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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 68 – Control Room Habitability – RAI Numbers 6.4-1 through 6.4-4**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-379, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 68 Related to ESBWR Design Certification Application*, October 10, 2006

Enclosure:

1. MFN 06-468 – Response to Portion of NRC Request for Additional Information Letter No. 68 – Control Room Habitability – RAI Numbers 6.4-1 through 6.4-4

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0060-4421

Enclosure 1

MFN 06-468

Response to Portion of NRC Request for

Additional Information Letter No. 68

Related to ESBWR Design Certification Application

Control Room Habitability

RAI Numbers 6.4-1 through 6.4-4

NRC RAI 6.4-1:

In DCD Tier 2, Rev. 1, Section 6.4, "Control Room Habitability Systems," the applicant did not provide a list of Codes and Standards used in the design of the ESBWR Control Room Habitability Systems. The design of these systems will typically reference ASTM Standards, ASHRAE Standards, Regulatory Guides, the Code of Federal Regulations, and others. Provide (as references) a list of Codes and Standards used in the design of the ESBWR Control Room Habitability Systems. The NRC staff expects the ESBWR design to commit to the latest revisions of the applicable Codes and Standards and include this commitment in the DCD.

GE Response:

A list of references, including applicable codes, standard, and regulatory references will be added to Section 6.4 in DCD Tier 2 Revision 3.

DCD Impact:

DCD Tier 2, Section 6.4 will be revised as noted above.

NRC RAI 6.4-2:

Relocate the system description of emergency breathing air system (EBAS) from DCD Tier 2, Rev. 1, Section 9.4.1 to DCD Tier 2 Section 6.4. Also, the systems described in DCD Tier 2, Sections 6.4 and 9.4.1 should include additional details as follows:

a. Provide component descriptions of major components (compressed breathing air tanks, isolation and relief valves, piping, instrumentation including flow orifices and flow and pressure indicators, self contained portable breathing apparatus, etc.) with their applicable Codes and Standards and their design features (e.g. capacity, material, differential pressures, leak tightness, etc.)

b. Provide details of the design features of the concrete walls, slabs, system components, control room habitability area (CRHA) envelope doors, sealing materials (for construction joints and penetrations) piping, conduits, electrical cable trays penetrations, etc., and unfiltered inleakages inside CRHA envelope.

c. Provide a detailed description of how the inservice inspection and testing will be conducted in accordance with applicable Technical Specifications.

d. Confirm that:

1) *EBAS air flow rate is sufficient to maintain pressurization of the CRHA envelope of at least 1/8-inches of W.G. with respect to adjacent areas*
2) *Air quality including carbon dioxide concentration below one-half percent by volume for 5 persons (evaluate for maximum numbers of occupants during accident conditions) within the CRHA envelope is within the guidelines of Table 1, and Appendix C, Table C-1, of the ASHRAE Standard 62-[Latest-Edition].*
3) *State that the storage capacity of the compressed breathing air tanks is verified to assure 72-hours of air supply, i.e. 72-hours for the required number of CRHA envelope occupants (provide data indicating the amount of air stored in cfm and the corresponding pressure). In addition, provide a discussion explaining how the breathing air quality meets the U.S. Occupational Safety and Health Administration (OSHA) and ASHRAE Standards.*

e. Provide a description of how air sampling is performed and at what frequency to conform with the guidelines of Table 1, and Appendix C, Table C-1 of the ASHRAE Standard 62-[Latest-Edition].

f. GDC 19, "Control Room," requires applicants to provide adequate protection to permit access and occupancy of the control room under accident conditions including loss of coolant accidents. In order to meet GDC 19 requirements, the control room shall be maintained by providing safety-related radiation protection, toxic protection and safety-related cooling function. In DCD Tier 2, Rev. 1, Table 6.4-1, the applicant provided temperature profiles for the CRHA envelope during normal operation and station Blackout (SBO) conditions. However, DCD Tier 2, Rev. 1, Section 6.4 does not address CRHA envelope environment and equipment operability under accident conditions. Address the safety-related cooling function by providing a habitable environment below the human threshold and maintaining appropriate equipment operability inside CRHA envelope such that the control room operators can carry out needed

actions to maintain the nuclear power plant in a safe condition under accident conditions, including loss-of-coolant accidents.

g. The applicant did not address the "Failure Mode and Effect Analysis" (FMEA) in DCD Tier 2, Rev. 1, Sections 6.4 and 9.4.1 when concluding that EBAS is capable of functioning in spite of the loss of active components and detecting and controlling leakage of airborne contamination (radiation, smoke, and toxic chemicals) to meet the requirements of GDC 19 and conform with the guidance of NUREG-0800, Standard Review Plan (SRP) Section 6.4, "Control Room Habitability System" and SRP Section 9.4.1, "Control Room Area Ventilation System." Provide a FMEA (table format preferred) and provide EBAS and CRHA heating, ventilation, and air conditioning sub-system (CRHAHVS) assessments in DCD Tier 2 Sections 6.4 and 9.4.1 to conclude that EBAS and CRHAHVS are capable of functioning despite the loss of active components, detecting and controlling leakage of airborne contamination (radiation, smoke, and toxic chemicals), and functioning during a loss-of-power events.

GE Response:

a. Component descriptions of major components (compressed breathing air tanks, isolation and relief valves, piping, instrumentation, including any flow orifices and flow and pressure indicators, self contained portable breathing apparatus, etc.) with their applicable Codes and Standards and their design features will be included in a future revision of the DCD.

b. Details of the design features of the concrete walls and slabs are described in DCD Tier 2 Section 3.8 and Appendix 3G. Details of MCR envelope construction, system components, control room habitability area (CRHA) envelope doors, and unfiltered in-leakage inside CRHA envelope will be included in the future revision of the DCD.

c. Inservice inspection and testing of the EBAS system and the CRHA is conducted in accordance with the surveillance requirements specified in the technical specifications in Chapter 16. This statement will be added to Section 6.4 in a future DCD Tier 2 Revision 3.

d. Confirmations:

1) The EBAS air flow rate is sufficient to maintain pressurization of the CRHA envelope of at least 1/8-inches of w.g. (water gauge) with respect to adjacent areas. The EBAS flow rate is nominally 100 scfm. The CRHA is an underground room built with poured concrete walls. All penetrations are robustly airtight and duct penetrations are limited to that of the CRHAVS with only one supply, one exhaust, and one bathroom exhaust penetration. The robust construction of the CRHA, including the use of airlock vestibule entry/exit passages, provides for pressurization with a small amount of flow. For comparison, the AP1000 Main Control Room Envelope is pressurized to 1/8" w.g. with 60 scfm.

2) ASHRAE 62-1989 Appendix C, Table C-1:

The ESBWR CRHA design complies with ASHRAE Standard 62-2001, which is the latest version of ASHRAE 62, as identified in DCD Tier 2 Table 1.9-22, and review of all Addendums through Addendum AF to ASHRAE 62-2001, reveals no existence of a Table C-1 in Appendix C.

A review of ASHRAE 62-1989 reveals that Appendix C supplies additional guidance for the establishment of indoor air quality under special circumstances where the ventilation

rates applied in Table 2 are not adequate due to special situations 'where large quantities of specific contaminants are introduced into the building atmosphere'. Therefore, this ASHRAE 62-1989 Appendix does not apply to CO2 concentration, and Table C-1 in this Appendix makes no mention or listing of CO2 concentration.

In 29CFR1910.134(d)(1), OSHA states that compressed "breathing air shall meet at least the requirements of the specification for Grade D air as described in the ANSI Compressed Gas Association Commodity Specification for Air, G-7.1-1989."

ASHRAE 62-1989/2001 Table 1:

Table 1 in ASHRAE 62 for both the 1989 and 2001 editions is entitled 'National Primary Ambient-Air Quality Standards for Outdoor Air as Set by the U.S. EPA' and does not make any reference to CO2 concentration.

ASHRAE Table 1 and Table C-1 Irrelevance/AP1000 Methodology:

Based on the above, the reference to both Table 1 and Appendix C, Table C-1 of ASHRAE 62-1989 in the AP1000 DCD in relation to control room CO2 concentration appears to be in error since neither Table has any relevance to CO2 concentration.

By applying Figure D-2 of Appendix D, physical activity up to and including 3 metabolic units can be applied for MCR activity ("light machine work"). Applying Figure D-3 of Appendix D results in a ventilation rate of approximately 5.45 cfm/person, or 60 cfm for 11 people, which is obtained by determining the ventilation required for 3 metabolic units on the 0.5% CO2 concentration line.

ASHRAE 62-2001 and ESBWR Design:

ESBWR considers the use of the methodology in ASHRAE 62-1989, and a 0.5% CO2 (5000ppm) concentration, to be unacceptable to meet the intent of GDC 19 for MCR habitability. The generic guidance in ASHRAE 62 with respect to CO2 concentration as a measure of indoor air quality is to limit the nominal indoor CO2 to no more than 700ppm above the nominal outdoor CO2 concentration (ASHRAE 62-2001, Section 6.2.1). A CO2 concentration of 700 ppm is a constant goal for everyday occupant comfort. Considering that outdoor CO2 is nominally in the 300-500 ppm range, the ASHRAE nominal goal for CO2 concentration for normal occupancy is 1000-1200 ppm. Exceeding a 1200 ppm indoor concentration for an emergency situation of limited duration is not necessarily unacceptable; however, the acceptance of a CO2 concentration of 5000 ppm is considered excessive.

The EBAS nominal flow rate is 100 cfm and MCR accident occupancy is 5 people. The maximum EBAS stored air CO2 concentration is 1000 ppm to meet ANSI G-7.1 Grade D air quality requirements. ESBWR CRHA design meets the ASHRAE normal occupancy goal for CO2 concentration during emergency conditions by providing a fresh air ventilation rate of 20 cfm/person, which meets or exceeds the ASHRAE 62-2001 Table 2 ventilation requirements for commercial facilities under all headings that apply to the type of MCR occupancy expected. Therefore, ESBWR EBAS design parameters maintain MCR CO2 concentration far below a CO2 concentration of < 0.5%.

3) The statement that the storage capacity of the compressed breathing air tanks is verified to assure 72-hours of air supply, including data indicating the amount of air stored in

cubic feet and the corresponding pressure, will be included in Section 6.4 in DCD Tier 2 Revision 3.

OSHA [29CFR1910.134(d)(1)] states that compressed breathing air shall meet the Grade D requirements of ANSI CGA G-7.1. A discussion of compliance to ANSI Compressed Gas Association (CGA) Standard G-7.1 Grade D, which also complies with OSHA breathing air quality standards, for the compressed air in EBAS system will be added to Section 6.4 of the DCD Tier 2 in Revision 3. The compressed breathing air system compliance to the latest (2004) edition of ANSI CGA G-7.1is identified in Table 1.9-22.

e. As stated above Table 1 is not applicable, and Appendix C, Table C-1 of the ASHRAE Standard 62-2001 is not well suited for qualification of compressed breathing air stored in the EBAS system tanks. Air sampling will occur quarterly and will be analyzed to meet the requirements of ANSI CGA G-7.1 (2004) Grade D requirements, which is referenced by OSHA as the requirement for breathing air quality. EBAS design compliance with G-7.1 Grade D requirements will be included in Section 6.4 of the DCD Tier 2 in Revision 3, and the quarterly surveillance of the air quality will be included in Chapter 16 (Technical Specifications) of the DCD Tier 1 in Revision 3.

f. Table 6.4-1 lists the maximum temperature rise for the MCR under the "CRHA (SBO)" heading. This limit also applies to accident conditions. The heading will be revised to reflect "CRHA (SBO and Accident Conditions)" to clarify this in Revision 3 of the DCD.

g. An FMEA and assessments to conclude EBAS and CRHAVS are capable of functioning despite the loss of active components, detecting and controlling leakage of airborne contamination (radiation, smoke, and toxic chemicals), and functioning during a loss-of-power events will be included in Sections 6.4 and/or 9.4 as applicable in Revision 3 of the DCD Tier 2.

DCD Impact:

DCD Tier 2, Sections 6.4 and 9.4 will be revised as noted above.

NRC RAI 6.4-3:

Provide information regarding onsite chemicals (table format preferred) with chemical names such as hydrogen, nitrogen, CO2, oxygen scavenger, pH addition, sulfuric acid, sodium hydroxide, dispersant, fuel oil, corrosion and scale inhibitors, biocide/disinfectant, algicide, etc., with their associated states (i.e. gas or liquid), and their specific building locations for the staff's review. Also provide a list of main control room habitability indications and alarms, and information regarding loss of ac power heat load limits including type of rooms, room numbers, heat load for 0-24 hours in "btu/sec," and heat load for 24-72 hours in "btu/sec."

GE Response:

Toxic Chemicals: The ESBWR DCD currently meets the requirements of RG 1.78 for toxic gas protection of the operators in the main control room. DCD Tier 2 Subsection 2.2.3 states that one of the functions of the CRHA ventilation system is: "Detects and limits the introduction of airborne hazardous materials (radioactivity, smoke, chlorine gas, or other site-specific toxic gas) into the CRHA".

The site-specific onsite chemicals and locations will be described in the COL phase. Information stating that analysis of these sources is in accordance with Regulatory Guide 1.78 and the methodology in NUREG-0570, 'Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release', and that the analysis shows that these sources do not represent a toxic hazard to control room personnel," will be included in Section 6.4 in DCD Tier 2, Revision 3.

CRHA Indications and Alarms: CRHA indications and alarms are discussed in detail in DCD Tier 2, Section 6.4 and 9.4. Subsection 6.4.4.1 states: "CRHAVS instrumentation detects and automatically protects the CRHA habitability upon detection of high airborne radioactivity, toxic gases, or smoke." Further, Subsection 6.4.8 lists the following Instrumentation Requirements:

"A description of the required instrumentation is given in Subsection 9.4.1.5. Alarms for the following CRHA/CRHAVS conditions are provided in the MCR:

- Low airflow (each fan and air handling unit)
- High filter pressure drop
- High space temperatures
- Low space temperatures
- Low coil entering air temperature
- Low CRHA differential pressure
- Smoke detected
- Toxic gas detected
- High and low humidity in the CRHA
- CRHA airlock doors are open during an SBO"

Indications and alarms for the EBAS, including air storage tank pressure, MCR pressure boundary DP, and EBAS delivery flow rate will be added to this list or provided in table format in Section 6.4 of DCD Tier 2, Revision 3.

MCR Heat Loads: The ESBWR MCR is designed to meet the URD based requirement of maintaining a temperature no greater than 15°F above the ambient for any loss of cooling event, including SBO or LOCA conditions. The heat loads in the MCR envelope for the most bounding conditions are applied to assure compliance with the 15°F temperature rise under all postulated conditions.

DCD Impact:

DCD Tier 2, Section 6.4 will be revised as noted above.

NRC RAI 6.4-4:

Revise DCD Tier 2, Rev. 1, Figure 6.4-1, "Emergency Breathing Air System Schematic Diagram," to show details such as major components (e.g. compressed breathing air tanks, pressure control and relief valves, orifices, pressure relief dampers, etc.) and piping (located inside and outside the CRHA envelope) with their Tag numbers and associated instrumentation including sizing and capacity data.

GE Response:

DCD Tier 2 Figure 6.4-1 is a simplified flow diagram of EBAS. The detailed design of the EBAS system including P&ID level of detail of components will be developed in the COL phase.

DCD Impact:

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