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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application – Technical Specifications – RAI Numbers 16.2-126 and 16.2-129**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) responses to the subject NRC RAIs transmitted via the Reference 1 letter.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 07-292, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application,* May 10, 2007

Enclosure:

1. MFN 07-634 – Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application – Technical Specifications – RAI Numbers 16.2-126 and 16.2-129

cc:

AE Cubbage	USNRC (with enclosure)
DH Hinds	GEH (with enclosure)
RE Brown	GEH (with enclosure)
eDRF Sections	69-3515, 69-3516

Enclosure 1

MFN 07-634

Response to Portion of NRC Request for

Additional Information Letter No. 97

Related to ESBWR Design Certification Application

- Technical Specifications -

RAI Numbers 16.2-126 and 16.2-129

NRC RAI 16.2-126

LCO 3.8.1, Required Action A2, states that if one or both required battery chargers are inoperable on one required division, the associated battery must be returned to the fully charged condition. Fully charged condition is specified in the Bases as either three consecutive hourly current readings change less than {0.5} amps or the float current is <{2} amps. LCO 3.8.1 must define fully charged condition, not the bases. In addition, no technical justification was given for three consecutive hourly readings change of less than {0.5} amps in lieu of float current < than {2} amps.

GEH Response

IEEE Standard 1188-2005, "Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications," Section 7.8 and Annexes A.1 and A.2, describe two methods for determining that a battery is fully charged. Both of these methods for determining battery state of charge (SOC) are based on current monitoring because monitoring the electrolyte specific gravity of a Valve Regulated Lead Acid (VRLA) is not feasible.

The method for determining SOC described in IEEE-1188, Annex A.1, requires verification that the cumulative recharge current is equal to or greater than the cumulative discharge current. This method is not practicable for periodic verification of the state of charge of a battery in standby service for long periods.

The method for determining SOC described in IEEE-1188-2005, Annex A.2, and Section 7.8, requires verification that charging current has stabilized for three consecutive hourly readings while being maintained at the charging voltage following a battery charge. The technical justification for this approach is that charging current decreases exponentially to the steady state float current as the battery approaches the fully charged condition. Although not explicitly stated in IEEE-1188, this method will also confirm that a battery being maintained in standby service at the temperature-compensated float voltage is "near 100% charged."

A third method for determining SOC is monitoring the float current, which is specifically designed for a battery being maintained in standby service at float voltage. This method is used in NUREG-1434, "Standard Technical Specifications General Electric Plants, BWR/6," Revision 3.1. This method is not described in IEEE-1188 but is consistent with a method recommended in Annex A.4 of IEEE 450-2002 for those types of vented lead acid batteries that do not require increasing float current as the battery ages. However, as indicated in IEEE-1188, Annex A.2, chemical changes occur within the VRLA battery due to the aging process that will cause the float current for a fully charged ESBWR VRLA battery to increase with battery age. Therefore, unless the float current acceptance criterion is periodically increased, this method could result in a conservative but incorrect determination that a fully charged ESBWR VRLA battery is inoperable.

ESBWR Surveillance Requirement (SR) 3.8.3.1 is a requirement to verify that a battery being maintained in standby service at the temperature-compensated float voltage is fully charged. LCO 3.8.1, Required Action (RA) A.2, and LCO 3.8.3, RA B.2, are requirements to verify that a partially discharged battery has been restored to a fully charged condition. GEH will revise the Bases for LCO 3.8.1, "DC Sources -Operating," and LCO 3.8.3, "Battery Parameters," to include

a "Reviewer's Note" specifying that use of the float current monitoring option to verify the SOC requires that the battery manufacturer confirm the acceptability of this method and the acceptance criteria and that battery capacity includes margin for SOC uncertainty. As described in the response to RAI 16.2-55, Supplement 1, battery-sizing calculations include allowances to account for uncertainty in the determination of battery SOC.

GEH will revise DCD Chapters 16 and 16B, LCO 3.8.1, Condition A, and LCO 3.8.3, Condition B, to include a requirement to verify that the affected battery is "fully charged" with bracketed descriptions of acceptable methods in the associated Bases. GEH will revise DCD Chapters 16 and 16B, SR 3.8.3.1, to include a requirement to verify that each required battery is "fully charged as indicated by {float current within limits}." A bracketed description of acceptable methods for verifying the battery is fully charged is provided in the associated Bases. Bases descriptions of the float current method for verifying SOC will be preceded by a reviewer's note that describes requirements for battery manufacturer's confirmation prior to the use this method.

DCD Impact

GEH will revise the Background Section of the Bases for LCO 3.8.1 to delete the discussion of the acceptance criteria for restoration of a partially discharged battery, which is appropriately addressed in the Bases for LCO 3.8.1, Required Action A.2:

> Charging current then reduces exponentially during the remainder of the recharge cycle. The 72-hour batteries have recharge efficiencies such that once approximately 105% to 110% of the ampere-hours discharged have been returned, the battery capacity would be restored to the same condition as it was prior to the discharge. ~~This can be monitored by direct observation of the exponentially decaying charging current. When either three consecutive hourly current readings change by < {0.5} amps or the float current is < {2} amps the battery is considered to be in fully charged condition.~~

GEH will revise LCO 3.8.1, Required Action A.2, as follows:

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One or both required battery chargers inoperable on one required division.	A.1	Restore battery terminal voltage to greater than or equal to the minimum established float voltage.	2 hours
	AND		
	A.2	Verify battery ~~returned is~~to fully charged ~~condition~~.	Once per 24 hours
	AND		
	A.3	Restore required battery chargers to OPERABLE status.	72 hours

GEH will revise the Bases for LCO 3.8.1, Required Action A.2, as follows:

{---------- REVIEWER'S NOTE ----------
Use of float current monitoring option requires that battery manufacturer confirm acceptability and acceptance criteria and that battery capacity includes margin for state of charge uncertainty.
----------}

Required Action A.2 requires that the battery be fully charged. A fully charged condition is achieved when ~~float current be verified as indicating the battery is returned to the fully charged condition (i.e., {either~~ {charging current has stabilized as indicated by three consecutive hourly current readings changinge by < {0.5} amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a fully recharged condition is achieved when ~~or~~ the float current is < {5.02} amps~~}~~ while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method ~~This indicates~~ verifies ~~that~~that a partially discharged ~~, if the~~ battery ~~had been discharged as the result of the inoperable battery charger, it~~ has ~~now~~ been fully recharged.} If at the expiration of the initial 24 hour period the battery ~~float current~~ is not returned to the fully charged condition, this indicates there may be additional battery problems and the battery must be declared inoperable.

GEH will revise the third paragraph of the Bases for SR 3.8.1.2 as follows:

The other option requires that each battery charger be capable of recharging the battery after a service test coincident with supplying the

largest combined demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when ~~{either three consecutive hourly current readings change by < {0.5} amps or the float current is < {2} amps}~~the requirements of SR 3.8.3.1 are met.

GEH will revise LCO 3.8.3, Condition B, as follows:

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. SR 3.8.3.1 not met for o~~O~~ne or two batteries on one required division ~~with float current > {2} amps~~.	B.1 Perform SR 3.8.1.1. AND B.2 Verify battery is fully charged.~~Restore battery float current to ≤ {2} amps.~~	2 hours 24 hours

GEH will revise the Bases for LCO 3.8.3, Required Actions B.1 and B.2, as follows:

B.1 and B.2

When SR 3.8.3.1 is not met, it ~~A battery with float > {2} amps~~ indicates that a partial discharge of the battery has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours, verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. LCO 3.8.1, Condition A, addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 24 hours (Required Action B.2). The battery must therefore be declared inoperable.

If the float voltage is found not to be satisfactory and there are one or more battery cells with float voltage less than {2.14} V, the associated "OR" statement in Condition F is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than {2.14} V, there is good assurance that, within 24 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

{---------- REVIEWER'S NOTE ----------
Use of float current monitoring option requires that battery manufacturer confirm acceptability and acceptance criteria and that battery capacity includes margin for state of charge uncertainty.
----------}

Required Action B.2 requires that the battery be fully charged. A battery is fully charged when {charging current has stabilized as indicated by three consecutive hourly current readings changing by < {0.5} amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a battery is fully charged when the float current is < {5.0} amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method verifies that a partially discharged battery has been fully recharged.}

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus, there is good assurance of fully recharging the battery within 24 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than {2.14} V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 24 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.1.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.1.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

GEH will revise LCO 3.8.3, Condition F, as follows:

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. Required Action and associated Completion Time of Condition A, B, C, D, or E not met. OR Required battery with one or more battery cell float voltage < {2.14} V and ~~float current > {2} amps~~SR 3.8.3.1 not met.	F.1 Declare associated battery inoperable.	Immediately

GEH will revise the Bases for LCO 3.8.3, Required Action F.1 as follows:

F.1

When any battery parameter is outside the allowances of the Required Actions for Condition A, B, C, D, or E, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding battery must be declared inoperable. Additionally, discovering one battery with one or more battery cells float voltage less than {2.14} V and ~~float current greater than {2} amps~~SR 3.8.3.1 not met indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

GEH will revise SR 3.8.3.1 as follows:

	SURVEILLANCE	FREQUENCY
SR 3.8.3.1	---------- **- NOTE -** Not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.1.1. ----------	
	Verify each required battery is fully charged as indicated by {stabilized charging current or float current ~~is ≤ {2} amps~~ within limits}.	31 days

GEH will revise the Bases for SR 3.8.3.1 as follows:

SR 3.8.3.1

{---------- REVIEWER'S NOTE ----------
Use of float current monitoring option requires that battery manufacturer confirm acceptability and acceptance criteria and that battery capacity includes margin for state of charge uncertainty.
----------}

This SR verifies that a battery is fully charged as indicated by {stabilized charging current or float current within limits} while the battery is being maintained within the temperature compensated float voltage limits required by SR 3.8.1.1. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The float current requirements are based on the float current indicative of a charged battery. A fully charged condition exists when {charging current has stabilized as indicated by three consecutive hourly current readings changing by < {0.5} amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a fully charged condition exists when the float current is < {5.0} amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method verifies that a battery is fully charged.} Use of float current to determine the state of charge of the battery is consistent with IEEE-1188 (Ref. 1) and manufacturer recommendations. The 31-day Frequency is consistent with IEEE-1188 (Ref. 1).

This SR is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.1.1. When this float voltage

is not maintained, the Required Actions of LCO 3.8.1, ACTION A, are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of {52} amps is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

NRC RAI 16.2-129

The bases for LCO 3.8.1, DC Sources, states that all safety-related Class 1E loads are isolated from the IPC buses by diodes on the output of both the nonsafety-related rectifiers and the 250 VDC bus associated with the DC sources. Explain why there are no surveillance requirements to periodically verify that the blocking diodes are operable.

GEH Response

GEH will revise DCD, Tier 2, Chapters 16 and 16B, to add Surveillance Requirements (SRs) for periodic verification of the safety function described in DCD 8.1.5.2 that prevents degradation of the safety-related DC power system by the nonsafety-related AC power system.

GEH will add SR 3.8.1.4 and associated Bases to require verification every 24 months that the output diodes for the battery chargers and safety-related rectifiers do not allow current to flow from the DC source to an IPC bus that is de-energized or has degraded voltage. SR 3.8.1.4 will periodically verify that the output diodes for the battery chargers and safety-related rectifiers function as described in DCD 8.1.5.2 to prevent degradation of the safety-related DC power system by the nonsafety-related AC power system. GEH will revise SR 3.8.2.1 and the associated Bases to require SR 3.8.1.4 for required battery chargers and associated safety-related rectifiers in Modes 5 and 6.

GEH will revise DCD, Tier 1, Section 2.13.3, and Table 2.13.3-3, Item 9, to ensure that ITAAC requirements are consistent with design requirements in DCD 8.1.5.2. Specifically, DCD, Tier 1, Section 2.13.3, and Table 2.13.3-3, Item 9, will be revised to address requirements in Tier 2, DCD 8.1.5.2, that the output diodes for the battery chargers prevent degradation of the safety-related DC power system by the nonsafety-related AC power system.

GEH will also revise DCD, Tier 1, Section 2.13.5, and Table 2.13.5-2, to add ITAAC requirements for the uninterruptible AC power supply consistent with design requirements in DCD 8.1.5.2. Specifically, DCD, Tier 1, Section 2.13.5, Item (9), and Table 2.13.5-2, Item 9, will be added to address requirements in Tier 2, DCD 8.1.5.2, that the output diodes for the safety-related rectifiers prevent degradation of the safety-related DC power system by the nonsafety-related AC power system.

DCD Impact

GEH will revise DCD, Tier 2, Chapters 16 and 16B, LCO 3.8.1, "DC Sources - Operating," and LCO 3.8.2, "DC Sources - Shutdown," and DCD, Tier 1, Section 2.13.3, and Table 2.13.3-3, Item 9, as shown below:

Specification 3.8.1 INSERT:

	SURVEILLANCE	FREQUENCY
SR 3.8.1.4	Verify the output diode for each required battery charger and safety-related rectifier connected to the Isolation Power Center bus prevents reverse current flow.	24 months

Bases 3.8.1 INSERT:

SR 3.8.1.4

Operability of a DC Source requires that the output diodes for the associated battery chargers and safety-related rectifiers prevent reverse current flow from the DC Source to the associated IPC bus when the IPC bus is de-energized or has degraded voltage. This function is required to prevent degraded conditions on the nonsafety-related AC power system from affecting the safety-related DC power system. This SR is not required for battery chargers and safety-related rectifiers that are not connected to the IPC bus. This SR is also not required for standby battery chargers that are not connected to the 250 VDC bus. The 24 month Frequency is based on engineering judgment.

Bases 3.8.1, Background Section, Change:

Each division has two 120 VAC Uninterruptible AC Power inverters, which receive power from an associated rectifier or battery and battery charger. 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 Class 1E 72-hour battery and battery charger of that division supply 250 VDC emergency power through diodes to a common inverter. {The output diodes for battery chargers and safety-related rectifiers isolate the output of each required battery from an associated 480 VAC IPC bus that is de-energized or has degraded voltage. ~~All safety-related Class 1E loads are isolated from the 480 VAC Isolation Power Centers by diodes on output of both the rectifiers and the 250 VDC bus associated with the DC source prevent degraded voltage from either source affecting the performance of the other source.}~~

Specification 3.8.2 Change:

	SURVEILLANCE	FREQUENCY
SR 3.8.2.1	For DC Sources required to be OPERABLE the following SRs are applicable: SR 3.8.1.1 SR 3.8.1.2 SR 3.8.1.3 SR 3.8.1.4.	In accordance with applicable SRs

Bases 3.8.2 Change:

SR 3.8.2.1

SR 3.8.2.1 requires performance of all Surveillances required by SR 3.8.1.1 through SR 3.8.1.4~~3~~. Therefore, see the corresponding Bases for Specification 3.8.1 for a discussion of each SR.

Bases 3.8.4 Background Section Change:

Each division has two 120 VAC Uninterruptible AC Power inverters, which receive power from an associated rectifier or battery and battery charger. 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 Class 1E 72-hour battery and battery charger of that division supply 250 VDC emergency power through diodes to a common inverter. ~~{~~The output diodes for the battery chargers and safety-related rectifiers isolate the output of each required battery from an associated 480 VAC IPC bus that is de-energized or has degraded voltage. ~~All safety-related Class 1E loads are isolated from the 480 VAC Isolation Power Centers by diodes on output of both the rectifiers and the 250 VDC bus associated with the DC source prevent degraded voltage from either source affecting the performance of the other source.}~~

Tier 1 Changes:

2.13.3 Direct Current Power Supply

(9) The output diodes for the battery chargers are designed to prevent their AC source from becoming a load on the 250 VDC safety-related batteries ~~because of power feedback from loss of~~when the AC power source is de-energized or has degraded voltage.

Table 2.13.3-3
ITAAC For The Direct Current Power Supply

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9. The battery chargers are designed to prevent their AC source from becoming a load on the 250 VDC safety-related batteries ~~because of power feedback from loss of~~when the AC power source is de-energized or has degraded voltage.	Testing of the output diodes for each 250 VDC safety-related battery charger will be performed to demonstrate that there is no power feedback from a loss of AC input power.	Test report(s) document that the output diodes for ~~the~~ 250 VDC safety-related battery chargers prevents the AC input source from becoming a load on the 250 VDC safety-related batteries during a loss of AC power condition.

2.13.5 Uninterruptible AC Power Supply

(9) The output diodes for the safety-related AC power rectifiers are designed to prevent their AC source from becoming a load on the 250 VDC safety-related batteries when the AC power source is de-energized or has degraded voltage.

Table 2.13.5-2
ITAAC For The Uninterruptible AC Power Supply

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9. The safety-related AC power rectifiers are designed to prevent their AC source from becoming a load on the 250 VDC safety-related batteries when the AC power source is de-energized or has degraded voltage.	Testing of the output diodes for each 250 VDC safety-related AC power rectifier will be performed to demonstrate that there is no power feedback from a loss of AC input power.	Test report(s) document that the output diodes for 250 VDC safety-related AC power rectifiers prevent the AC input source from becoming a load on the 250 VDC safety-related batteries during a loss of AC power condition.