not the only method of leak detection available for any of the areas served by the system and this method is not considered in the facility flood analysis. The designation of most of the system as non-nuclear safety-related is appropriate. However, the staff indicated in DSER (SECY-91-355) Open Item 77 that the check valves that provide backflow protection for sumps in the ECCS equipment rooms should be classified as Safety Class 3 and designed to seismic Category I and Quality Group C criteria. GE has committed to revise SSAR Table 3.2-1 and Figure 11-2 to include the designation of these valves as being Safety Class 3, and designed to seismic Category I and Quality Group C criteria. This information resolves DSER Open Item 77, however, incorporation of the information into the SSAR is Confirmatory Item 9.3.8-1.

The staff noted in the DSER (SECY-91-355) that SSAR Section 9.3.8.2 inaccurately refers to SSAR Section 9.3.9.1, when the interface requirements discussed in SSAR Section 9.3.12 would be the appropriate reference. Also, the staff indicated that GE should revise the first design basis discussed in SSAR Section 9.3.8.1 to clearly indicate, consistent with the staff's dialogue with GE, that only portions of the drain system are considered safety-related. Correction of the SSAR reference and revision of SSAR Section 9.3.8.1 will resolve DSER Open Item 79. Incorporation of the revisions in the SSAR is Confirmatory Item 9.3.8-2.

Smoke detectors in the control room and the control equipment room activate an alarm on detection of smoke. Atmospheric exhaust of 100-percent of conditioned air is provided by manual activation of a switch, which closes return dampers and opens exhaust dampers. In the DSER (SECY-91-325) the staff stated that this system design meets the control room habitability requirements of

TMI Action Item III.D.3.4 of NUREG-0737 with regard to smoke removal, contingent upon GE providing revised P&IDs showing smoke detection capability. The P&IDs for the control room and the control equipment room currently do not include smoke detectors at the air intakes. However, GE has committed to providing smoke detectors at the air intakes that will cause the control room HVAC system to shift to the recirculation mode in the event smoke is detected in the air supply. This commitment satisfies the second part of DSER Open Item 60, however, incorporation of the commitment in the SSAR is Confirmatory Item 9.4.1.1-1.

During a meeting with the staff on May 5, 1992, GE committed to move one train of the SGTS to an available space on a mezzanine level directly above the location presently shown (SSAR Figure 9A.4-6). These 2 areas will be completely separated from each other by 3-hour fire-rated barriers. This arrangement satisfies the staff's concern. Pending revision of the SSAR to include this change, this is a Confirmatory Item 9.5.1.2.2-1.

Instrumentation provided for the fuel oil storage and transfer system includes level indication for the day tank, temperature sensors at the intake and discharge of the day tank, and pressure indication for the suction of the engine-mounted and dc-driven fuel oil pumps. In the DSER (SECY-91-355), the staff indicated as part of DSER Open Item 83[7] that the sensor on the tank discharge did not appear on the fuel oil system P&ID. GE has provided a revised figure showing this temperature sensor, which resolves this part of DSER Open Item 83. However, incorporation of the revised figure in the SSAR is Confirmatory Item 9.5.4.2-1.

Level sensors provide signals to start the fuel oil transfer pumps, one starts on low level, a second on low-low level. At the low level, a 60-minute supply (at full diesel generator load) of fuel oil is available for diesel generator operation. From the information GE provided it is unclear whether storage tank level instrumentation is provided. In describing its commitment for a stick gauge provision, GE stated that level switches are provided to monitor tank level. In the DSER (SECY-91-355), the staff identified inconsistencies in the listing of these level switches between parts of SAR Sections 9.5.4 and 8.3. GE has committed to include the level switches and the stick gauge provision in the appropriate parts of SSAR Section 9.5.4, Section 8.3.1.1.8.5, and the referenced figures. This commitment resolves DSER Open Item 82, however, incorporation of this information into the SSAR is Confirmatory Item 9.5.4.2-2.

SSAR Figure 9.5-6 depicts the standby diesel generator fuel oil system. From review of this figure, the staff concluded in the DSER (SECY-91-355), that the fuel storage tanks and associated instrumentation should be added to the figure. The staff noted discrepancies between the text and Figure 9.5-6, regarding the optional characterization of the electric fuel oil pump. Also, GE's response to RAI 430.273 stated, in part, that "two local fuel oil temperature indicators are provided (one in the suction line and one in the

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[9] In DSER (SECY-91-355) Open Item 83 the staff identified two concerns. The second part of Open Item 83 is addressed in a subsequent paragraph.

discharge line) from the day tank." Figure 9.5-6, however, identifies only one temperature sensor. GE has committed to include a revised Figure 9.5-6 in the SSAR that will include the fuel storage tanks and their associated instrumentation. This commitment resolves the other part of DSER Open Item 83. However, incorporation of these revisions into the SSAR is Confirmatory Item 9.5.4.2-3. (See also Confirmatory Item 9.5.4.2-1 discussed previously.)

In the DSER (SECY-91-355), the staff noted a discrepancy between the text of SSAR Section 9.5.5 and Figure 9.5-7 regarding the circulating water pump. Section 9.5.5 identifies the jacket circulating water pumps as engine- and motor-driven while Figure 9.5-7 identifies both as being motor-driven. (This discrepancy was considered part of DSER Open Item 85.) Additionally, the interface criteria of Section 9.5.13.6 stated that the selection of the motive power for these pumps was an interface requirement. This implication disagrees with the text of Section 9.5.5 and Figure 9.5-7, wherein motive power for the pumps, although inconsistent, was clearly specified by GE. (This was the other part of DSER Open Item 85.) GE has committed to provide consistent information regarding the power source for the jacket cooling water pumps. The references to specific power sources are to be removed, and the selection of the power supply is to be incorporated as COL Action Item 9.5.5-1. These changes close DSER Open Item 85, however, incorporation of these changes into the SSAR is Confirmatory Item 9.5.5-1.

Also for item 3 above, the selection of an Amot type or equivalent valve was not specifically identified as part of the interface criteria for the selection of this valve. The staff concluded in DSER (SECY-91-355) Open Item 86 that GE should include this selection information as COL Action Item 9.5.5-1 for temperature sensor selection. GE has committed to incorporate the reference to an Amot-type temperature sensor, or equivalent into the SSAR. Therefore, DSER Open Item 86 is resolved, however, incorporation of this reference into the SSAR is Confirmatory Item 9.5.5-2.

In Amendment 16 of the SSAR, GE responded to Q430.285, stating that each air dryer system be provided with an air dryer equipped with pre-filters and after-filters. SSAR Figure 9.5-8 does not specifically identify pre-filters and after-filters for the air dryers. Addition of these filters to the P&ID (or a statement specifically identifying the filters as an integral part of the air dryer component) was identified as DSER (SECY-91-355), Open Item 88. GE has committed to revise SSAR Figure 9.5-8 to incorporate the pre- and after-filters into the design. This modification will resolve DSER Open Item 88. However, incorporation of the modification into the SSAR is Confirmatory Item 9.5.6-1.

GE identified several design parameters as future interface requirements to be determined once a diesel generator vendor has been selected. Interface requirements to be specified included the devices to crank the engine, air start requirements with regard to the duration of the cranking cycle, and the number of engine revolutions per start attempt. These interface requirements would dictate design parameters such as the volume and design pressure of the air receivers (sufficient for 5 start cycles per receiver) and compressor size (sufficient discharge flow to recharge the system in under 30 minutes). The staff believed, that once established these interface criteria would provide an adequate basis for the selection of component capacities. This was identified as DSER (SECY-91-355), Open Item 89. As a result of its review of the ABWR interface requirements, the staff reclassified these items to fall within the design certification scope. GE has committed to providing two requirements: one addressing the number of starts possible from the air receivers, and a second on the time needed to recharge the air receivers. The staff will verify system compliance with these requirements as part of the ITAAC program. This resolves DSER Open Item 89, however, incorporation of the modifications into the SSAR is Confirmatory Item 9.5.6-2.

The starting air system description does not include a reference to coolers at the discharge of the air compressors, although SSAR Figure 9.5-8 includes after-coolers located downstream of the starting air compressors. This discrepancy was identified as DSER (SECY-91-355) Open Item 90. GE has committed to incorporate the coolers into the description of the starting air system. This modification resolves DSER Open Item 90, however, incorporation of the modifications into the SSAR is Confirmatory Item 9.5.6-3.

The major components of the lubrication system include the engine lube oil pump (within the engine frame), an engine-driven pump, an oil cooler, a generator shaft lube oil cooler, an electric lube oil heater, a keep-warm circulating pump, oil filter, and strainer. Local alarms signal low oil pressure, high oil temperature, and low oil level. These signals are part of a general diesel generator trouble alarm located in the control room. Low oil level alarms are described in SSAR Section 8.3.1.1.8.5 and refill is described in SSAR Section 9.5.7 as being performed on the indication of low level (a lube oil supply pump actuated by a low level indication in the engine sump). In DSER (SECY-91-355) Open Item 91, the staff noted that SSAR Figure 9.5-9 did not show any level indication for the lube oil system. GE has subsequently committed to correct the figure to include the level instrumentation, which had been mistakenly identified as a flow transmitter. This correction will resolve DSER Open Item 91, however, incorporation of the modifications into the SSAR is a Confirmatory Item 9.5.7-1.

GE also stated that the protective features to prevent crankcase explosions and features to mitigate the consequences of such an event (such as relief ports) are vendor specific and would also be included as interface criteria after selection of a diesel engine vendor. As a result of staff review of interface requirements, these protective features have been reclassified as ITAAC items and will be verified as part of the ITAAC program. Inclusion of these design criteria was as Open Item 92 in the DSER (SECY-91-355). GE has committed to incorporate the above identified system design characteristics into the SSAR for use when the diesel vendor is selected. The means to protect the diesel generator from crankcase explosions are: the use of vacuum blowers to maintain the crankcase at negative pressure and the diesel will be shutdown on high pressure conditions unless a LOCA signal is present. This information is to be incorporated into Section 9.5.8 of the SSAR and will close DSER Open Item 92. Incorporation of the modifications into the SSAR remains Confirmatory Item 9.5.7-2.

All diesel generator lubrication system piping and components will be designed in accordance with ASME Code Section III, Class 3 requirements or ANSI B31.1, guidance and will be seismic Category I. The diesel engine interface for the lubrication system has not been identified (a diesel engine vendor-specific definition) and, therefore, the components to be designated to meet ASME requirements, have not been separately identified from those required to meet the ANSI standard. To meet NRC requirements, all components up to the diesel engine interface must meet the ASME requirements. The NRC staff has, in the past, accepted the ANSI classification of engine-mounted components provided they are pressure tested to 1.5 times design pressure and information to that effect is documented. Recognizing that the keep-warm heater and the priming pump do not have to be nuclear safety grade, the staff identified classification of components in the lubrication system as Open Item 93 in the DSER (SECY-91-355). The staff noted that identification of components that meet the ASME requirements and those that meet the ANSI requirements with the pressure testing provision was Open Item 94. GE has subsequently committed to revise the response to RAI 430.271 to clearly indicate which components are to meet the ASME requirements and which are to meet the ANSI requirements. Engine-mounted components are to be designed to the ANSI standards, all others, except the keep warm-heater and the priming pump, are to meet the ASME standard. The proposed modification will resolve DSER Open Items 93 and 94, however, incorporation of the changes into the SSAR is Confirmatory Item 9.5.7-3.

The combustion air intakes are located on the side of the reactor building and are protected (by vertical grills) from tornado missiles. The intakes are located 11.5 m (37.7 ft) above grade and are designed to minimize any effects from dust and debris through the use of vertical grills set into the reactor building wall with filters located behind the grills. The intakes are protected from flooding by their location. The diesel generator exhausts are partly housed within the reactor building with the exhaust silencer located on the roof of the reactor building. The design basis for the silencer requires that it be seismically qualified and able to withstand the effects of tornadoes. In DSER (SECY-91-355) Open Item 96, the staff noted that the means of protection from tornado missiles had not been adequately discussed. GE has committed to update the SSAR to indicate that the silencers are seismically mounted and bolted in a horizontal position. However, this design change does not adequately address protection of the silencers from tornado missiles. Therefore, this issue remains as Open Item 9.5.8-1. In SSAR Section 9.5.8, GE committed to housing the system in a seismic Category I structure to provide tornado-missile protection. This resolves DSER Open Item 96, however, confirmation that the SSAR has been updated is Confirmatory Item 9.5.8-1.

The SSAR provides no information on the design of the diesel generator combustion air intake and exhaust system which extends from the crankcase vacuum blowers to the outside environment. DSER Open Item 97 (SECY-91-355), requested additional information regarding this area, identified in SSAR Figure 9.5-6. GE has committed to modify the response to RAI 430.294 to indicate that this part of the system consists of piping only. This information resolves DSER Open Item 97, however, incorporation of the modification into the SSAR is Confirmatory Item 9.5.8-2.

CHAPTER 10

OPEN ITEMS

GE has submitted the inspections, tests, analysis, and acceptance criteria (ITAAC) for the turbine generator. The results of this review will be included in the final safety evaluation report (FSER). This is Open Item 10.2.1-1.

An applicant or licensee referencing the advanced boiling water reactor (ABWR) standard plant design must submit the turbine disk test data and the calculated toughness curve to the NRC staff for review. This requirement will be included in the turbine ITAAC. This is Open Item 10.2.2-1.

The turbine rotor design will be a solid forged monoblock rotor rather than one with shrunk-on disks. A forged rotor will not be as susceptible to stress corrosion cracking as experienced in the shrunk-on disks. The combined stresses of low-pressure turbine disk at design overspeed resulting from centrifugal forces, interference fit, and thermal gradients will not exceed 75 percent of the minimum specified yield strength of the material. The design overspeed of the turbine will be 5 percent above the highest anticipated speed resulting from a loss of load. The applicant or licensee referencing the ABWR standard plant design must provide the basis for the turbine design overspeed to the Nuclear Regulatory Commission (NRC). This requirement will be included in the turbine ITAAC. This is Open Item 10.2.2-2.

GE has submitted ITAAC for the main steam supply system. The results of this review will be included in the FSER. This is Open Item 10.3.1-1.

GE has submitted the ITAAC for the main condenser. The results of the staff's review will be included in the FSER. This is Open Item 10.4.1-1.

GE has submitted the ITAAC for the MCES. The results of the staff's review will be included in the FSER. This is Open Item 10.4.2-1.

GE has submitted the ITAAC for the TGSS. The results of the staff's review will be included in the FSER. This is Open Item 10.4.3-1.

GE has submitted the ITAAC for the TBS. The results of the staff's review will be included in the FSER. This is Open Item 10.4.4-1.

GE has submitted the ITAAC for the CWS. The results of the staff's review will be included in the FSER. This is Open Item 10.4.5-1.

GE has submitted the ITAAC for the CFS. The results of the staff's review will be included in the FSER. This is Open Item 10.4.7-1.

CONFIRMATORY ITEMS

SSAR Appendix 3F indicates that since the safety-related portions of the condensate and feedwater system (CFS) and the main steam supply system (from the reactor up to and including the seismic interface restraints) are qualified for the leak-before-break (LBB) criterion, a high-energy pipe break does not need to be considered in these portions of the above systems solely for considering the local dynamic effects associated with such breaks. GE has provided generic LBB evaluation procedures and methodology for the systems in SSAR Appendix 3F to support this claim. As stated in Section 3.6.3 of this report, the staff expects that a bona fide LBB analysis should use plant-specific data such as piping geometry, materials, fabrication procedures, loads, degradation mechanisms, and pipe support locations. Therefore, the staff will evaluate the acceptability of the above LBB claim on a plant-specific basis to determine if the essential portion of the main steam supply system will be adequately protected against dynamic effects associated with high-energy pipe breaks. In a meeting with the staff on May 5, 1992, GE committed to remove references to LBB from the SSAR. This is Confirmatory Item 10.3.1-1. GE has provided, in SSAR Section 6.2.3, an analysis of a main steamline and main feedwater line pipe failure inside the main steam tunnel (MST). The results of the staff's review of this analysis are contained in Section 6.2.1.7 of this report. Features to protect the MSIVs from the effects of a pipe failure inside the MST are evaluated in Section 3.6.1 of this report.

Regarding the other aspect of GDC 4, which deals with the environmental design basis for systems, structures, and components important to safety, in SSAR Appendix 3I, GE indicates that the essential equipment of the system is environmentally qualified to function following a postulated high-energy pipe break. Specifically, this means that the MSIVs will be required to function to ensure main steam isolation and will be qualified to function in the expected steam environment resulting from a steamline break. Further, GE identified an interface requirement for a COL applicant that requires the COL applicant to explain how the MSIV functional capability will be protected against the effects of postulated pipe failures. Following its review of all interface items, GE committed to revise the SSAR and include an ITAAC requirement to address this issue as discussed below. This is Confirmatory Item 10.3.1-2.

On each of the feedwater lines from the common feedwater header to the reactor, there will be a seismic interface restraint. A remote manual motor-operated gate valve powered by a non-safety-grade bus will serve as a feedwater shutoff valve. Downstream of this motor-operated gate valve, there will be a spring-closing check valve that will be held open by air and serve as the outboard containment isolation valve. On the other side of the containment, a check valve will serve as the inboard containment isolation valve, and downstream of this check valve will be a manual maintenance valve. However, the staff identified in Open Item 69 in the DSER (SECY-91-235) that the provision of a non-safety-grade power source for the remote manual shutoff gate valve was inappropriate because the valve and the portion of piping in which it will be located are designed as seismic Category I and the valve will serve as a long-term isolation for containment. In a meeting with the staff on May 5, 1992, GE stated that insights from the probabilistic risk assessment (Chapter 19 of the SSAR) indicate that the ability to open the valve using diverse non-safety-grade on-site power instead of safety-related power to initiate feedwater flow reduces the risk. This valve is not relied upon as a long-term leakage barrier. Instead, GE has provided high reliability check valves.

Additionally, the spring-closing check valves will be testable and a provide positive means of isolation. Therefore, the use of diverse non-safety-grade power for the manual shutoff gate valve will be acceptable subject to GE providing documentation of the information discussed in the May 5 meeting. This is Confirmatory Item 10 4.7-1.

In a meeting with the staff on May 5, 1992, GE committed to remove references to LBB from the SSAR. This is Confirmatory Item 10.3.1-1 in Section 10.3.1 of this report. GE has provided, in SSAR Section 6.2.3, an analysis of a main steamline and main feedwater line pipe failure inside the MST. The results of the staff's review of this analysis are found in Section 6.2.1.7 of this report.

CHAPTER 11

OPEN ITEMS

Tier 1 design information and inspections, tests, analyses, and acceptance criteria (ITAAC) are required for the radwaste system. GE has submitted the Radwaste System ITAAC for staff review. The results of this review will be included in the final safety evaluation report (FSER). This is Open Item 11.0-1.

CONFIRMATORY ITEMS

IE Bulletin 80-05 identified an issue concerning the release of radioactive material or other detrimental effects as a result of low vacuum conditions causing tank buckling. The low vacuum condition is created by cooling hot water in the low-pressure tank. Per fax dated May 21, 1992, GE stated that several low-pressure tanks that could contain primary system water have vents to prevent the development of a low vacuum condition. This will satisfy the tank failure concern in IE Bulletin 80-05, subject to confirmation of the above information in the SSAR. This is Confirmatory Item 11.2.2-1. GE will provide the above design information in a future standard safety analysis report (SSAR) amendment.

(1) The design includes monitoring the radioactivity of effluents to unrestricted areas. The exhausts from certain areas of the reactor building (serviced by the essential electrical equipment and essential diesel generators HVAC subsystems) and the turbine island (serviced by the electrical building ventilation system) will be directly released to the environs unmonitored. In addition to the above areas, the staff stated in the DSER that the exhausts from the battery rooms and lube oil area in the turbine island and the reactor internal pump (RIP) control panel room in the reactor building were unmonitored (DSER Open Item 78). However, Amendment 16 of the ABWR SSAR shows the lube oil exhaust being monitored at the plant vent and does not show a battery room in the turbine island (Figures 9.4-2a and 2b). Amendment 20 shows the RIP control panel room HVAC subsystem as a closed cooling HVAC subsystem with no outside air supply to the room or exhaust from the room to the environs (Figure 9.4-5). Further, by telefax dated June 9, 1992, GE proposed a

revision to SSAR Subsection 11.5.2.2.4 that states that the exhausts from the areas serviced by the HVAC systems mentioned above are not monitored since the subject areas do not contain any radioactive systems and that the only releases to the environment by these systems would first have to be brought into the areas by their own HVAC system's supply fans. This lack of monitoring effluents is acceptable since GDC 60 does not require the monitoring of pathways with no potential for radiation. Therefore, this part of DSER (SECY-91-235) Open Item 78 is resolved pending revision of the SSAR. This is Confirmatory Item 11.5.2-1. GE will provide the above design information in a future SSAR amendment.

CHAPTER 12

OPEN ITEMS

In addition to the radiation protection features addressed in the DAC above, SSAR Chapter 12 describes several features that are incorporated into the ABWR design to ensure that radiation doses to operators and the public are within the limits of 10 CFR Part 20 and are ALARA. These features include the limited use of cobalt bearing components in the reactor water systems; the use of titanium main condenser tubing; remote back-flushing capability on all filter-demineralizers; the use of seamless piping, butt-welds, and straight-through valves, where practicable, to eliminate crud traps; the use of an electro-mechanical switch on the TIP drive and the TIP warning alarm at the lower drywell access; and the fittings on the RWCU, RHR, and RIP heat exchangers to facilitate decontamination. GE has not completed its submittal of the ABWR Tier 1 design description and ITAAC. Therefore, the staff cannot verify that these features are included in this Tier 1 documentation. This is an open item pending a satisfactory review of the completed ABWR Tier 1 documentation. This is Open Item 12.3.5.3-1.

CONFIRMATORY ITEMS

GE provided a draft revision to the SSAR (dated March 26, 1992) that includes additional information concerning the radiation protection design features of the ABWR TIP system. These features include a shielded room for the TIP drive units with a separate shielded room for the parked TIP. Additional shielding will be provided for the parked TIP probe and its drive cable to allow personnel to enter this room with the TIP out of the reactor. Also the TIP drive units will have an electro-mechanical switch that cuts power to the drive spooler to prevent the activated portions of the TIP from being completely withdrawn into the drive housings. These features are designed such that radiation exposures resulting form TIP operations, and related abnormal AOOs, can be maintained ALARA. Therefore, they are acceptable to the staff, however, GE is required to amend its SSAR accordingly. This is Confirmatory Item 12.1.2-1.

SSAR Section 12.2.3 identifies two issues as plant interfaces: (1) the compliance with 10 CFR Parts 20 and 50, and (2) the determination of gamma shine from the turbine building. It is the staff's position that these issues are incorporated in the DAC discussed in Section 12.2.2 above and should not be identified as interfaces. During a conference call following the meeting of

February 27, 1992, on plant interfaces, GE agreed to amend the SSAR and appropriately characterize these issues. This is Confirmatory Item 12.2.3-1 pending a review of the amended SSAR.

In the DSER, the staff identified several deficiencies (Open Items 108 through 110) with SSAR Chapter 12 Figures 12.3-1 through 12.3-73, which depict plant radiation zones (during normal operations, normal shutdown, and accident conditions) and area radiation monitor locations. GE has amended the SSAR to provide more legible figures for the reactor, control, and radwaste buildings. These updated figures also indicate the normal controlled and uncontrolled access routes to the plant as well as the access and egress routes to plant vital areas under accident conditions. In response to a staff question, the radiation zone designation above the spent fuel pool (from greater than 1.0 mSv (100 mrem)/hr) was found to be in error. The radiation zone designation for this area was revised to less than 0.05 mSv (5 mrem)/hr). These dose levels for above the spent fuel pool are consistent with industry experience, and therefore are acceptable to the staff. The staff considers this resolved. On April 13 and May 1, 1992, GE provided draft revised copies of the reactor and turbine building figures. The revised figures resolved the inconsistencies between the turbine building figures noted in the DSER. This is Confirmatory Item 12.3.1-1 pending a review of a corresponding amendment to the SSAR.

The DSER (SECY-91-355) contained Open Item 111 concerning the provision in the ABWR design to facilitate chemical decontamination of heat exchangers in systems that carry radioactive water. On April 9, 1992, GE provided a draft SSAR amendment that indicates that separate decontamination connections are provided on the reactor water cleanup non-regenerative and regenerative heat exchangers. Heat exchangers in the residual heat removal (RHR) system and the heat exchangers for reactor internal pump (RIP) cooling will be provided with fittings that allow flushing with clean water. GE's corrosion product control features are consistent with the guidance in RG 8.8 (Rev. 3) and the SRP and are acceptable. This is Confirmatory Item 12.3.1-2 pending a review of the SSAR amendment.

The adequacy of the shielding in the upper drywell was identified as an Open Item 112 in the DSER (SECY-91-355). The biological shield surrounding the reactor vessel (depicted in SSAR Figures 12.3-23 and 12.3-24) does not cover a significant portion of the top of the reactor vessel. As noted in Section 12.1 of this report, a fuel handling mishap resulting in dropping an SFA across the reactor flange is a significant radiological hazard in BWRs. In addition to the radiological hazard presented by this AOO, it appears that raising an irradiated fuel bundle in proximity of the vessel wall could result in significant radiation dose rates in the upper drywell. On July 29, 1991, GE provided details of a proposed design change to the shielding in the upper drywell. This design change would raise the biological shield to within 4 inches of the upper drywell ceiling. The staff's evaluation of this proposal indicated that the revised design would provide sufficient shielding during the normal withdrawal of SFAs from the reactor. However, a dropped SFA resting across the reactor flange would still produce significant radiation streaming into the upper drywell. Personnel in the upper drywell during this AOO could receive lethal radiation doses before they could escape. The staff concludes that the ABWR design as described in the SSAR and revised by the memorandum of July 29, 1991, is inadequate to ensure radiation protection during this event and is not acceptable. In addition, GE has not provided an update to the seismic or containment analysis to reflect the impact of this design change. During a management meeting held on March 25 and 26, 1992, in San Jose, California, GE committed to revise the upper drywell shielding to resolve this issue. This remains an open item pending a review of the revised design. This is Confirmatory Item 12.3.2-1.

The shielding of the TIP system was identified as an Open Item (106) in the DSER (SECY-91-355). As discussed in Section 12.1.2 of this report, TIP drive and storage are located in separate shielded rooms. However, the conduit that guides the TIP from the reactor to its storage is virtually unshielded. This conduit shares the primary containment penetration with the lower drywell personnel access. Personnel located at the lower drywell access hatch, or in the access tunnel, would be exposed to the unshielded activated TIP and drive cable as they are retracted from the reactor core. On March 26, 1992, GE provided a draft SSAR amendment that discusses the radiation design features associated with the TIP system. This amendment notes that the lower drywell access will be located in a separate shielded room that can be locked to prevent access to these areas while the TIP is being withdrawn from the core. In addition, flashing alarms at the door to this room and at the lower drywell access hatch will be provided to warn personnel when power is applied to the TIP drives. Also, the TIP system will operate so that the TIP is withdrawn in the high speed mode, which will minimize the transit time of the activated components through the unshielded portions of the system. These features ensure that the personnel radiation exposures resulting from the operation of the TIP system can be maintained ALARA and are acceptable. This is Confirmatory Item 12.3.2-2.

These design features are in accordance with the guidelines of RG 8.8 (Rev. 3)* and are acceptable. However, as noted in Section 12.2 of this report, the expected leakage of radioactive fluids from plant systems cannot be determined at this stage of the ABWR design. Without this source term, GE is not able to provide the concentrations of airborne contamination in cubicles, rooms, and corridors as specified in the SRP (SECY-91-355) Open Item 113. Therefore, the staff cannot verify that the plant ventilation system design meets the criteria in the SRP. As an alternative, GE provided DAC that require the COL applicant to calculate the expected concentrations of airborne radionuclides, consistent with the SRP, to verify that adequate ventilation is provided. Section 12.3.5.2 of this report contains the staff's evaluation of this DAC. In addition, on May 1, 1992, GE provided a draft proposed appendix to SSAR Chapter 12 that describes the calculational methods and assumptions that will be used to satisfy the DAC (3.7b). These calculational methods and assumptions are consistent with provisions of the SRP and are acceptable subject to the above information being included in a SSAR amendment. This is Confirmatory Item 12.3.3-1.

CHAPTER 13

OPEN ITEMS

Therefore, the TSC for the ABWR standard plant should be sized for 25 persons and be compatible with the control room in order to meet the criteria of NUREG-0696. This is Open Item 13.3-1.

GE considers other facilities that support emergency planning to be outside the scope of the ABWR standard plant. These include: (1) an onsite OSC (assembly area) separate from the control room and TSC where licensee operations support personnel report in an emergency, and (2) an offsite EOF for the management of overall licensee emergency response, including coordination with Federal, State and local officials. The staff agrees that the EOF is not within the scope of the ABWR standard plant design, but must be addressed by an applicant referencing the ABWR standard plant design. This is COL Action Item 13.3-2. However, an OSC should be provided as part of the ABWR standard plant design. This is Open Item 13.3-2.

The requirements for the TSC and OSC are not covered in the Tier 1 design descriptions or inspections, tests, analyses, and acceptance criteria (ITAAC). This is Open Item 13.3-3.

The Electric Power Research Institute (EPRI) Advanced Light Water Reactor (ALWR) Requirements Document (Volume II, Revision 1, Chapter 11, Section 8.4.1) specifically requires the protected area lighting to be powered from an uninterruptible power source. GE's response to request for additional information (RAI) Q910.18 identified a site security load on the non-Class 1E vital (uninterruptible) load list (SSAR Table 20B-1), but the staff considered the description of this interconnection to be insufficiently defined. In response to staff comments, GE added SSAR Section 19B.3.12, which clarified the connection between the security system uninterruptible power requirements (to be later so determined by the plant-specific security system designer as to meet required security system performance) and the non-Class 1E vital power supply capacity. SSAR Section 19B.3.12 allows the protected area lighting to be powered from an interruptible power source, which conflicts with the lighting guidelines in the EPRI ALWR Requirements Document. This is part of Open Item 1.1-1 discussed in Chapter 1 of this report.

The staff expects that at least 60 days before loading fuel, a COL licensee referencing the ABWR design shall have confirmed that the as-built bullet-resistant feature of walls and doors and the penetration-resistant feature of barriers in HVAC ducting and exhausts, committed to in SSAR Section 13.6.3.6, have been installed in all locations required by the commitment. This inspection requirement should be included in appropriate building ITAAC and is Open Item 13.6.3.6-1.

CONFIRMATORY ITEMS

(none)

CHAPTER 14

OPEN ITEMS

The staff has requested GE to develop a cross reference of key aspects, analyses, and features of the design from the SSAR to the ITAAC in order to document how these issues have been incorporated into the ITAAC. Specifically, the cross reference will show how key aspects of the accident analyses, PRA, and severe accident issue resolutions are included in ITAAC. This is Open Item 14.1.1.5.2-1.

GE has proposed that certain systems could have Tier 1 design descriptions, but may not require any corresponding ITAAC to verify the design for those systems. Examples of these systems are the fuel service equipment, the internal pump maintenance facility, and the fuel cask cleaning facility. The staff is reviewing this proposal. This is Open Item 14.1.1.5.3-1.

The system ITAAC information provided in the Tier 1 design certification material is under staff review, and the evaluation will be provided in the FSER. This is Open Item 14.1.2-1.

The staff's evaluation of generic ITAAC for EQ will be provided in the FSER. This is Open Item 14.1.3.1-1.

At this time, GE has not provided the staff any specific information regarding the method to be used for the structural design of small-bore piping systems and instrumentation lines in the ABWR standard plant. This information must be included in the SSAR. This is Open Item 14.1.3.3.3.6-1.

In SSAR Section 3.7.3.12, GE outlines criteria that will be used in the analysis of buried seismic Category I piping systems. These criteria conform to the applicable guidelines in SRP Section 3.9.2. However, GE has not provided any detailed information on how the criteria are to be applied in the design of buried piping. Specifically, GE should address, as a minimum, (1) the maximum bearing loads, (2) the categorization of seismic stresses in the Code evaluation, and (3) the allowable stress limits for the piping. This information must be included in the SSAR. This is Open Item 14.1.3.3.3.9-1.

The staff is currently performing an independent confirmatory piping stress analysis of representative piping systems in the ABWR standard plant. The purpose of these analyses is to verify the adequacy of the GE computer program used to generate the sample piping analyses that were audited by the staff on March 23-26, 1992, at GE's offices in San Jose, California. The results of the confirmatory analysis will be included in the FSER. This is Open Item 14.1.3.3.4.1-1.

The NRC staff is currently reviewing the adequacy of the GE computer program used in the representative ABWR piping analyses that were audited by the staff on March 23-26, 1992, at GE's offices in San Jose, California. The staff is performing an independent confirmatory piping analysis and will compare the results of its analysis with those provided by GE. Contingent on an acceptable resolution of this confirmatory analysis, the staff will conclude that the computer program used by GE for the ABWR piping analysis is adequate. This is Open Item 14.1.3.3.4.3-1.

If GE plans to use this criteria for all ABWR piping systems, it should provide the basis for the one-third ratio for staff review. GE also needs to define how the mass effect of the decoupled line is accounted for in the model of the main line and how the frequency ratio effect (or resonant amplification of the main line) is accounted for in the modeling and analysis of the branch line. GE should revise its SSAR to include this information. This is Open Item 14.1.3.3.4.4-1.

However, for a design life of 60 years, the number of cycles for each transient should be increased by a factor of 1.5. The SSAR should be revised to reflect this factor. This is Open Item 14.1.3.3.5.2-1.

ASME Section III requires that the cumulative damage from fatigue be evaluated for all ASME Code Class 1 piping. The cumulative fatigue usage factor should take into consideration all cyclic effects caused by the plant operating transients listed in SSAR Table 3.9-1. For a 60-year design life, the number of cycles for each transient listed in Table 3.9-1 shall be multiplied by a factor of 1.5. However, recent test data indicates that the effects of the reactor environment could significantly reduce the fatigue resistance of certain materials. A comparison of the test data with the Code requirements indicates that the margins in the ASME Code fatigue design curves might be less than originally intended. The staff is currently developing an interim position to account for the environmental effects in the fatigue design of the affected materials that will be available at a later date. This is Open Item 14.1.3.3.5.7-1.

For the ABWR, GE discussed with the staff its tentative procedure that it is currently using for a foreign boiling water reactor (BWR) plant design. The information was provided to the staff during an audit held at the GE offices in San Jose, California, on March 23-26, 1992. The specified material for the ASME Code Class 1 piping in the ABWR is carbon steel. Using the GE position, additional fatigue evaluations would not be required when certain conditions are met, such as when the fluid temperature is below 245 °C, the oxygen content is below 0.3 ppm, or the tensile stress hold time does not exceed 10 seconds. The exemption rules also extend to piping elbows and tees and valve bodies when these components are conservatively designed and analyzed using the stress index method. Thus, only the circumferential girth butt welds in piping are considered to be critical by GE and are evaluated for environmental effects. The approach used by GE to account for the environmental effects on the girth butt welds is to modify the local peak stress through (1) the notch factor, (2) the mean stress factor, (3) the environmental correction factor, and (4) the butt-weld strength reduction factor. The staff is currently reviewing the approach used by GE for accounting for the environmental effects on the fatigue life of the ASME Code Class 1 components. The results of the staff's review will be included in the FSER. GE should include in its SSAR the proposed approach for accounting for the environmental effects in its fatigue analyses. This is Open Item 14.1.3.3.5.7-2.

On the basis of current data, the staff is of the opinion that the margins built in to the ASME fatigue design curves might not be sufficient to account for variations in the original fatigue test data because of various environmental effects. Therefore, consistent with the staff position discussed in Section 14.3.3.5.7 above, the staff's position for ASME Code Class 2 and 3 piping for which a fatigue analysis is performed is that the environmental effects shall be considered in the fatigue analysis. This is Open Item 14.1.3.3.5.8-1.

The analysis methodology was reviewed and discussed with the cognizant GE engineers. The staff found the analysis method acceptable with the exception of an apparent discrepancy in load application. GE defined the stratified temperature profile in the pipe cross section as a constant hot temperature in the top half and cold temperature in the bottom half with a step change in temperature at the centerline. However, in the pipe stress analysis, a linear top-to-bottom temperature profile was applied. The linear temperature profile provides lower bending moments and stresses than the step change profile. GE was asked to justify the adequacy of the piping analysis load input. In addition, GE could not readily explain why potential high-cycle fatigue effects resulting from thermal striping should not be considered in the analysis. The staff asked GE to provide additional justification for their methodology including test information to support their thermal stratification load definition. GE should provide this information in the SSAR. This is Open Item 14.1.3.3.5.10-1.

In lieu of the above method, time histories of support excitations may be used, in which case both inertial and relative displacement effects are already included. Consideration of these effects and analyses is Open Item 4.1.3.3.5.13-1.

The NRC staff is currently proposing rulemaking to revise Appendix A to 10 CFR Part 100 to decouple the operating basis earthquake (OBE) from the SSE or possibly eliminate the OBE from design altogether for advanced light water reactors. For the ABWR, GE proposed that the OBE be equal to one-third of the SSE. The staff is currently discussing the details with GE of the necessary actions that will be required for decoupling or possibly eliminating the OBE from the design of systems, structures, and components in the ABWR. The staff's evaluation of using a single-earthquake design based on only the safe-shutdown earthquake will be addressed in the final FSER. In this report, the staff's evaluation is based on the OBE remaining in the design basis with the ABWR plant components evaluated using the maximum OBE ground motion equal to one-half of the maximum SSE ground motion. This is Open Item 14.1.3.3.5.15-1.

GE indicated that these values were presented because modal damping for composite structures could be used in a response spectrum analysis as an option. If GE plans to use the modal damping for composite structures as an option for piping analysis, then a description and justification of the approach must be provided in the SSAR. This is Open Item 14.1.3.3.5.17-1.

GE has not provided the staff any information that would establish a minimum temperature at which an explicit piping thermal expansion analysis would be required. Unless GE provides this information in the SSAR, the staff requires that thermal analyses will be performed for all temperature conditions above ambient. This is Open Item 14.1.3.3.5.18-1.

In SECY-90-016 dated January 12, 1990, the NRC staff discussed the resolution of the intersystem LOCA issue for advanced light water reactor plants by requiring that low-pressure piping systems that interface with the reactor coolant pressure boundary be designed to withstand full reactor coolant system (RCS) pressure to the extent practicable. For the ABWR, GE has not yet submitted the details of the piping design for the full RCS pressure. This is Open Item 14.1.3.3.5.19-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should address in the SSAR the use of seismic restraints other than snubbers and their modeling assumptions. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should address in the SSAR the types of snubbers to be used in the ABWR standard plant and their characteristics. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should address in the SSAR, the pipe support stiffness values and support deflection limits used in the piping analyses. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should address in the SSAR, the seismic excitation of the pipe supports (especially large frame-type structures) in the design of the pipe support anchorage. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should include in the SSAR the coefficient of friction to be used for considering friction forces between the pipe and the steel frames. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should address the hot and cold gaps to be used between the pipe and the box-frame-type of support. This is Open Item 14.1.3.3.6-1.

GE has not provided any information on the design criteria for the structural design of instrumentation line supports. This should be included in the SSAR. This is Open Item 14.1.3.3.6-1.

GE has not provided the specific analysis methods or procedures to be used for the ABWR pipe support design. GE should include in the SSAR design criteria that will ensure that the maximum deflections of the piping at support locations for static and dynamic loadings are within an allowable limit to preclude failure of the pipe supports and hangers. This is Open Item 14.1.3.3.6-1.

In addition, the criteria of ANS 58.2, "Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Pipe Rupture," (1988) will be used for evaluating the effects of the postulated pipe breaks and leakage cracks. The staff found that the reference edition of ANSI/ANS-58.2 in SSAR Section 3.6.2.2.1 was not current and that the criteria in SSAR Section 3.6.2.3.1 for evaluating the effects of fluid jets on essential structures, systems, and components were not in complete agreement with the guidelines of SRP Section 3.6.2 and with ANSI/ANS-58.2, 1988 Edition. GE should revise its SSAR accordingly to ensure that the SSAR is consistent with SRP Section 3.6.2 and ANSI/ANS-58.2, 1988 Edition. This is Open Item 14.1.3.3.7-1.

The inspection to be performed by the COL applicant or licensee ensures that the ASME Code requirements for fatigue will be satisfied upon completion of the Code-required stress report. However, an additional certified design commitment is needed for any ASME Code Class 2 and 3 piping system that is expected to experience 7000 or more thermal stress cycles in its 60-year design life. For any such piping, the COL applicant should use a stress reduction factor of less than 1.0 as required by Subparagraph NC/ND-3611.2 of the ASME Code, Section III. In addition, if an ASME Code Class 1 fatigue evaluation is required for ASME Code Class 2 and 3 piping systems, as discussed in Section 14.1.3.3.5.8 of this report, a cumulative usage factor of 1.0 should be met and environmental effects should be considered. This is Open Item 14.1.3.3.9.1-1.

GE should revise Tier 1 design certification material for piping design to ensure that all its certified design commitments in Table 3.3 are included in the design description. This is Open Item 14.1.3.3 `.13-1.

The staff's evaluation of the generic ITAAC for the reliability assurance program will be provided in the FSER. This is Open Item 14.1.3.8-1.

The staff is currently reviewing Section 3.9, "Welding," of "Tier 1 Design Certification Material for the GE ABWR." This is Open Item 14.1.3.9-1.

The information provided in the Tier 1 design certification material is under staff review, and will be provided in the FSER. This is Open Item 14.1.4-1.

The information provided in the Tier 1 design certification material is under staff review, and will be provided in the FSER. This is Open Item 14.1.5-1.

The staff determined that the level of detail in the test abstracts is insufficient to determine conformance with RG 1.68, Position C.2. (Open Item 6.118.) The individual test abstracts in SSAR Sections 14.2.12.1.1, 14.2.12.1.7, 14.2.12.1.11, 14.2.12.1.12, 14.2.12.1.13, 14.2.12.1.18, 14.2.12.1.21, 14.2.12.1.22, 14.2.12.1.43, 14.2.12.1.45.1, 14.2.12.1.45.2, 14.2.12.1.45.3, 14.2.12.1.45.4, 14.2.12.1.53, 14.2.12.1.59, 14.2.12.1.67, 14.2.12.1.68, and 14.2.12.1.69 do not specify basic systems required to be available, interface systems, or criteria required as prerequisite or initial conditions for the preoperational tests. GE should address specific prerequis 'es in these individual test abstracts. This remains Open Item 14.2.12.3-.

GE indicated that SSAR Chapter 14 was written primarily to document the appropriate testing commitments contained in RG 1.68. GE indicated that precise acceptance criteria would be provided as part of the ITAAC effort in its May 20, 1991, submittal. However, GE has not provided this information in either ITAAC or in SSAR Chapter 14. This remains Open Item 14.2.12.3-2.

This response to the staff's open item is not acceptable. Of 35 individual test abstracts in SSAR Section 14.2.12.2, 33 do not specify the required actions or precautions for dealing with criteria failures and other testing exceptions or anomalies. GE has not adequately modified Section 14.2.12.2 or the individual test abstracts to address the subject acceptance criteria or actions. This remains Open Item 14.2.12.3-3.

The staff has reviewed the GE design certification material and has determined that the initial test programs are not included in Tier 1 or ITAAC material. The staff expects that this Tier 1 material should be at a high level limited to a commitment to an initial test program and a description of the program and the major program documents (i.e., a site specific startup administrative manual, GE test specifications, and test procedures). This is an Open Item 14.2.12.7-1.

<u>Confirmatory Item</u>

For this reason, the staff's position is that the main steam piping beyond the second outermost isolation valve up to the seismic interface restraint and connecting branch lines up to the first normally closed valve be classified as Quality Group B (Safety Class 2) and seismic Category I. The main steamline from the seismic interface restraint up to but not including the turbine stop valve (including branch lines to the first normally-closed valve) should be classified as Quality Group B and inspected in accordance with the applicable portions of ASME Section XI. but may be classified as non-seismic Category I if it has been analyzed using a dynamic seismic analysis method to demonstrate its structural integrity under SSE loading conditions. However, all pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 are applicable to ensure that the quality of the piping material is commensurate with its importance to safety during normal operational, transient, and accident conditions. To ensure the integrity of the main steam bypass line from the first valve to the main condenser hot well, although it is not required to be classified as safety-related or as Seismic Category I, the main steam bypass line from the first valve up to the condenser inlet and the main steam piping between the turbine stop valve and the turbine inlet should be analyzed using a dynamic seismic analysis to demonstrate its structural integrity under SSE loading conditions. This is Confirmatory Item 14.1.3.3.3.8-1.

Lastly, the main steam piping and bypass line in the turbine building should be protected from the collapse of any non-seismic Category I structure in the event of an SSE. As a final confirmatory measure, the staff requires that a plant-specific walkdown be performed before operation to assess the potential failures of non-seismically designed systems, structures, and components overhead, adjacent to, and attached to the alternate leakage path (i.e., the main steam piping, by-pass line, and the main condenser). This walkdown should be performed as a part of the ITAAC verification of non-seismic/seismic interaction. This is Confirmatory Item 14.1.3.3.3.8-2.

The staff reviewed the method for selecting the number of masses or degrees of freedom in the mathematical piping model to determine its dynamic response. GE's internal documents that were audited by the staff on March 23-26, 1992, showed pipe and fluid masses are lumped at nodes that are selected to coincide with the locations of large masses (e.g., valves, pumps, and tanks) and with locations of significant geometric changes (e.g., pipe elbows, reducers, and tees). Additional mass points are selected to ensure that the spacing between any two adjacent piping nodes and masses is no greater than an idealized value. This value corresponds to the length of a simply supported beam with a uniformally distributed mass whose undamped natural frequency is equal to the cutoff frequency. Since this approach in effect would capture all modes up to the cutoff frequency, the staff finds that the ABWR method for locating mass points is acceptable. The SSAR should be revised to reflect the above described approach. This is Confirmatory Item 14.1.3.3.4.2-1.

Additionally, because the amplified response spectra are generally specified at discrete building node points, any additional flexibility between these points and the pipe support (e.g., supplementary steel) also should be addressed. The SSAR should be revised to incorporate the above information. This is Confirmatory Item 14.1.3.3.4.2-2.

In piping terminates at non-rigid equipment (e.g., tanks, pumps, or heat exchangers), the analytical piping model should consider the flexibility and mass effects of this equipment. The SSAR should be revised to address how the flexibility and masses of equipment attached to the piping are to be modeled. This is Confirmatory Item 14.1.3.3.4.2-3.

GE proposed to use the damping values specified in ASME Code Case N-411 with the independent support motion (ISM) method of response spectrum analysis. The staff's position on the application of N-411 damping values to the ISM method of analysis is that it is acceptable when the ISM method is used in accordance with the information and recommendations in Sections 2.3 and 2.4 of NUREG-1061, Volume 4. This is Confirmatory Item 14.1.3.3.5.4-1.

The staff's position on the use of N-411 damping values with ASME Code Case N-420 is that the two code cases may only be used in separate analyses as a further condition of RG 1.84 because the damping values established in Code Case N-411 might not be entirely appropriate for the damping characteristics of the linear energy absorbing supports. Therefore, the two code cases are not to be used in the same analysis. This is Confirmatory Item 14.1.3.3.5.4-2.

The SSAR should be revised to reflect the above staff positions or if an alternative method is used, then the details of its basis shall be submitted to the staff for review and approval before use. This is Confirmatory Item 14.1.3.3.5.6-1.

SSAR Section 14.2.2.1 states that the normal plant staff responsibilities, authorities, and qualification are given in SSAR Chapter 13. This statement is incorrect, since SSAR Chapter 13 indicates that such information is out of scope of the ABWR. This is Confirmatory Item 14.2.2.1-1.

GE indicated this change by markup submitted on March 11, 1992. This is acceptable subject to incorporation of GE's proposed change into a future SSAR revision. This closes DSER Open Item 6.C, as related to DSER Section 14.2.10. This is Confirmatory Item 14.2.7-1.

GE subsequently submitted a power-flow operating map, Figure 14.2-1, that provides an appropriate indication of test conditions and a table of startup tests, Table 14.2-1. This will be acceptable subject to incorporation into a future SSAR revision and staff review. This is Confirmatory Item 14.2.11-1.

The information discussed above is acceptable subject to the incorporation of it into a future SSAR revision. This is Confirmatory Item 14.2.11-2. Additionally, a COL applicant will need to provide a startup administrative manual (procedures) and any other documents that delineate the test program schedule for staff review. This is COL Action Item 14.2.11-1.

The staff verified that GE incorporated the word change from "should" to either "will" or "shall" into most test abstracts. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.3-1.

GE revised SSAR Section 14.2.13 (in draft) to state that criteria contained in the RG 1.68, Position C.1, will be used to determine if any testing is currently specified for systems that are not essential for demonstrating conformance with the aforementioned criteria. The staff will find this item acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.3-2.

GE incorporated into SSAR Section 14.2.12.1.51 cross-references to SSAR Sections 3.9.2.1 and 5.4.14.4. These references were evaluated in the report in Chapters 3 and 5, respectively. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.4-1.

The staff verified that Section 14.2.12.2 was revised in draft to add SSAR Section 14.2.12.2.39 to address testing of steam and power conversion systems. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.4-2.

GE added Section 14.2.12.2.36 to address loose parts monitoring system baseline data collection. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.4-3.

GE agreed to add SSAR Section 14.2.12.2.37 to address concrete penetration temperature surveys. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.4-4.

GE agreed to add Section 14.2.12.2.38 to address radioactive waste system testing. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.4-5.

GE revised test abstracts 14.2.12.1.1(3)(a), 14.2.12.1.9(3)(j), and 14.2.12.1.44(3)(a) to include a reference to 1A.2.4 of Appendix A to SSAR Chapter 1 and revised 1A.2.4 to discuss the requirements of Action Item I.G.1 Appendix E applicable to the initial test program. The staff will find this item acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.5-1.

GE agreed to revise SSAR Sections 14.2.12.1.22 and 14.2.12.2.1 to more specifically address functioning of conductivity meters, which are a major focus of RG 1.56. The staff will find this item acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.6-1.

The staff verified that GE's proposed test matrix to be included in the SSAR will identify feedwater system performance and feedwater control system adjustment/confirmation tests to be performed at the nuclear heat-up and low-power testing plateaus. This will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.6-2.

Further, GE agreed to revise SSAR Section 14.2.12.1.8 (1) to specifically address testing of features designed to ensure isolation of low-pressure portions of the RHR system from the RCS at high pressure. The staff will find this item acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.6-3.

Section 14.2.12.1.8 was revised to allow for verification of proper set point of system relief valves per ASME code requirements (including those intended to meet the requirements of RG 1.139 using the results of vendor tests and the appropriate documentation of such). This item will be acceptable subject to incorporation into a future SSAR revision. This is Confirmatory Item 14.2.12.6-4.

CHAPTER 15

OPEN ITEMS

The staff recently was notified through the 10 CFR Part 21 process that a fuel misorientation event may lead to fuel damage in BWR/6 designs. The staff does not know at this time whether a similar conclusion applies to the ABWR. GE is required to evaluate the applicability of the issue for the ABWR and should provide a discussion of its evaluation in the SSAR. This is Open Item 15.3-1.

The staff has reviewed Section 2.10.1, "Turbine Main Steam System in the Tier 1 Design Certification Material (TDCM)," and finds that the design description and its related inspections, tests, analyses, and acceptance criteria (ITAAC) (Table 2.10.1) should include (1) the operability requirement of main steam drain valve from main control room via essential power supply (Class 1E) and (2) the structural integrity requirement for main steamlines, drain lines, and main condenser for their leak-tightness following a postulated LOCA. The main steamlines from MSIV to the main condenser, including the drain lines, should be analyzed using a seismic analysis to demonstrate appropriate structural integrity for leak-tightness under site specific SSE loading conditions. This is Open Item 15.4.4.2.1-1. The staff has provided a credit for iodine removal in the main steamlines, drain lines, and condenser following a postulated LOCA and accepted the ABWR design without a MSIV leakage control system.

Since the staff has accepted an alternative main steamline design which meets the intent of 10 CFR Part 100, the staff must document this new requirement in the final safety evaluation report (FSER) or require that GE request exemption from 10 CFR Part 100 and provide an evaluation of the request in the FSER. This staff action is Open Item 15.4.4.2.2-1.

The ABWR complies with prescriptive design requirements of the ATWS rule and is designed to mitigate the effects of an ATWS event. However, as discussed in Section 4 of this report, large power oscillations resulting from thermal-hydraulic instability associated with ATWS events might invalidate the analyses and basic conclusions that were the basis for the prescriptive ATWS rule. Evaluation of this contingency for operating reactors is nearing conclusion. This remains an open item as discussed in Chapter 4 of this report (Open Item 4.4-1).

However, the results of TRACG calculations to evaluate the thermal hydraulic stability of ABWR under the recirculation runback and feedwater runback conditions associated with ATWS events have not been provided for staff review. Therefore, ATWS must remain an open item until it has been demonstrated that ABWR design response to ATWS enables avoidance of large oscillations and the staff audit of TRACG qualifications for stability calculations is complete. This is Open Item 4.4-1.

CONFIRMATORY ITEMS

The staff, with the technical assistance of Brookhaven National Laboratory (BNL), audited ODYNA and REDYA during January 1992 at GE offices in San Jose, California. The evaluation consisted of three major areas: (1) formulation and models, (2) quality assurance procedures, and (3) verification and validation. The staff concluded that the modifications to the ODYN and REDY codes for ABWR were adequately justified. The report of the staff's audit will be provided in a separate report. The staff therefore found the changes to ODYN and REDY to be acceptable. However, there was no documentation to verify that the coding changes to implement new models were independently checked. GE should inform the staff, in writing, to confirm that the implementation of the code modifications have been independently verified as correct. This is Confirmatory Item 15.1-1.

RG 1.3 (Rev. 2) assumes a constant containment leak rate for the duration of a LOCA, although it permits a reduced leak rate with supporting justification. The rationale for a constant containment leak rate is two fold: (1) the pressure profile for a BWR does remain at high pressures for a long period of time and (2) for most plants, the leakage is only measured at the maximum value in accordance with Appendix J to 10 CFR Part 50. Therefore, the primary containment leak rate was identified as Open Item 143 in the DSER. Subsequently, GE revised the primary containment leak rate of 0.5 percent by volume per day for the duration of a LOCA, accepting the staff's position in a draft revision to the SSAR. This is Confirmatory Item 15.4.4.1-1.

CHAPTER 16

OPEN ITEMS

GE indicated that the ABWR TS could not exactly conform to the standard technical specification (STS) because portions of the design were significantly different from the design of the BWR/6. For those portions of the STS where the completion times (CTs) are applicable to the ABWR design, GE has committed to providing computer based revisions of the STS in Wordperfect 5.1 format to reflect ABWR system nomenclature and appropriate design references and boilerplate information. GE has not provided this information to the staff at this time. This is Open Item 16-1. For those portions of the STS where the design is different from the BWR/6, GE committed to provide to the staff submittals of CTs for these design characteristics. As of this date GE has provided two submittals for non-I&C and selected I&C systems. As of this date, instrumentation and control (I&C) systems still have not been submitted. This is Open Item 16-2.

The ABWR design involves the use of a three subsystem concept for the engineered safety feature systems. GE intended to facilitate maintenance on one subsystem by extending the CT for one inoperable subsystem from 7 days to 30 days. GE has not, however, provided justification that the ECCS design consists of three independent redundant subsystems. Extending the CTs forthe ECCS or other systems will require this justification. When GE submits this additional information, the staff will complete its evaluation. The resolution of this open item will be documented in the final safety evaluation report. This is Open Item 16-3.

CONFIRMATORY ITEMS

(none)

CHAPTER 17

OPEN ITEMS

In SSAR Section 17.3.5, GE responded to Question 5 in the RAI dated September 19, 1991, by providing a description of its organizational structure and accountability for implementing D-RAP in the design process. In its review of SSAR Section 17.3.5, the staff has identified an inconsistency between the SSAR Section 17.3.5 narrative and SSAR Figure 17.3-1. In SSAR Section 17.3.5, GE has designated its D-RAP organization for use in a <u>future</u> D-RAP, however in Figure 17.3-1, the GE D-RAP organization does not contain any reference to the future. In addition, in SSAR Section 17.3.5, GE used the future tense in describing the D-RAP organizational structure. GE needs to delete any references in SSAR Section 17.3.5 to the future in describing its D-RAP organization. This is Open Item 17.3.5-1.

The staff has reviewed SSAR Section 17.3.5 with respect to the GE organizational description and accountability for implementing the ABWR D-RAP for design certification, and concluded that it is responsive to the staff's question and does not conflict with existing regulatory requirements. The staff will conclude, subject to resolution of Open Item 17.3.5-1, that the GE organizational description and accountability for implementing the ABWR D-RAP is acceptable.

CONFIRMATORY ITEMS

(none)

CHAPTER 18

OPEN ITEMS

The above discussions are examples of USI/GSI items that contain human factors or HSI aspects. However, there are others that likewise contain aspects that should be considered by the COL applicant in the post-certification design process. The specific issues to be addressed by the COL applicant in the COL's operating experience review will include specific TMI and USI/GSI issues. However, the identification of specific operating experience review issues has not been made at this time (see Section 18.8 of this report), and the operating experience review is Open Item 18.9.2.2.1-1. This issue will be resolved when the operating experience review issue is resolved.

The ITAAC/DAC "Design Description" for Section 3.6 of the "Tier 1 Design Certification Material for the GE ABWR Design" (DCM) is not complete. Therefore, this is Open Item 18.9.1-1.

There is one general open issue pertaining to Tier 2 guidance descriptions for each of the GE process elements. Element 1 (in the HFE Program Review Model), for example, specifies that "the documents to be used as guidance." Each element has a similar specification. GE has not incorporated the specific documents to serve as guidance from the staff's review model into its process, the list of guidance documents is Open Item 18.9.2.2-1 for each element and this will not be restated under each element.

(1) The Tier 2 guidance document descriptions for each of the GE process elements was identified as Open Item 18.9.2.2-1 above. The specific documents (e.g., codes, standards and guidance) to serve as guidance for the COL applicant in the design process implementation have not been identified by GE. GE will address this issue in a subsequent submittal.

However, the staff has identified an open item with regard to the operating experience review. The operating experience review will be performed on a specified list of issues. General Criterion 1 for Element 2 states that: "The following industry operating experience issues shall be identified: <List to

be developed>." The specific list of items has not yet been identified and, therefore, GE has not yet incorporated them into their process. The list of issues is Open Item 18.9.2.2.1-1.

(2) The operating experience review will be performed on a specified list of identified issues. The specific list of issues to be considered by theCOL applicant in the design process implementation has not yet been identified by GE. GE will address this issue in a subsequent submittal. (This is Open Item 18.9.2.2.1-1 discussed above.)

CONFIRMATORY ITEMS

Since Element 8 is specified in general terms, the general issue of validation of the detailed design of the standard features is identified as a COL action item to be addressed in the HFE issue tracking system. Therefore, DSER Issues 18.02 and 18.06 are resolved pending receipt of the amended SSAR, which incorporates the February 1992 submittal. This is Confirmatory Item 18.3.2.1-1.

Evaluation: GE addressed this issue in its letter of February 18, 1992. SSAR Section 18.4 will provide a revised description of the standard features. On the basis of the DSER issues, the feature-by-feature evaluation, and subsequent discussions with GE, the description of the standard features will be modified to a level of detail supported by the design and evaluation efforts discussed with respect to Issue 18.06 above. The use of a prototype in design and evaluation is addressed as part of the design process discussed in Section 18.8 of this report. Detailed design resolutions of these issues will be subject to the requirements expressed in the appropriate DAC. As discussed previously, conformance review points are specified throughout the design process to ensure that these issues are acceptably resolved by the COL applicant prior to plant operation. Therefore, DSER Issue 18.08 is resolved pending receipt of the amended SSAR incorporating the agreed upon information. This is Confirmatory Item 18.3.2.1-2.

Evaluation: GE addressed this issue in its letter of February 18, 1992. Aspects 1 and 2 of this issue are addressed in the evaluation of Issue 18.06 above. The specification of workload evaluations during post-certification will be addressed in the discussion of the design process in Section 18.8 of this report, and will be resolved by the COL applicant upon completion of the functional analysis as required by Table 18.E.2.2 of the SSAR. Therefore, DSER Issue 18.09 is resolved pending receipt of the amended SSAR incorporating the February 1992 letter. This is Confirmatory Item 18.3.2.1-3.

Evaluation: This issue is addressed under the evaluation of Issue 18.06. Following discussions with GE, several design details were eliminated by GE from specification as standard features including the use of touch screen interfaces. Those that remain are those supported by the test program. Detailed design resolutions of these issues will be subject to the requirements expressed in the appropriate DAC. As discussed previously, conformance review points are specified throughout the design process to ensure that these issues are acceptably resolved by the COL applicant prior to plant operation. Therefore, DSER Issue 18.11 is resolved pending receipt of the amended SSAR. This is Confirmatory Item 18.3.2.1-4.

Evaluation: The evaluation of Issue 18.06, which includes a description of GE's HSI testing, satisfactorily addresses this issue. Detailed design resolutions of these issues will be subject to the requirements expressed in the appropriate DAC. As discussed previously, conformance review points are specified throughout the design process to ensure that these issues are acceptably resolved by the COL applicant prior to plant operation. Therefore, DSER Issue 18.12 is resolved pending receipt of the amended SSAR. This is Confirmatory Item 18.3.2.1-5.

Paragraph 4.1d was addressed in GE's DSER response. SSAR Table 3.b-1 states that the selection of information for inclusion in the SPDS is based on the current BWR Owner's Group EPGs rather than the ABWR EPGs. GE stated that this would be corrected to specifically address the ABWR EPGs. However, this correction has not been made to the SSAR. This is Confirmatory Item 18.3.2.2-1.

DSER Issues 18.02, 18.06, 18.0[illegible], 18.09, 18.11, and 18.12 are resolved pending receipt of an amended SSAR. This is Confirmatory Item 18.3.3-1. DSER Issue 18.18 will be addressed by the COL applicant as part of the design development in accordance with the HFE issue tracking system.

The staff concludes that GE has developed an acceptable minimum set of displays, controls, and alarms that will mitigate transients and accidents associated with the EPGs and the PRA sensitivity study pending the incorporation of the comments above, into the appropriate SSAR sections. Therefore, DSER Issue 18.26 is resolved and the minimum inventory of displays, controls, and alarms is considered adequate, pending receipt of the amended SSAR. The staff considers this Confirmatory Item 18.4.3-1. Several specific issues were also addressed as COL Action Item 18.4.3-1 to be incorporated into the HFE issue tracking system.

Evaluation: GE indicated that the RSS will not employ digital technology in order to maintain diversity from the CR. An assessment of the mix of analog and digital technologies in the plant as a whole will be included in the post-certification test activities conducted by the COL applicant as part of the verification and validation element. The staff notes that independence (i.e., isolation and separation) and diversity are needed for the RSS. The approach to RSS design will be evaluated by the COL applicant and incorporated into the HFE issue tracking system. Therefore, this issue is resolved pending receipt of an amended SSAR and the ITAAC/DAC. This is Confirmatory Item 18.5.2.1-1.

Evaluation: The design and implementation process described in the SSAR and in the HFE DCM document will adequately address the HFPP and the types of analyses to be performed. All relevant portions of the HFE model were incorporated into the GE documents. Therefore, DSER Issue 18.07 will be resolved pending receipt of final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.1-1.

Evaluation: GE's description of the design commitment, ITAAC, and general criteria for task analysis in the DCM and in the SSAR Tier 2 adequately address detailed task analyses. DSER Issue 18.10 will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.5-1.

Evaluation: The design commitment, ITAAC, and general criteria for HSI design described in the DCM and in the SSAR Tier 2 description adequately address the detailed design of the HSI. Therefore, DSER Issue 18.13 will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.6-1.

Evaluation: The design commitment, ITAAC, and general criteria for HSI design described in DCM and in the SSAR Tier 2 description adequately address the detailed design of the HSI. Therefore, DSER Issue 18.15 will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.6-2.

Evaluation: The design commitment, ITAAC, and general criteria for HSI design described in the DCM and in the SSAR Tier 2 description adequately address the detailed design of the HSI. Therefore, DSER Issue 18.17 will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.6-3.

Evaluation: The staff determined that development of detailed procedures and training materials is beyond the scope of the ABWR certification and is the responsibility of the COL applicant under 10 CFR Part 50. The design commitment, ITAAC, and general criteria for HSI design described in the DCM for HFE Element F and in the SSAR Tier 2 description adequately address procedure development criteria. Therefore, DSER Issue 18.21 will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.7-1.

This criterion specified: "A verification shall be made that all critical human actions as defined by the task analysis and PRA/HRA have been adequately supported in the design. The design of tests and evaluations to be performed as part of HFE V&V activities shall specifically examine these actions." Risk critical human actions (those to which the plant design is especially sensitive in a risk model) should receive special attention in the V&V process. GE commits to confirming all critical tasks as part of the V&V process and defines critical tasks under the task analysis element to include all PRA/HRA items included in Appendix D to SSAR Chapter 19, Section D.7. These will include those operator actions that have significant safety impact. This approach is acceptable. This is Confirmatory Item 18.9.2.2.8-1.

Evaluation: The V&V element requires the evaluation of all plant evolutions. These simulations will address this issue. Therefore, this item is resolved by incorporation into the V&V process to be a COL action item and addressed as part of the HFE issue tracking system. This is Confirmatory Item 18.9.2.2.8-2.

Evaluation: The V&V analyses conducted by the COL applicant as part of the HFE ITAAC/DAC described in Table 3.6 of the DCM specifically address this issue, which will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.8-3.

Evaluation: The V&V analyses conducted by the COL applicant as part of the HFE ITAAC/DAC described in Table 3.6 of the DCM specifically address this issue and it will be resolved pending receipt of the final ITAAC/DAC. This is Confirmatory Item 18.9.2.2.8-4.

Evaluation: V&V analyses conducted by the COL applicant as part of the HFE ITAAC/DAC described in Table 3.6 of the DCM specifically require prototype evaluation. Therefore, this issue will be resolved pending receipt of the final ITAAC. This is Confirmatory Item 18.9.2.2.8-5.

CHAPTER 19

OPEN ITEMS

In the DSER (SECY-91-309), the staff required GE to provide information describing (1) how PRA insights were used in the ABWR design process, (2) what ABWR design features, if any, were included as a result of PRA insights to reduce risk-significant sequences and phenomena, (3) how plant operating experience was factored into the ABWR PRA, and (4) how PRA insights were used to address severe accident phenomena (Open Item 22). GE has not submitted final responses to these information requests. This is Open Item 19.1.2.2-1.

GE did not submit, in time for this report, its reanalysis of the ABWR PRA on the basis of its updated design. The staff has no up-to-date analysis of core damage frequency or containment failure for internal and external events. This is Open Item 19.1.2.2.1-1.

GE did not provide an up-to-date analysis of the robustness of its design to withstand seismic events that are beyond the design basis. This is Open Item 19.1.2.2.2-1.

The ABWR design incorporates physical separation (3-hour fire barriers) between the three safety divisions and precludes the use of spatial separation as a fire barrier. The adequacy of the ABWR design and its attendant PRA is predicated, in part, on the adequacy of the barriers between the safety divisions. GE stated that penetrations between divisions will be qualified to 1038 °C (1900 °F) (3-hour fire with a peak temperature of 1038 °C (1900 °F) followed by the penetration being hit with a fire hose spray). A breakdown in the installation or maintenance of these barriers could negate the significant advantage created by the physical separation of the divisions. GE states that the equipment in the three safety divisions inside of secondary containment will be qualified to 100 °C (212 °F) and very tolerant of smoke. It is particularly important that these parameters be achieved in an as-built plant. GE will develop inspections, tests, analysis, and acceptance criteria (ITAAC) to ensure that (1) 3-hour fire barriers between safety divisions will be built and installed properly, (2) smoke, hot gases, and fire suppressants will not migrate from a safety division with a fire to a safety division without a fire to the extent that the division without the fire could be adversely affected, and (3) the smoke control system will be capable of preventing migration of smoke between divisions with either an open door between the divisions or with the failure of a supply or exhaust line valve to close. This is Open Item 19.1.2.2.2-2.

GE performed the severe accident fire analysis for the ABWR using a combination of its internal PRA for the ABWR and the fire-induced vulnerability evaluation (FIVE) methodology. The staff reviewed GE's analysis and determined that these methodologies were used in an appropriate manner. GE found the most important contributor to core damage from fires was a fire in the control room. All other fire areas in the design had less than a one-in-a-million chance per year of core damage. By use of the systematic methods discussed above, GE determined that it needed to modify its remote shutdown panels by adding an additional control that could operate a fourth safety-relief valve from the panel. The staff considers this to be a design vulnerability that GE discovered during the severe accident fire analysis and remedied. Because only assumptions and no design details were available for certain parts of the design that are to be the responsibility of the COL applicant (e.g., the ultimate heat sink), there needs to be a fire ITAAC that covers those parts of the design that are not within GE's nuclear island. This is Open Item 19.1.2.2.2-3.

GE has not submitted an analysis of the important systems, structures, or components in the ABWR design with regard to the severe accident fire analysis. These components are to be factored into the reliability assurance program and the COL applicant's response to the maintenance rule. This analysis was not received in time for review in this report. This is Open Item 19.1.2.2.2-4.

GE did not provide its internal flooding analysis in time to be reviewed in this report. GE's submittal of its internal flooding analysis will include insights to be factored into the reliability assurance program (RAP) and the COL applicant's response to the maintenance rule. This is Open Item 19.1.2.2.2-5 (Appeared in the DSER as Interface Item, I-9).

GE did not provide the results of its shutdown study of the ABWR in time to be included in this report. The staff will evaluate GE's submittal in the FSER. This is Open Item 19.1.2.2.3-1.

The ABWR design was influenced by PRA insights. While there does not appear to have been a documented, systematic effort on the part of GE to use the PRA to minimize core damage frequency or risk estimates in the ABWR design, GE did use PRA insights and mini-PRA studies to help decide a number of design options. These considerations include core cooling system, reactivity control, and instrumentation optimization from a cost standpoint and control rod drive improvements that will provide substantial reduction in the probability of ATWS. In addition, in developing the ABWR design, GE has attempted to limit or eliminate the dominant contributors to core damage frequency found in most BWR PRAs. GE provided a preliminary report describing how it used PRA as a design tool for the ABWR design. GE's report discussed the use of alternate rod insertion valves to minimize the frequency or ATWS, ac-independent water addition through a diesel-powered engine and a fire truck hookup to minimize station blackout core damage frequency, a combustion turbine generator capable of handling manually loaded safety loads to minimize station blackout core damage frequency, a lower drywell flooder system to cover a core-on-the-floor in the cavity with water to increase the chance for quench of core debris, and a containment overpressure protection system to allow for relief of high containment pressure buildup while still allowing the containment to be subsequently secured. However GE's list of design features that are expected to significantly lessen core-damage-frequency and risk estimates is incomplete. For example, GE has not addressed the increase in the drywell head design pressure, the physical separation of safety divisions in the design, and improvements in the design to withstand external events and loss-of-coolant accidents (LOCAs). This was identified as Open Item 22 in the DSER and is identified here as Open Item 19.1.2.3-1.

Based on the level of detail in the information provided, GE appears to have made significant improvements in the ABWR design (i.e., in reducing core damage frequency estimates) by limiting or eliminating from the design those features whose failure or malfunction could initiate or contribute to an internal event that could cause core damage. This process has limited important contributors to core damage frequency, such as LOCAs and station blackout events, that were important contributors to core damage frequency in previous BWR PRAs. GE agreed to compare the dominant sequences from applicable existing BWR PRAs to those of the ABWR PRA. This is Open Item 19.1.2.3-2.

GE did not provide a list of systems, structures, and components for both internal and external events that should be used by the COL applicant to help develop its reliability assurance program in time for inclusion into this report. GE did not address reliability targets for such equipment and did not provide the results of its importance analyses evaluations in time for inclusion into this report. This is Open Item 19.1.2.4.1-1.

GE did not provide design acceptance criteria (DAC) and ITAAC based on evaluation of the ABWR PRA for both internal and external events in time for inclusion into this report. This is Open Item 19.1.2.4.2-1.

The staff's evaluation of these uses of PRA is provided below. As part of the staff's review of the ABWR PRA, the staff intends to evaluate the effectiveness of the ABWR PRA in identifying vulnerabilities and leading contributors to risk for the ABWR. To support the staff's assessment, GE stated that it would provide a discussion of vulnerabilities discovered during the performance of the ABWR PRA. The staff will use this additional information in evaluating GE's use of PRA in the ABWR design process and will include the results of this evaluation in the FSER. This is Open Item 19.1.2.4.3-1.

GE stated that it would provide a discussion of the balance between prevention and mitigation for the ABWR. The staff will use this information as well as the results of the updated PRA to develop PRA perspectives on the balance between prevention and mitigation. This is Open Item 19.1.2.4.3-2.

The staff performed a preliminary evaluation of design alternatives for severe accident prevention and mitigation, as required by 10 CFR 50.34(f). The results of this evaluation indicate that none of the design alternatives analyzed by GE are justified on the basis of cost-benefit considerations. However, this analysis will be further evaluated by staff, to take into consideration: (1) the effect of revised PRA results, including corrections to the consequence calculations discussed in Section 19.1.9 of this report, (2) the effect of different cost benefit criteria, and (3) the value of additional design alternatives not treated by GE. This is Open Item 19.1.2.4.3-3. The staff's evaluation will be provided in Section 20.3 of the final safety evaluation report (SER).

The above assessment is different than the evaluation of severe accident mitigation design alternative (SAMDA) required by 10 CFR Part 51. GE stated that it would submit additional information in support of the SAMDA evaluation. This is part of Open Item 19.4-1.

(4) GE did not document the details of the contribution of support system failures (such as loss of dc power, loss of service water system) as initiating events. The staff's concerns were identified in DSER Open Item 2. GE agreed to provide an analysis of the contribution of support system failures as initiating events in the ABWR PRA. This analysis was not provided by GE in time to be included in this report. This is Open Item 19.1.5.2-1.

(6) GE did not provide results of accident analyses of postulated interfacing LOCA events as applicable to the ABWR design. This was identified in the DSER as Open Item 3. Subsequently, GE agreed to upgrade and document the quality of its piping that interfaces between high- and low-pressure systems. The staff has not completed its review to determine whether the proposed interfacing piping upgrades are adequate to address staff concerns regarding interfacing LOCAs. This is Open Item 19.1.5.2-2.

    Confirmation of the upgraded quality of the pipes that interface between high- and low-pressure systems should be included in ITAAC. This is Open Item 19.1.5.2-3.

(7) GE did not document the results of the accident analyses of postulated LOCA events outside the containment (in particular, steam line breaks in the reactor core isolation coolant steam piping and the reactor water cleanup (RWCU) lines) in combination with failure of the isolation valves. This was identified as Open Item 4. GE stated that it performed an evaluation of LOCAs outside of containment, but that there were errors in the analysis. GE did not provide an updated version of this analysis for internal and external events in time to be incorporated in this report. This is Open Item 19.1.5.2-4.

In the DSER the staff required GE to provide further justification that, by calculating common-mode-failure at the train level, it was able to capture the full contribution to common-mode-failure probability in the analysis as if it had calculated at the component level (Open Item 5). In further discussions with GE, the staff refined its request to require GE to requantify the PRA with and without taking into account the additional areas of common mode failure that were not in the ABWR PRA as originally submitted. The results of this sensitivity study will be used to provide insights into what additional systems, structures, or equipment should be added to the reliability assurance program or GE's response to the maintenance rule. GE did not provide this information in time to be incorporated into this report. This is Open Item 19.1.5.4-1.

In the DSER the staff required GE to provide a list of systems not included in the GE nuclear island, the assumed reliability for each system, and any safety significant insights GE believes are important to designing the systems to meet the assumptions of the PRA (Open Item 21). GE did not provide this information in time to be incorporated into this report. This is Open Item 19.1.5.4-2. The staff further indicated that GE should develop an ITAAC for COL applicants to demonstrate how its design for interfacing systems meets the reliability assumptions and design insights for the ABWR. This is Open Item 19.1.5.4-3.

After completion of the DSER, the NRC's ACRS performed an independent investigation of the RWCU system. It found that the RWCU system success criteria were suspect and that the system would isolate on high temperature, rather than act as a high-pressure, high-temperature heat removal path. GE subsequently stated that it would modify the ABWR design to make the RWCU system function as was assumed in the ABWR PRA. GE did not provide this information, which included RWCU and condensate and feedwater system fault trees, in time to be incorporated into this SER. This is Open Item 19.1.5.4-4.

GE did not supply the sensitivity study on the effect of varying outage times in time for it to be incorporated in this report. This is Open Item 19.1.5.5.3-1.

The staff identified four open items, one confirmatory item, and six interface items in the DSER relevant to ABWR PRA Human Reliability Analyses (HRA). Subsequently, the staff met with GE to discuss the information needed to address these issues. GE provided a partial submittal, but did not submit the balance of the requested analyses in time to incorporate this information into the report. This is Open Item 19.1.5.6-1.

In the DSER the staff identified GE's modeling and analyses of human errors in the ABWR PRA to be lacking in details and documentation that is essential for scrutability of the results and derivation of insights. Technical concerns raised by the staff in the DSER Open Items O-7, O-8, and O-9 are closely related. GE did not provide documentation to resolve these issues in time to be incorporated into this report. This is Open Item 19.1.5.6.1-1.

In the DSER the staff requested GE to perform of sensitivity and uncertainty analyses of human errors modeled in the ABWR PRA (Open Item 10). GE did not provide this information in time to be incorporated into this report. This is Open Item 19.1.5.6.2-1.

In the DSER the staff identified concerns in the area of Human Reliability Analyses (Confirmatory Item C-5; Interface Items I-2 to I-7). Resolution of these issues hinges on design details that are not currently available (e.g., control room design, plant-specific data, man/machine interface for advanced technologies). GE did not provide its submittal, which should address PRA input to DAC/ITAAC and guidance to the COL applicant, in time to be incorporated into this report. This is Open Item 19.1.5.6.3-1.

In the DSER the staff required GE to provide an input to the reliability assurance program that lists the equipment to be included into the program and provides reliability targets for systems and/or components (Interface Item 15). GE did not provide this information in time to be incorporated into this report. This is Open Item 19.1.5.9-1.

In the DSER the staff stated that GE had to perform an uncertainty analysis for internally initiated events (Open Items 11 and 18). GE did not provide its response to this item in time to be incorporated into this report. This is Open Item 19.1.5.11.1-1.

After the staff issued its DSER, GE modified the ABWR plant design and updated the PRA. The staff's assessment of the updated PRA will be provided in the FSER and will include a comparison of leading contributors to core damage frequency. This is Open Item 19.1.5.11.2-1.

Because the original seismic analysis was based on an outdated plant design, GE will submit a new seismic analysis. GE indicated its submittal will concentrate on providing high confidence low probability of failure (HCLPF) values for core damage sequences and for the plant. This analysis will consist of a PRA-based seismic margins analysis and will not be based on any particular hazard curve. The analysis will also identify seismic capacities for systems not in the certified design. The staff finds the use of a PRA-based seismic margins analysis to be an acceptable method for evaluating the robustness of the ABWR design to withstand seismic events beyond the design basis, without having to debate the merits of any particular hazard curve. GE did not provide this information in time for it to be included in this report. This is Open Item 19.1.6.3.2-1.

In the DSER the staff indicated that it believed that the seismic capacities of flat-bottomed tanks, diesel generators, and electrical equipment were optimistic and would need to be evaluated at the time of plant construction (Staff Corrections 6, 7, and 8). Subsequently, GE indicated that it is considering reducing these capacity assumptions. GE did not provide this information in time for it to be included in this report. This is Open Item 19.1.6.3.2-2.

The seismic capacities of components modeled in the PRA-based margins analysis should be included in an ITAAC. This is Open Item 19.1.6.3.2-3.

In the DSER the staff stated that the COL applicant must confirm the seismic capacities of structures, systems, and components modeled in the PRA and these capacities should be included in the design specifications for the equipment (Interface Items 10 and 14). Subsequently, GE stated that this would probably be covered by the PRA input to the ITAAC program. GE did not provide the ITAAC in time for evaluation in this report. This is part of Open Item 19.1.6.3.2-3.

In the DSER the staff pointed out that the ABWR PRA did not address the failure of containment penetrations and isolation valves during a seismic event (Open Item 19). GE did not provide its response to this issue in time for evaluation in this report. This is Open Item 19.1.6.3.2-4.

In the DSER the staff pointed out that the ABWR PRA incorrectly took too much credit for firewater as a mitigating system in the seismic Class II CET (Staff Correction 3). GE stated that it will correct this CET. This is Open Item 19.1.6.3.2-5.

In discussions with GE, the staff requested that GE submit its analysis of seismically induced LOCAs that bypass containment. While performing this analysis, GE indicated that the safety relief valve discharge lines have HCLPF in the range of 0.6g for the portion of the piping in the wetwell air space. However, GE did not provide a discussion of how it methodically searched for such potential failures. This is Open Item 19.1.6.3.2-6.

Because the original ABWR PRA submittal, including the seismic analysis, was based on an outdated plant model, GE will submit a remodeled, requantified internal events PRA. Because the internal event fault trees are used to develop simplified seismic fault trees, the staff expects that there will be some modifications to the seismic fault trees. The staff's evaluation of the seismic fault trees in GE's original ABWR submittal is documented in the DSER. No conclusions about the robustness of the design with regard to beyond-design-basis seismic events can be made without an updated set of seismic fault trees that are to be used in the PRA-based margins method. This is Open Item 19.1.6.3.4.1-1.

The ABWR seismic risk analysis, as originally submitted by GE, used a single seismic hazard curve with no explicit consideration of uncertainty. Subsequently, GE stated that it intended to submit a reanalysis of the ABWR seismic analysis using a PRA-based margins method (i.e., without convoluting the hazard and fragility curves). This method is acceptable to the staff. The staff does not require a seismic hazard uncertainty analysis in using this method because no seismic hazard curves are used. The use in the PRA-based margins method of HCLPF values to help judge the robustness of the plant implicitly takes into account of the variability of the fragilities. The HCLPF value is the peak ground acceleration at which there is a 95 percent confidence that less than 5 percent of the time the equipment will fail. The staff will confirm in the FSER the adequacy of the ABWR HCLPF values for core damage sequences and for the plant using the updated ABWR design. This is Open Item 19.1.6.3.7-1.

GE has provided several draft justifications for this assumption. Regarding fire spread between divisions, GE states that there are 3-hour fire barriers between divisions. Penetrations between divisions are to be qualified to 1038 °C (1900 °F) (3-hour fire with a peak temperature of 1038 °C (1900 °F) followed by the penetration being hit with a fire hose spray). GE also indicated that some penetrations between divisions would be qualified to a lower standard if the penetrations contain non-safety equipment. The staff requested that GE clarify this statement because these penetrations could conceivably become pathways for a fire to spread between divisions. This is Open Item 19.1.6.4-1.

Regarding the spread of smoke between divisions, the staff's review concentrated on the effects of a fire in secondary containment. The staff is still evaluating the spread of smoke in safety-related buildings other than the reactor building. This is Open Item 19.1.6.4-2. GE stated that the secondary containment design includes a smoke control system that will limit the spread of smoke and hot gases between divisions. The staff reviewed the smoke control system and concluded that the design should remove smoke from the division where the fire began and provide a pressure differential to help limit smoke movement into the other safety divisions even if a single door was open between the division with the fire and another division. However, GE must determine if opening more than one door between a division with fire and one without fire will defeat the smoke control system to the point that sufficient smoke/hot gases could move between divisions to damage equipment or hamper recovery activities. If so, GE must advise COL applicants to train their fire fighters regarding this potential vulnerability. This is Open Item 19.1.6.4-3.

The staff believes it is particularly important that these fire-related assumptions are achieved in the as-built plant. Therefore, GE must develop an ITAAC for the assurance that (1) 3-hour fire barriers between safety divisions are built/installed properly, (2) smoke, hot gases, and fire suppressants will not migrate from a safety division with a fire to a safety division without a fire to the extent that the division without the fire could be adversely affected, (3) the smoke control system must be shown to be capable of preventing migration of smoke between divisions with either an open door between the divisions or the failure of a supply or exhaust line valve to close, and (4) water intrusion mitigation devices (e.g., curbs and shields) are in place. This is Open Item 19.1.6.4-4.

GE found the most important contributor to core damage from fires was a fire in the control room. All other fire areas in the design had less than a one-in-a-million chance per year of causing core damage. By using the systematic methods discussed above, GE determined that it needed to modify its remote shutdown panels by adding an additional safety-relief valve. However, GE did not perform a systematic study to determine if a fire followed by hot shorts in the control room could defeat the emergency core cooling system function from the remote shutdown panels. Because only assumptions and no design details are available for certain parts of the design that will be the responsibility of the COL applicant (e.g., the ultimate heat sink), GE should develop a fire ITAAC that covers those parts of the design that are not within GE's nuclear island. This is part of Open Item 19.1.6.4-5.

The staff is waiting for GE's analysis of the important systems, structures, and components in the ABWR design with regard to the severe accident fire analysis. These components are to be factored into the reliability assurance program and the COL applicant's response to the maintenance rule. This is Open Item 19.1.6.4-6.

Although internal flooding was originally assigned in the DSER as Interface Item 9, the Commission subsequently required severe accident internal flooding to be analyzed at the design certification stage. GE and the staff have had extensive discussions on this analysis. However, GE did not provide a submittal on this issue in time for it to be evaluated in this report. In addition, the staff requested GE to address the effect on safety of non-safety-related cable trays that appear to be allowed to penetrate divisional walls and floors. This issue is important because it appears that non-safety-related cable trays are not qualified to the same level as safety-related cable trays. This could result in flooding between divisions which is contrary to PRA assumptions. This is Open Item 19.1.6.5-1.

The staff has not performed a detailed review of the information provided by GE because of its preliminary nature. GE did not submit its complete and final containment bypass analysis in time to be evaluated in this report. The staff will report the results of its final review in the FSER. This is Open Item 19.1.7.2-1.

GE committed to provide documentation indicating results of sensitivity and uncertainty analyses of the COPS and giving the basis for the COPS setpoint. The staff expects that these analyses will be based on GE's modified CETs, which have been presented to the staff in a preliminary form. GE did not provide its submittal in time for evaluation in this report. The staff will report the results of its review in the FSER. This is Open Item 19.1.7.3-1.

The staff noted in the DSER, that venting in less than 24 hours should not be equated with containment failure and the issues will be addressed separately in the SER (Staff Correction 9). The staff will address this matter in the FSER. This is Open Item 19.1.7.3-2.

GE committed to provide documentation indicating results of sensitivity and uncertainty analyses of the passive flooder system. The staff expects these analyses will be based on GE's modified CETs. GE did not provide this information in time to be evaluated in this report. The staff will report the results of its review in the FSER. This is Open Item 19.1.7.4-1.

The staff's review of GE's preliminary information indicates the modified CET and DETs appear to capture key parameters governing CCI. However, the staff has not reviewed the quantification of the CET and DETs in detail. GE has performed only a preliminary quantification of the CET and DETs in the information presented to staff, but has not provided any documentation to justify selection of branch point probabilities and has not submitted the details of the parametric calculations for CCI. GE has also not addressed the implications of CCI on source terms and noncondensible gas generation. GE has not provided this information. This is Open Item 19.1.7.5-1.

GE also presented results of a structural analysis of the reactor pedestal. These results indicate that only the outer steel shell of the pedestal, plus 15 cm of the pedestal web stiffener, is required to ensure that pedestal failure does not occur. Thus, with the 1.7 m thickness of the pedestal wall, about 1.5 m of concrete ablation would be required for the pedestal to fail. On the basis of typical radial erosion rates, the margins in the pedestal design, if confirmed by staff review, should ensure that failure from CCI will not occur within the first 24 hours of an accident. GE did not provide this information in time for evaluation in this report. The staff will report the results of its review in the FSER. This is Open Item 19.1.7.5-2.

Based on its preliminary review of GE's treatment of direct containment heating, the staff concluded that the overall structure (i.e., top events) of the CET and the parameter values and split fractions assigned to the various DET branches appear reasonable. However, GE did not provide the basis and technical justification for the numerical values. GE agreed to provide additional information regarding the bases and justification for the ranges, split fractions, and distributions for each of the decomposition variables. GE did not provide this information in time for evaluation in this report. The staff will report the results of its review in the FSER. This is Open Item 19.1.7.6.1-1.

GE provided additional information concerning rapid steam generation loads of fuel-coolant interactions (FCI) for the ABWR. GE assessed the maximum rates at which steam would be generated from fuel-coolant interaction in the lower drywell from various sources and estimated the corresponding peak pressures for the ABWR. Two cases were considered: (1) water added to debris in the lower drywell and (2) corium pour from the reactor vessel into a pre-existing pool of water. In the first case, four potential sources of water addition to the lower drywell were assessed, including actuation of the passive flooder system. In the second case, a series of different rates of corium mass addition to the pool was evaluated, corresponding to different assumptions regarding the number of reactor vessel penetrations that fail coincident with reactor vessel failure. Peak containment pressures were estimated to be 807 kPa (117 psig) in the lower drywell region, which is less than the 1241 kPa (180 psig) estimated failure pressure for this region. On this basis, GE concluded that FCI leading to failure of the lower drywell is not a credible event. These results appear reasonable; however, the staff has not completed its review. The staff's evaluation will be documented in the FSER. This is Open Item 19.1.7.6.2-1.

A remaining issue is energetic FCIs, or steam explosions. Such interactions occur on the order of milliseconds in contrast to rapid steam generation events, which occur on the order of seconds. GE contends that an ex-vessel FCI caused by a rapid energy transfer when debris enters water in the lower drywell is precluded by pressure/temperature regimes and the size of the debris particles (SSAR Section 19E.2.3.1). The staff considers this justification to be inadequate and will require GE to provide additional rationale for excluding this phenomena from consideration in the PRA. This is Open Item 19.1.7.6.2-2.

The present approach being pursued by GE (i.e., use of DETs for selected key issues) is consistent with these objectives and is therefore acceptable. However, to date GE has only submitted partial, preliminary analyses. The staff will report the results of its review in the FSER. This is Open Item 19.1.7.7-1.

GE is still required to address the effect of core concrete interactions and suppression pool bypass on source terms. The staff understands that GE will address this as part of the final quantification of the ABWR, based on final versions of the DETs for these issues. The staff will report the results of its review in the FSER. This is Open Item 19.1.8-1.

GE committed to provide the results of the updated ABWR PRA (Levels 1, 2, and 3) reflecting modifications to the plant design, as well as modeling enhancements and corrections identified by GE and staff since the original PRA. GE did not provide this information in time for evaluation in this report. The staff will report the results of its review in the FSER. This is Open Item 19.1.10-1.

The staff is waiting for GE's complete submittal on this issue. As part of its review the staff will decide if GE's information is sufficient to continue to exclude treatment of ex-containment LOCAs from the PRA. The results of the staff review will be provided in the FSER. This is Open Item 19.1.11.4-1.

The ACRS correctly indicated that GE erroneously took credit for the RWCU system at high pressure during transients. GE has acted to correct this design deficiency by redesigning the isolation logic of the RWCU system, realigning the isolation configuration so that only the heat-vulnerable resin beds are isolated on high temperature, and limiting the total isolation of the RWCU to those periods when the containment isolation function is actuated. In addition, the RWCU will only be put into operation by emergency procedure after the RHR fails; thereafter, cooling water will be diverted by procedure from the RHR heat exchangers to the RWCU heat exchanger to limit the temperature increase across the RWCU heat exchanger. GE calculates that this temperature increase is only a few degrees above the design temperature and argues that this is acceptable because the RWCU is a backup system that only will have to be used in this configuration for very low probability, beyond-design-basis events. GE did not provide its submittal addressing the RWCU concern in time to be incorporated in this report. This is Open Item 19.1.11.4-2.

The staff will provide its evaluation of the ABWR severe accident design features in the final SER. Staff positions for an acceptable resolution to severe accident phenomena have been specified in the Commission papers identified in Table 1.5 of this report. The staff will also provide its evaluation of the ABWR design to these Commission approved technical and severe accident issues in the final SER. This is Open Item 19.2-1.

CONFIRMATORY ITEMS

(3) GE estimated the inadvertent open relief valve (IORV) frequency to be about 0.01 per reactor-year in the ABWR PRA. The staff noted in the DSER that this estimate was substantially lower than the value (0.07 per reactor-year) used for the Limerick plant and identified it as Confirmatory Item 2. GE stated that it would use a 0.1 IORV frequency per reactor-year in its updated PRA. The staff finds this to be a more reasonable estimate, based on historical failure rate data, and requested that GE update its standard safety analysis report (SSAR) accordingly. This is Confirmatory Item 19.1.5.2-1.

In the DSER the staff questioned ambiguities in the writeup of the IORV event (Confirmatory Item 1). GE subsequently provided a preliminary change to its SSAR that clarifies the text and the accompanying Table. GE is required to update its SSAR accordingly. This is Confirmatory Item 19.1.5.3-1.

In the DSER the staff said GE should have taken credit for the use of the fire water system in both level 1 and level 2 parts of the ABWR PRA as was done by the staff, rather than just the level 2 portion (Staff Correction Item 11). GE subsequently stated that its position was conservative from the standpoint of core damage frequency, but indicated that the fire water system will be modeled so that its value can be evaluated for inclusion in the reliability assurance program. This is Confirmatory Item 19.1.5.4-1.

In the DSER the staff questioned the applicability of using GESSAR II design information for the ABWR design on a train basis (Confirmatory Item 4). GE subsequently stated that it will increase the assumed test and maintenance unavailabilities to levels acceptable to the staff and include these new values in its updated PRA. GE did not provide this information in time for it to be incorporated into this report. This is Confirmatory Item 19.1.5.5.2-1.

After the DSER was completed, the staff requested GE to perform a sensitivity study on the effect of varying outage times and surveillance intervals on core damage frequency. GE subsequently indicated that it does not intend to vary surveillance intervals. GE did not document this position in time for it to be incorporated into this report. This is Confirmatory Item 19.1.5.5.3-1.

The staff identified a number of minor errors in GE's quantification approach used in combination with its design-specific and generic data to quantify the sequence frequency estimates. However, these errors were corrected in the staff's requantification. The staff will review GE's revised PRA to confirm that these errors have been corrected in GE's final risk analysis. This is Confirmatory Item 19.1.5.7-1.

As is done in most PRAs, GE has grouped postulated accident sequences into a small set of accident classes. In the DSER the staff found that GE's accident class definitions contained some potential inconsistencies with regard to the classes to which certain sequences were assigned. GE did not provide information on its accident sequence classification in time to be incorporated into this report. This is Confirmatory Item 19.1.5.8-1.

In the DSER the staff indicated that it believed the fuel assembly seismic capacity was optimistic (Staff Correction 5). After discussions with GE, the staff determined that a capacity of 1.2g is achievable and reasonable. The justification for the 1.2g capacity must be documented in the SSAR. This is Confirmatory Item 19.1.6.3.2-1.

The evaluation of the seismic event trees for the ABWR PRA is documented in Section 19.4.3.4.2 of the DSER. It is possible that with the PRA update, GE may be required to modify one or two event trees. This is Confirmatory Item 19.1.6.3.4.2-1.

In the DSER the staff noted that GE's treatment of Class II events (events with successful core cooling but with loss of containment cooling) was inconsistent because the bulk of Class II events employed firewater as the only available means of core cooling, but were given additional credit for recovery of containment heat removal, continued core cooling, and firewater addition in the seismic containment event tree (Staff Correction 3). The staff also noted an apparent inconsistency between the frequency of Class IV sequences reported in two different tables in the SSAR. Subsequently, GE committed to correct the treatment of firewater in the seismic containment event tree and to include the correction in the PRA-based seismic margins analysis to be submitted to the staff in June 1992. This is Confirmatory Item 19.1.6.3.5-1.

As is done in most PRAs, GE has grouped postulated accident sequences into a small set of accident classes. In the DSER the staff found that GE's accident class definitions contained some potential inconsistencies with regard to the classes to which certain sequences were assigned in the PRA. The staff will confirm the adequacy of GE's accident sequence classification as part of the review of the updated PRA, and will report the results of this review in the FSER. This is Confirmatory Item 19.1.6.3.6-1.

An additional item related to this issue concerns the composition of concrete used in the lower drywell. GE intends to use concrete (i.e., basaltic or similar types) with a lower rate of noncondensible gas production. The results of GE's calculations explored core debris coolability and concrete erosion under various assumptions and suggest that COPS actuation would occur at about 17 to 20 hours after scram in the presence of extensive CCI. COPS actuation would occur even earlier if concrete were used. Accordingly, the staff will require that as part of design certification for the ABWR, a Tier 1 requirement be established to specify that concrete which reduces the production of noncondensible gases be used in the construction of the ABWR lower drywell floor and reactor pedestal. This is Confirmatory Item 19.1.7.5-1.

GE subsequently provided their analysis of pool swell and flashing. The staff's preliminary review indicates GE's analysis is reasonable; however, the review is not final. The staff will report the results of its review in the FSER. This is Confirmatory Item 19.1.8-1.

GE committed to correct this error in the revised consequence calculations that will accompany the updated PRA. GE did not provide these calculations in time for evaluation in this report. The staff will discuss these results in a supplement to this report. This is Confirmatory Item 19.1.9-1.

CHAPTER 20

OPEN ITEMS

In accordance with 10 CFR 52.47(a)(IV), an application for design certification should include proposed technical resolutions of those unresolved safety issues (USIs) which are identified in the version of NUREG-0933 current on the date six months prior to application and which are technically relevant to the design. GE included in standard safety analysis report (SSAR) Appendix 19B a list of USIs and provided references to sections of the SSAR where each was addressed. The staff has reviewed GE's original submittal and determined that it was not adequate because not all issues were characterized accurately in the tables in Appendix 19B. GE revised these tables but subsequent staff review identified that it was difficult to determine exactly how the advanced boiling water reactor (ABWR) design addressed each of the applicable USIs because the design discussion in the body of the SSAR often did not discuss or reference the USI requirements. GE needs to modify the SSAR to explicitly discuss the resolution of each USI in the appropriate SSAR section for clarity to enable the staff to evaluate each item. This is Open Item 20.1-1.

The staff finds the inerted containment and the provision of permanently installed hydrogen recombiners acceptable as hydrogen control measures. However, GE should provide the information requested in the discussion of hydrogen combiners in Section 20.3 regarding paragraph (f)(3)(vi) of 10 CFR 50.34. See the discussion of this subject in Section 6.2.5 of this report. This is identified in Section 20.3 of this report as Open Item 20.3-1.

ABWR SSAR Sections 19B.3.5 and 19B.2.10 establish the interface criteria for plant-specific applications for designing the UHS which is within their scope. These criteria include the two EPRI criteria identified above. These criteria provide sufficient general guidance to a referencing applicant for designing a plant-specific UHS which meets the intent of USI B-32. However, the staff is concerned that the identified interface requirements do not explicitly include the reactor service water system, portions of which (e.g., exposed piping may be vulnerable to the adverse effects of ice.) GE should address the above concern. This is Open Item 20.1-2. Subject to acceptable resolution of Open Item 20.1-2 the staff will conclude that the ABWR meets the intent of USI B-32. The COL applicant must address the capability of plant-specific reactor service water system and UHS designs to meet the intent of USI B-32 as part of its site-specific license application. This is COL Action Item 20.1-3.

10 CFR 52.47 requires that an application for design certification include proposed technical resolutions of those generic safety issues (GSIs) which are identified in the version of NUREG-0933 current on the date six months prior to application and which are technically relevant to the design. GE included in SSAR Appendix 19B a list of GSIs and provided references to sections of the SSAR where each was to be addressed. The staff has reviewed GE's original submittal and determined that it was not adequate because not all issues were characterized accurately in the tables in Appendix 19B. GE revised these tables but subsequent staff review identified that it was difficult to determine exactly how the ABWR design addressed each of the applicable GSIs because the design discussion in the body of the SSAR often did not discuss or reference the GSI requirements. GE needs to modify the SSAR to explicitly discuss the resolution of each GSI in the appropriate SSAR section for clarity to enable the staff to evaluate each item. This is Open Item 20.2-1.

GE needs to add the above items to its interface criteria. This is Open Item 20.2-2. The staff has determined that an acceptable resolution of the above concern in conjunction with the implementation of the identified interface requirements will result in an effective site surveillance and control program to prevent degradation of the UHS and the associated RSW system will due to accumulation of biofouling, mud, silt, or corrosion products in the system parts. Therefore, the staff will conclude that GE's proposed interface requirements for the design of the UHS including the associated RSW system will adequately address the concerns of GI 51, subject to an acceptable resolution of the concerns identified above. The staff will review site-specific aspects of the resolution of GI 51 as part of its review of the site-specific application. Such a review will include, among other things, site-specific surveillance and control program and whether the referencing applicant commits to meet all the GE identified interface requirements.

GE submitted a preliminary evaluation of the following systems: residual heat removal (RHR), high pressure core flooder (HPCF), standby liquid control system (SLCS), and reactor core isolation cooling (RCIC). During a telephone conference on May 14, 1992, the staff commented on the applicant's evaluation. The staff will complete its evaluation upon receiving the information and will issue its evaluation in the FSER. The interfacing systems LOCA remains as Open Item 20.2-3.

Based on the above, the staff requires GE to address all the above concerns and accordingly modify the two identified interface requirements to provide sufficient guidance to the applicable referencing applicants. Such guidance is needed to that each plant-specific applicant will be able to provide supporting documentation and analysis to justify modifications to the ABWR essential cooling water systems if a multi-unit site is to incorporate shared cooling water systems in the modified designs. This analysis and documentation should demonstrate that the revised plant design meets the concerns identified in GI 130 as well as the requirements of GDC 5. This is Open Item 20.2-4.

Based on the above, the staff concludes that space cooling for the HPCF and the RCIC systems will be available as required following a complete loss of offsite ac power to the plant for at least 2 hours. However, the design characteristics for the fan coil units were not specifically identified in ABWR SSAR Section 9.4.5. The ability of the fan coil units to remove sufficient heat to maintain the pump room temperatures within design limits was not confirmed. Also, SSAR Tables 8.3-1 and 8.3-2 which list diesel generator loads, do not include the fans of the pump rooms fan coil units. This is Open Item 20.3-1.

The accumulators including the associated equipment to the ADS valves, and the safety-related portions of the nitrogen gas supply system are designed to seismic Category I, quality Group B or C as appropriate, and quality assurance B requirements. The nitrogen supply system is designed to 1379 kPa (200 psig) and 66 °C (150 °F). The accumulators including the associated equipment to the ADS valves are designed to operate in the environmental conditions to be found in the drywell after a design basis accident (see SSAR Subsection 7.3.1.1.1.2 for specific additional information and SER Section 3.11 for general information on environmental qualification design criteria for equipment important to safety). ABWR SSAR Subsection 7.3.1.1.10 states that the safety-related equipment in the nitrogen gas supply system are selected to accommodate the hostile environment to which they may be exposed during an accident situation. The staff is concerned that SSAR Subsection 6.7-2, however, states that the supply system is designed to 66 °C (150 °F). This is significantly lower than the temperature to which some portions of the system (e.g., inside the drywell and the reactor building) may be exposed during an accident situation. The staff is also concerned that ABWR SSAR Subsection 6.7.4 does not explicitly specify a requirement for periodically testing the leakage through each valve to verify that such leakage is within the assumed value of 28 liters per hour (1 scfh). GE should resolve the above concerns. This is Open Item 20.3-2.

GE has not provided any information that such an evaluation has been performed. GE should provide this analysis. This is Open Item 20.3-3.

The staff finds the inerted containment and the provision of permanently installed hydrogen recombiners acceptable as hydrogen control measures. However, GE should provide the information requested in the discussion of 10 CFR 50.34(f)(3)(vi) below (Open Item 20.3-9) to demonstrate that the recombiners can perform their function.

As discussed in draft safety evaluation report (DSER) Sections 6.2.4 and 6.2.4.1, some penetrations do not have two isolation barriers in series that conform to the containment isolation requirements of GDC 56. This is Open Item 20.3-4.

In response to the staff's request for additional information (RAI) dated June 5, 1990, GE stated that the isolation signal to valve T31-F007 would be deleted from SSAR Figure 6.2-39a. Amendment 11 of this figure still contains an isolation signal to this valve. This is Open Item 20.3-5.

In another response to this RAI, GE agreed to amend the ABWR technical specifications to allow a 24-hour (rather than a 72-hour) window at the beginning and end of a fuel cycle, during which the large diameter 56 cm (22 in) purge lines can be open in accordance with the Standard Technical Specifications. This is Technical Specification Item 6.2.5-1 discussed in Chapter 6 of this report. In addition to proper operation during normal conditions, GE should provide justification that these valves will close during accident conditions. This is Open Item 20.3-6.

GE has stated in the SSAR (1A.2.15) that the ABWR design meets the requirements of Regulatory Guide (RG) 1.97, Revision 3 and believes that this RG incorporates the requirements of II.F.1. This, as well as GE's responses to the RAI dated June 5, 1990, is under staff review. This issue will be included in the FSER. This is Open Item 20.3-7.

The staff has reviewed the ABWR design for the reactor vessel water level measurement system and found that it meets the requirements specified in GL 84-23, "Reactor Vessel Water Level Instrumentation in BWRs." However, Generic Letter 92-04, "Resolution of the Issues Related to Reactor Vessel Water Level Instrumentation in BWRs Pursuant to 10 CFR 50.34(f)" dated August 19, 1992 identified a recent staff concern that noncondensable gases may become dissolved in the reference leg of BWR water instrumentation and can lead to a false high level indication after a rapid depressurization event. The staff has provided a copy of the GL to GE for its evaluation relative to the ABWR design. GE needs to provide a discussion in the SSAR to address the concerns in the GL and include any design changes if necessary to preclude the potential for false reactor coolant level readings. GE needs to also determine if compliance with 10 CFR 50.34(f)(1)(viii) is affected by any design changes. This is Open Item 20.3-8.

The staff's review of SSAR Table 6.2.8, "Primary Containment Penetration List," SSAR Section 19G.4 and SSAR Figure 19G.4-1 indicate that the only primary containment penetration that can be used during a severe accident situation is a 56-cm (22-in.) opening in the wetwell vapor space associated with a 56-cm (22-in.) wetwell purge exhaust/vent line. Containment venting during a severe accident when needed will be via a 36 cm (14-in.) line to the plant stack connected at its other end to the 56-cm (22-in.) wetwell purge exhaust/vent line upstream of the wetwell purge exhaust system inboard isolation valve. The SSAR identified containment penetration size for the ABWR does not comply with the explicit requirement for the size of the penetration that can be used for venting the containment via the associated line during a severe accident situation. Therefore, the staff will require GE to submit a request for exemption from the above requirement with supporting justification. The justification should include a demonstration that the penetration size is adequate to permit a vent relief path which is capable of providing the needed overpressure relief for the primary containment to prevent its uncontrolled failure during any credible severe accident situation. This is Open Item 20.3-9.

GE should provide the following:

- information to clearly demonstrate that the permanently installed hydrogen recombiners have redundant dedicated containment penetrations and that the penetrations meet all applicable design requirements. This information should include:
  - how long after a LOCA and at what hydrogen concentration the recombiner is to be utilized.
  - line sizes as related to flow requirements.
  - duration of recombiner operation.
  - interface requirements for referencing applicants with regard to the recombiners.
- a clearer copy of Figure 6.2-40, "Flammability Control System P&ID."

This is Open Item 20.3-10.

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(none)

CHAPTER 21 AND CHAPTER 22

No Open Item/Confirmatory Item