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MFN 08-911

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U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Document Control Desk
Rockville, MD 20852

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 265 Related to ESBWR Design Certification Application – Electrical Power - RAI Number 8.3-60**

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 (RAIs) sent by NRC letter No. 265, dated October 10, 2008 (Reference 1).

GEH response to RAI 8.3-60 is provided in Enclosure 1.

Please contact me if you have any questions concerning this submittal.

Sincerely,

Ger F. Daughtry for

Richard E. Kingston
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 08-811 - Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 265 Related To ESBWR Design Certification Application*, dated October 10, 2008

Enclosure:

1. MFN 08-911 -Response to Portion of NRC Request for Additional Information Letter No. 265 Related to ESBWR Design Certification Application – Electrical Power - RAI Number 8.3-60

cc: AE Cubbage USNRC (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
DH Hinds GEH/Wilmington (with enclosure)
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Enclosure 1

MFN 08-911

Response to Portion of NRC Request for Additional Information Letter No. 265 Related to ESBWR Design Certification Application

Electrical Power

RAI Number

8.3-60

NRC RAI 8.3-60

ESBWR DCD, Tier 2, Section 8.3.1.1.2 (Page 8.3-4) states that "Isolation power centers are protected against degraded voltage and frequency conditions by way of voltage and frequency relays installed in each Isolation Power Center to prevent tripping of all Isolation Power Center loads, in accordance with BTP PSB1." In this regard, provide the following information:

a. Clarify what is meant by "prevent tripping of all Isolation Power Center loads" in the above statement.

b. Discuss the effect of degraded voltage and frequency on the safety-related loads (battery charger, UPS, regulating transformer).

c. Provide the number of relays per isolation power center bus, the coincident logic, the trip set points of the degraded voltage and frequency relays and their functions.

d. Are there any time delay relays associated with this scheme?

e. Provide your rationale for providing degraded voltage and frequency protection only at isolation power centers.

GEH Response

GEH offers the following information in response to the reviewer's questions. DCD Tier 2, Subsection 8.3.1.1.2 will be revised to clarify the purpose of the degraded voltage and frequency relaying and number of relays on the IPC buses as discussed below in items a and c.

a. Clarify what is meant by "prevent tripping of all Isolation Power Center loads" in the above statement.

GEH Response:

This wording was selected to address the September 16, 1978 Arkansas Nuclear One event (IE Circular 79-02 and ref 3 in BTP PSB-1) where all 120 VAC vital power supplies transferred to their alternate source (bypass transformer) as the result of degraded voltage or overload on the UPS buses during an ESF actuation.

As discussed in DCD Tier 2, Subsection 8.3.1.1.2, the Isolation Power Center (IPC) buses are double ended such that each bus can receive power from either diesel generator backed 6.9 kV Plant Investment Protection (PIP) bus. The IPC buses are equipped with degraded voltage and frequency protection to facilitate bus isolation and transfers. This relaying also serves as a backup to the AC input monitoring built into the safety-related battery chargers and Uninterruptable Power Supplies (UPS) for protection against voltage and frequency transients on the AC supply as described below in item b.

DCD Tier 2, Subsection 8.3.1.1.2 will be revised to clarify the purpose of the degraded voltage and frequency relaying on the IPC buses per the attached markup.

b. Discuss the effect of degraded voltage and frequency on the safety-related loads (battery charger, UPS, regulating transformer).

GEH Response:

The regulating transformers have been removed from the ESBWR safety-related UPS to eliminate the possibility of islanding transients or other voltage and frequency transients from reaching the safety-related loads on the UPS buses. The bypass transformers are typical for classical single inverter UPS arrangements but the ESBWR design has two 100% rated inverters in parallel in each division, each capable of carrying 100% of the load. Each inverter will be designed with the required fault clearing and inrush current capability without the need to transfer to a bypass transformer. This is discussed in the GEH response to RAI 8.2-14 Supplement 1 (MFN-08-844, dated 11-17-08) including markups to DCD Tier 1, Figures 2.13.1-1 sh. 2 and 2.13.5-1, and Tier 2 Subsections 1.2.2.13.5, 8.1.1, 8.1.5.2.2.1, 8.3.1.1.2, 8.3.1.1.3, 14.2.8.1.67, 16B.3.8.4, 16B.3.8.5, 16B.3.8.6, Figures 8.1-4, 8.3-1, 8.3-3 and Table 8.3-4 to reflect this change.

The battery chargers and UPS rectifiers are equipped with AC input monitoring circuitry to trip the equipment and automatically restart after a predetermined delay when voltage and frequency have stabilized within the acceptable tolerances. The specifics related to the AC input monitoring is vendor specific, however, one potential vendor has the following scheme:

AC Input detection:

Voltage (rms): typical +10% / -25%, programmable steps –25%, -15%, -10%
Frequency: +8% / -8%

Action: Shut down rectifier

Delay:	Voltage error:	typical 100 ms with 50% drop typical 200 ms with 30% drop
	Frequency:	typical 100 ms fixed

Restart: Automatic when back in tolerance (programmable time delay)

The rectifiers automatically sense out of tolerance AC input voltage and frequency and trip before affecting the DC input to the inverters, then automatically restarts when sensed voltage and frequency are in tolerance after a programmed delay. The safety-related batteries supply the inverters during the rectifier shutdown period. The rectifier trip is accomplished by blocking of the thyristor firing pulses; the thyristors in each phase naturally commutate off at the next current zero crossing. The battery charger and UPS rectifier AC input voltage monitoring also works to limit or prevent the rectifier output DC overshoot that occurs when normal or elevated AC input

voltage is applied after a period of undervoltage, a typical scenario during a switchyard fault and a contributor to the Forsmark inverter trips.

Note this detailed information is vendor specific and will not be provided in the DCD.

It is also important to note there are no large inductive loads or other contactor-initiated loads on the safety related IPC buses. Historical problems with blown MCC or load center control power fuses due to degraded voltage conditions (July 5, 1976 Millstone event, ref 2 in BTP PSB-1) do not apply to the ESBWR design.

c. *Provide the number of relays per isolation power center bus, the coincident logic, the trip set points of the degraded voltage and frequency relays and their functions.*

GEH Response:

The IPC bus degraded voltage and frequency trip functions use two out of three (2/3) coincident logic to minimize the possibility of spurious trips. This 2/3 logic will require three relays for each function. It is expected that modern multi function digital relays will be employed in the design. Trip and alarm setpoints (magnitude and time delay) will be determined based on final selected equipment limitations during detailed design. The degraded voltage and frequency relays will provide alarms and facilitate IPC bus isolation and transfer functions.

DCD Tier 2, Subsection 8.3.1.1.2 will be revised to indicate the degraded voltage and frequency relaying on the IPC buses use two out of three logic per the attached markup

d. *Are there any time delay relays associated with this scheme?*

GEH Response:

Please see item c above.

e. *Provide your rationale for providing degraded voltage and frequency protection only at isolation power centers.*

GEH Response:

As stated in DCD subsection 8.3.1.1.6, degraded voltage and undervoltage protection is provided on the medium voltage bus incoming line breakers. This provides protection for all medium voltage buses, low voltage buses and connected loads from degraded voltage conditions on the normal and alternate preferred offsite power sources.

Under frequency protection is typically not provided on medium voltage or low voltage buses. Plant auxiliary loads are able to operate within a +/- 5% frequency tolerance,

the grid under frequency load shedding scheme will act to maintain frequency well within this band or turbine generators on the line will begin to trip within a few seconds. If islanding or on the onsite diesel generators, under frequency relaying associated with those sources will actuate and remove the out of tolerance source from the bus. The safety-related frequency protection on the IPC bus will remove the IPC bus from the source to protect the safety-related loads.

DCD Impact

DCD Tier 2, Subsection 8.3.1.1.2 will be revised in Revision 6 as noted in the attached markup.

Isolation Power Centers

The Isolation Power Centers are powered from the PIP nonsafety-related buses, which are backed up by the standby diesel-generators. There are four Isolation Power Centers, one each for Divisions 1, 2, 3 and 4. Each Isolation Power Center is double-ended and can be powered from either of the PIP load group buses. The normal and alternate source main breakers of each Isolation Power Center are electrically interlocked to prevent powering the Isolation Power Center from the normal and alternate sources simultaneously. The Isolation Power Centers are shown in Figure 8.3-1.

The Isolation Power Centers supply power to safety-related loads of their respective division. These loads consist of the safety-related battery chargers~~,~~ and rectifiers~~, and regulating transformers~~ as discussed in Subsections 8.3.2 and 8.3.1.1.3. In addition, there is no safety-related lighting that operates directly from the 480 VAC in the ESBWR design. The lighting system is discussed in Chapter 9.

Isolation power centers are protected against degraded voltage and frequency conditions by way of voltage and frequency relays installed in each Isolation Power Center to ~~prevent tripping of all Isolation Power Center loads, in accordance with BTP PSB1~~provide alarms and facilitate IPC bus isolation and transfer functions using two-out-of-three logic to prevent spurious actuation. The four safety-related Isolation Power Centers are located in the Seismic Category I Reactor Building in their respective divisional areas.

Motor Control Centers

MCCs supply power to motors, control power transformers, process heaters, motor-operated valves and other small electrically operated auxiliaries, including 480 - 208/120V and 480 - 240/120V transformers. MCCs are assigned to the same load group as the power center that supplies their power.

8.3.1.1.3 Uninterruptible AC Power Supply System

Safety-Related Uninterruptible AC Power Supply System

Figure 8.1-4 shows the overall safety-related Uninterruptible AC Power Supply (UPS) system. The safety-related UPS for each of the four divisions is supplied from a 480V Isolation Power Center in the same division. The Isolation Power Centers are connected to PIP nonsafety-related buses, which are backed by standby diesel-generators. Divisions 1, 2, 3 and 4 each have two rectifiers, two batteries and two inverters. Each rectifier receives 480 VAC normal power from the Isolation Power Center of that division and converts it to 250 VDC. The 480 VAC/250 VDC rectifier and a safety-related 72-hour battery of that division supply 250 VDC power through diodes to a common inverter with an output of 120 VAC single phase.

The safety-related UPS inverter high DC input voltage trip setpoint and time delay are greater than the associated battery charger and UPS rectifier high DC output voltage trip setpoint and time delay. This arrangement prevents safety-related UPS inverter trips as a result of fast transients on the AC supply that may occur during the ESBWR islanding transient or as a result of generator voltage regulator failures, for which protective relaying and breaker operations may not otherwise prevent safety-related UPS inverter trips.