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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 132 Related to ESBWR Design Certification Application, RAI Numbers 22.5-6 S01 and 22.5-7 S01**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated January 15, 2008 (Reference 1). The GEH response to RAI Numbers 22.5-6 S01 and 22.5-7 S01 is addressed in Enclosure 1. The original RAIs and responses are in References 2 through 4.

Verified DCD changes associated with this RAI response are identified in the attached markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-040. Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 132 Related To ESBWR Design Certification Application*, January 15, 2008.

2. MFN 07-357. Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 101 Related To ESBWR Design Certification Application*, June 21, 2007.

3. MFN 07-419. Response to Portion of NRC Request for Additional Information Letter No. 101 Related to ESBWR Design Certification Application, Regulatory Treatment of Non-Safety Systems (RTNSS) RAI Numbers 22.5-2 through 22.5-4, 22.5-6 and 22.5-15.

4. MFN 07-587. Response to Portion of NRC Request for Additional Information Letter No. 101 Related to ESBWR Design Certification Application, RAI Number 22.5-7.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 132 Related to ESBWR Design Certification Application, Non-Safety Structures, RAI Numbers 22.5-6 S01 and 22.5-7 S01.

cc: AE Cubbage USNRC (with enclosure)
GB Stramback GEH/San Jose (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
DH Hinds GEH/Wilmington (with enclosure)
eDRF 0000-0082-2733 Rev 1

# Enclosure 1

# MFN 08-388

# Response to Portion of NRC Request for Additional Information Letter No. 132 Related to ESBWR Design Certification Application*

# Non-Safety Structures

# RAI Numbers 22.5-6 S01 and 22.5-7 S01

*Original responses previously submitted under MFNs 07-419 & 07-587 included to provide historical continuity during review. Verified DCD changes associated with this response are identified in the attached markups by enclosing the text within a black box. Marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

**NRC RAI 22.5-6**

*Table 19A-2 identifies systems that are classified as RTNSS based upon the RTNSS criteria. The table lists no non-safety related structures that should be included as RTNSS based on Criterion B consideration. Confirm that the ESBWR design does not contain non-safety related structures, that either support or surround the RTNSS systems, whose failure may negatively affect the RTNSS system functions. If there are such structures, explain why they are not addressed within the table.*

**GEH Response**

DCD Tier 2 Table 19A-2 lists the ESBWR systems that meet RTNSS criteria for regulatory oversight. The structures that house the systems and components that meet RTNSS criterion B1 or B2 are required to be meet specific seismic, wind, and flooding design standards. The augmented design requirements for structures containing Criterion B1 and B2 RTNSS systems were addressed in MFN 07-373, Section 19A.8.3. Systems and components that meet RTNSS criteria other than B1 and B2 are listed below, with a description of the design capability of their supporting structures. In each case, the minimum structural design rating is Category II.

| System or Function | RTNSS Criterion | Structures | Seismic Category |
|---|---|---|---|
| Alternate Rod Insert | A | Reactor Building | I (II in stair towers and elevator shafts) |
| BiMAC | C | Containment | I |
| Diverse Protection System | C | Reactor Building, Control Building | I (II in stair towers and elevator shafts) |
| Drywell Hatches | C | Reactor Building | I (II in stair towers and elevator shafts) |
| FAPCS | C | Fuel Building, Reactor Building | I (II in Fuel Bldg HVAC penthouse, stair towers and elevator shafts) |
| Fuel Bldg HVAC | C | Fuel Building | HVAC Components – I and II; Building - I (II in HVAC penthouse, stair towers and elevator shafts) |
| Feedwater Runback | A | Reactor Building, Control Building | I (II in stair towers and elevator shafts) |
| SLCS Actuation | A | Reactor Building, Control Building | I (II in stair towers and elevator shafts) |

**DCD Impact**

There is no impact on the DCD.

**NRC RAI 22.5-6 S01**

*As stated by the applicant, structures that house Criteria B1 and B2 RTNSS systems are designed to the augmented standards of DCD, Section 19A.8.3.*
*With regard to IBC seismic provisions proposed by the applicant for the design of RTNSS SSCs meeting Criterion B2, the staff noticed that these seismic provisions utilize a 2500-year event as the "Maximum Considered Earthquake". This ground motion is then reduced by a factor of two-thirds to produce the "design" ground motion. Such ground motion may have a return period varying from approximately 500 to 1,500 years, depending on the regional seismicity. The design seismic demands are further modified (generally reduced) in the design calculations to account for earthquake energy absorption through nonlinear behavior, i.e. component cracking and yielding. Structures classified as IBC Occupancy Category IV are designed as Seismic Use Group III and are expected to achieve the Immediate Occupancy performance level at the "design" level ground motion. Based on the 2003 NEHRP Recommended Provisions for Seismic Regulations of New Buildings and Other Structures (FEMA 450, 2004), which forms the technical bases for the IBC seismic provisions, Immediate Occupancy is a performance level below an operational or a "functional" level. FEMA 450 further states that at the Immediate Occupancy level, damage to the structural systems is very slight and the structure remains safe to occupy; however, some repair is probably required before the structure can be restored to normal service. Equipment housed in such structures, on the other hand, is expected to experience more damage. In particular, utilities necessary for normal function of systems are not expected to be available. Also, some equipment and systems may experience internal damage due to shaking of the structure. Ultimately, minor structural repairs are required; however, significant nonstructural repair and cleanup are probably required before normal function of the structure can be restored. Based on the above, the staff believes that the IBC 2003 seismic provisions are not adequate to ensure that the post-72 hour systems, structures and components can withstand the effects of a safe-shutdown earthquake (SSE) without the loss of capability to perform their required functions.*

*The staff requests the following:*

1. *Identify in the DCD all non-safety-related, non-seismic structures that house/support RTNSS systems meeting Criteria B1 and B2.*
2. *Provide the technical rationale to support GEH's assertion that IBC seismic provisions will achieve functional performance under an SSE level earthquake.*
3. *Given the lower hazard level and performance level of the IBC as compared to the SSE hazard level with a functional performance level, explain how GEH will ensure availability and reliability of RTNSS B2 systems and their surrounding/ supporting structures.*

*In the event of an SSE, explain in the DCD how RTNSS B1 and B2 systems are protected against adverse interaction due to the failure of adjacent non-safety related, non-seismic structural and non-structural components that are designed to the IBC seismic provisions.*

**GEH Response**

1. The following Table shows RTNSS Criterion B2 Systems located in non-safety-related, nonseismic (NS) structures based on Table 19A-2 and Table 3.2-1. There are no RTNSS Criterion B1 Systems located in non-safety-related, nonseismic structures.

| System | RTNSS Criterion | Location | Building Category |
|---|---|---|---|
| Diesel Generators | B2, C | Electrical Building (EB) | NS |
| EB HVAC | B2, C | Electrical Building (EB) | NS |
| PIP Buses | B2, C | Electrical Building (EB) | NS |
| RCCWS | B2, C | Turbine Building (TB) | NS |
| Chilled Water System | B2, C | Turbine Building (TB)<br>Electrical Building (EB) | NS<br>NS |
| TB HVAC | B2, C | Turbine Building (TB) | NS |
| PSW | B2, C | Turbine Building (TB)<br>Service Water Building (SF) | NS<br>NS |

2. IBC seismic provisions use 2% exceedance (return period of about 2500 years) as the maximum considered earthquake ground motion that would result in acceptable seismic safety for most regions of the US following NEHRP-2003, Subsection 3.3.1.

   However, in the case of ESBWR, RTNSS systems and structures are designed to SSE ground motion. When RTNSS systems are located in non-C-I structures, these structures although categorized NS, are seismically designed using the International Building Code (IBC-2003) to maintain structural integrity with a margin of safety that is equivalent to a Seismic Category I structure under SSE conditions. Dynamic analysis method is used with the SSE ground input motion equal to two-thirds of the ESBWR Certified Seismic Design Spectra taken from DCD Tier 2, Revision 4, Figures 2.0-1 and 2.0-2 adjusted as required to the base of the building.

   The GEH Certified Seismic Design Response Spectra in DCD Tier 2 Revision 4 Figures 2.0-1 and 2.0-2 are based on RG 1.60 and North Anna Early Site Permit (ESP) site response spectra. The combined spectra envelope the site-specific spectra of most potential US sites for nuclear power plants. These site-specific spectra are based on median annual reference probability of 1E-4 which represents a return period of 10,000 years. Thus, the input ground motion vastly exceeds IBC earthquake motion.

The following additional criteria are used for the design of NS Buildings that house RTNSS systems:

a. Importance Factor of 1.5 (This cancels the 2/3rd reduction factor in response spectra above).

b. Seismic Design Category D/Seismic Use Group III.

c. Response Modification Factor, R = 2.
IBC-2003 allows an R value of 6 for specially reinforced concrete shear walls and R = 5 for concentrically braced steel frames. Using R = 2 results in seismic design loads which are about 3 times larger than required by IBC-2003.

d. Loads, load combinations and performance criteria follow IBC-2003.

Based on these conservatisms, damage to equipment and systems are not credible and functional performance equivalent to "operational level" is achieved.

The design of RTNSS Criterion B2 internal structures, piping or components is discussed in the response to RAI 22.5-7.

RTNSS Criterion B1 equipment is qualified to IEEE Std 344-1987 to demonstrate seismic performance. RTNSS B2 components have a less direct effect on the success of key safety functions and are not credited in the seismic margin analysis. RTNSS Criterion B2 equipment is qualified to IEEE Std 344-1987 to demonstrate structural integrity.

3. Consistent with the achievement of the "operational level" for the structures as discussed above, RTNSS Criterion B2 systems are also designed to SSE from DCD Tier 2, Rev. 4, Figure 2.0-1. The details are discussed in the response to RAI 22.5-7 contained in this letter (MFN 08-388).

DCD Tier 2 Subsection 19A.8.3 will be revised to state that any non-RTNSS system that can adversely interact with RTNSS B1 or B2 systems is designed to the same seismic requirements as the affected RTNSS system.

RTNSS Criterion B1 equipment is qualified to IEEE Std 344-1987 to demonstrate seismic performance and structural integrity. RTNSS B2 components have a less direct effect on the success of key safety functions and are not credited in the seismic margin analysis. RTNSS Criterion B2 equipment is qualified to IEEE Std 344-1987 only to demonstrate structural integrity.

**DCD Impact**

DCD Tier 2 Subsection 19A.8.3 will be revised as noted in the attached markup.

**NRC RAI 22.5-7**

*Section 19A.8.3 states "Systems that meet RTNSS Criterion B (i.e., for actions required beyond 72 hours) require augmented design standards to assure reliable performance in the event of hazards, such as seismic events, high winds, and flooding. These standards are applied to High and Low Regulatory Oversight systems that meet Criterion B." The ensuing text discusses systems classified as B1 and B2 and applicable seismic design - Seismic Category II and the requirements in accordance with the International Building Code (IBC) – 2003 by International Code Council, Inc. (300-214-4321).*

*Please respond to the following:*

*A. For each of the systems that are classified as RTNSS based on Criterion B consideration (Table 19A-2), discuss the specific deterministic seismic evaluation (including the selection of the code stipulated seismic hazard inputs) implemented to demonstrate their compliance with the seismic design requirements of the IBC – 2003 proposed as design standards.*

*B. As applicable, provide also the same discussion for RTNSS structures that may be identified as within the ESBWR scope in response to RAI 22.5-6 above.*

**GEH Response**

A. As stated in DCD Tier 2, Rev. 4, Section 19A.8-3, Criterion B is divided into two groups:

- Criterion B1, these RTNSS systems shown in Table 19A-2 of DCD Tier 2 (Rev.4) are designed as Seismic Category II (C-II). The deterministic seismic evaluation of these systems in this group follows the same methods of analysis and acceptance criteria as Seismic Category I (C-I) applying SSE loads.
- Criterion B2, the design of these RTNSS systems shown in Table 19A-2 of DCD Tier 2 (Rev.4) follows IBC-2003 requirements delineated as follows:
    1. The maximum earthquake ground motion response spectrum, $S_{aM}(T)$, where T is the natural period of the structure, is the single envelope ESBWR SSE design response spectrum shown in DCD Tier 2, Rev.4, Figure 2.0-1 for C-I and C-II SSC's.
    2. Section 1615.2.4 of IBC-2003 defines $S_a(T)$ as two third of $S_{aM}(T)$, where $S_a(T)$ is RTNSS design ground motion spectrum. Let $S_{DS}$ be the design spectral response acceleration at short period, according to Section 1615.2.5, $S_{DS} = S_a(0.2sec)$ but not less than 90% of the peak spectral acceleration $S_a$, at any period.

Let $S_{aM}$ = maximum (or peak) value of earthquake ground motion response spectrum (SSE), then

$S_{aM}$ = 1.35g [Ref: DCD Tier 2, Rev.4, Figure 2.0-1]

Let $S_a$ = maximum (or peak) value of design spectral acceleration, then

$S_a = (2/3)^* S_{aM}$ [Ref: IBC-2003, Section 1615.2.4]

= 0.9g

Let $S_{DS}$ = design spectral response acceleration at short period (or, short-period design spectral response acceleration), then

$S_{DS} = 0.9^* S_a$ [Ref: IBC-2003, Section 1615.2.5]

= 0.81g

3. Structures, piping or components, according to Section 1616.3, shall be designed as Seismic Design Category D under Seismic use group III with Importance Factor, IP=1.5.
4. The seismic loads shall be calculated as follows according to ASCE 7-02.

   Horizontal design seismic load: Equation 9.6.1.3-1 of ASCE 7-02,

   Maximum design seismic load: Equation 9.6.1.3-2 of ASCE 7-02,

   Minimum design seismic load: Equation 9.6.1.3-3 of ASCE 7-02,

   Vertical design seismic load: Equation 9.5.2.7 of ASCE 7-02,

B. Response to RAI 22.5-6 is related to this response.

The Electrical building (EB), as RTNSS structure, houses two nonsafety-related standby diesels and nonsafety-related power supplies. The EB also provides space for the Technical Support Center. The EB is nonsafety-related and Seismic Category NS, but the augmented design of B2 described in A above applies.

**DCD Impact**

No DCD changes will be made in response to this RAI.

**NRC RAI 22.5-7 S01**

*Based on the staff's understanding of the IBC code, the augmented seismic design criteria, as delineated in GEH's response, will allow Criterion B2 RTNSS SSCs to achieve Immediate Occupancy performance level at two thirds SSE. In accordance with FEMA 450, this is a state of some level of damage (lower for the structure and higher for the equipment) at two-thirds SSE. This is not sufficient to provide reasonable assurance that Criterion B2 SSCs will function after an SSE event. The staff requests the following:*

1. *Provide a detailed explanation for GEH's assertion that an Immediate Occupancy performance level at two-thirds SSE will provide reasonable assurance that Criterion B2 SSCs will function after an SSE event.*
2. *If applicable, provide in the DCD GEH's specific modifications to the IBC provisions in order to improve the performance criteria for RTNSS Criterion B2 SSCs to functional performance level at an SSE event level.*

**GEH Response**

1. RTNSS Buildings that house Criterion B2 systems are seismically designed per IBC-2003 using a dynamic analysis method with the SSE ground input motion equal to two-thirds of the Certified Seismic Design Spectra taken from DCD Tier 2 Rev. 4 Figures 2.0-1 and 2.0-2 adjusted as required to their bases. An Occupancy Importance Factor of 1.5, Response Modification Factor of 2 and Seismic Design Category D/Seismic Use Group III apply to the above RTNSS structures. Also, please see the RAI 22.5-6 S01 response. This RAI supplement supersedes the response to RAI 22.5-7 (B).

   Because the RTNSS Criterion B2 components have a less direct effect on the success of key safety functions and are not credited in the seismic margin analysis, they are qualified to IEEE-344-1987 to demonstrate structural integrity only. This provides sufficient assurance for the functionality of RTNSS B2 components commensurate with their significance.
2. Not applicable. Please see response to Item 1.

**DCD Impact**

DCD Tier 2 Subsection 19A.8.3 will be revised as noted in the attached markup.

# 19A.8 PROPOSED REGULATORY OVERSIGHT

## 19A.8.1 Regulatory Oversight

Regulatory oversight is applied to each system designated as RTNSS to ensure that it has sufficient reliability and availability to perform its RTNSS function, as defined by the focused PRA, or deterministic criteria. The extent of oversight is commensurate with the safety significance of the RTNSS function, and is categorized as either High Regulatory Oversight (HRO), Low Regulatory Oversight (LRO), or Support.

HRO - If the focused PRA analysis determines that a RTNSS system is significant to public health and safety (that is, necessary to meet the NRC safety goals) then it is classified as HRO. Technical Specification Limiting Condition for Operation should be established for the system/component, in accordance with 10 CFR 50.36.

LRO - If a RTNSS system is not significant, as described above, then the proposed level of regulatory oversight is Low Regulatory Oversight (LRO), which is addressed in regulatory availability specifications, which are described in the Availability Control Manual.

Support – These systems have low risk significance and they provide support (generally component and room cooling) for RTNSS systems that provide active mitigation functions. Treatment of support systems relative to the systems they support is described in the Availability Control Manual.

## 19A.8.2 Reliability Assurance

All RTNSS systems shall be in the scope of the Design Reliability Assurance Program, as directed by DCD Tier 2 Chapter 17, which will be incorporated into the Maintenance Rule program.

## 19A.8.3 Augmented Design Standards

Systems that meet RTNSS Criterion B (that is, for actions required beyond 72 hours) require augmented design standards to assure reliable performance in the event of hazards, such as seismic events, high winds, and flooding. These standards are applied to High and Low Regulatory Oversight systems that meet Criterion B.

A RTNSS system classified as B1 or B2 that is required to function following a seismic event requires an augmented seismic design criterion. For B1 SSCs, the design is performed in accordance with Seismic Category II. B2 SSCs are designed for seismic requirements consistent with the International Building Code (IBC) – 2003 by International Code Council, Inc. (300-214-4321). ~~The building structures are classified as Category IV (Power Generating Stations) with an Occupancy Importance Factor of 1.5. Either of the methods permitted by the IBC, simplified analysis or dynamic analysis, is acceptable for determination of seismic loads on NS structures and equipment including those designated as RTNSS.~~ Because these systems are designated to perform their function post 72 hours, the equipment does not need to be able to perform their functions during the seismic event, but must be available following the event.

Buildings that house RTNSS Criterion B2 systems are nonseismic (NS) structures that are designed using the IBC-2003 to maintain structural integrity with a margin of safety that is

equivalent to a Seismic Category I structure under SSE conditions. These RTNSS structures are seismically designed with dynamic analysis methods where SSE ground input motion is equal to two-thirds of the Certified Seismic Design Spectra taken from Figures 2.0-1 and 2.0-2 adjusted as required to their bases. An occupancy Importance Factor of 1.5, Response Modification Factor of 2 and Seismic Design Category D/Seismic Use Group III apply to the above RTNSS structures. In addition, any non-RTNSS system that can adversely interact with RTNSS B1 or B2 systems is designed to the same seismic requirements as the affected RTNSS system.

RTNSS Criterion B1 equipment are qualified to IEEE-344-1987 to demonstrate seismic performance and structural integrity. RTNSS Criterion B2 components have a less direct effect on the success of key safety functions and are not credited in the seismic margin analysis. RTNSS Criterion B2 equipment is qualified to IEEE-344-1987 only to demonstrate structural integrity.

In addition to seismic standards, all Criterion B systems must meet design standards to withstand winds and missiles generated from category 5 hurricanes. As with seismic, the systems do not need to perform their functions during the high wind event, but must be available following the event. Fire events are sufficiently addressed with the current regulatory standards, so no additional controls are applied.

The plant design for protection of SSCs from the effects of flooding considers the relevant requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," and 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," Section IV.C as related to protecting safety-related SSC from the effects of floods, tsunamis and seiches. The design meets the guidelines of Regulatory Guide 1.59 with regard to the methods utilized for establishing the probable maximum flood (PMF), probable maximum precipitation (PMP), seiche and other pertinent hydrologic considerations; and the guidelines of Regulatory Guide 1.102 regarding the means utilized for protection of safety-related SSC from the effects of the PMF and PMP.

Systems that meet RTNSS Criteria A, C, D, or E do not require augmented design standards described above, but must incorporate the defense-in-depth principles of redundancy and physical separation to ensure adequate reliability and availability.

### 19A.8.4 Regulatory Treatment

The proposed regulatory treatment of RTNSS systems is presented below, and is summarized in Tables 19A-2, 19A-3 and 19A-4.

#### 19A.8.4.1 *Alternate Rod Insertion (ARI)*

This function is RTNSS based on the requirements of Criterion A relative to the ATWS Rule, 10 CFR 50.62. The ARI function does not have a high risk significance due to the redundancy and diversity of the reactor protection system. The proposed level of regulatory oversight for this function should be in the Availability Control Manual.