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MFN 08-736

Docket No. 52-010

October 9, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 228 – Related to ESBWR Design Certification Application – Design of Structures, Components, Equipment, and Systems – RAI Numbers 3.11-30, 3.11-31, 3.11-33, 3.11-35, and 3.11-38**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 228 (Reference 1). The GEH response to RAI Numbers 3.11-30, 3.11-31, 3.11-33, 3.11-35, and 3.11-38 are addressed in Enclosure 1.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 08-623, *Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, Request for Additional Information Letter No. 228, Related To ESBWR Design Certification Application*, dated August 6, 2008

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 228, Related to ESBWR Design Certification Application – Design of Structures, Components, Equipment, and Systems – RAI Numbers 3.11-30, 3.11-31, 3.11-33, 3.11-35, and 3.11-38

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
eDRF	0000-0091-6849

Enclosure 1

MFN 08-736

Response to Portion of NRC Request for

Additional Information Letter No. 228

Related to ESBWR Design Certification Application

Design of Structures, Components, Equipment, and Systems

RAI Numbers 3.11-30, 3.11-31, 3.11-33, 3.11-35, and 3.11-38

NRC RAI 3.11-30

NRC Summary:

Revise the note to clarify the statement.

NRC Full Text:

On Page 3.11-2, revise the note following the title description of IEEE-323-2003 to read, "Applies only to electrical equipment in the mild environment" instead of "This version applies unless otherwise indicated."

GEH Response

Agree. The note following the IEEE-323-2003 will be modified to clearly indicate that this version only applies to electrical equipment in a mild environment.

DCD Impact

DCD Tier 2, Subsection 3.11.1.1(2)a will be revised as noted in the attached markup.

equipment located in areas characterized as mild environments, also meet RG 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-based Instrumentation and Control Systems in Nuclear Power Plants," (Reference 3.11-4), and type testing is the preferred method of qualification.

Mild environments do not experience a loss-of-coolant-accident (LOCA), high energy line break (HELB), or main steamline break (MSLB) and have the environmental limits shown in Table 3H-13.

Equipment supporting RTNSS functions located inside containment are included in the equipment qualification program, and are qualified using the appropriate methods for their location. The remainder of the RTNSS equipment is qualified as outlined in Section 19A. Table 3.11-1 includes RTNSS equipment located inside containment.[JD534]

The equipment in the EQ program is referred to as EQ equipment.[JD535]

3.11.1.1 Applicable Regulations and Standards

The environmental qualification of electrical and mechanical equipment meets the relevant requirements of the following regulations:

(1) Code Federal Regulations (CFR):

a. 10 CFR 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."

b. 10 CFR 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

c. 10 CFR 50, Appendix A, General Design Criterion 4, "Environmental and Dynamic Effects Design Bases."

d. 10 CFR 50, Appendix A, General Design Criterion 23, "Protection System Failure Modes."

e. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

f. 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Section III, "Design Control," Section XI, "Test Control," and Section XVII, "Quality Assurance Records."

(2) Institute of Electrical and Electronic Engineers (IEEE):

a. IEEE-323-2003, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." Note: ~~This version applies unless otherwise indicated.~~ Applies only to electrical equipment in a mild environment.

b. IEEE-317-1983 (R2003), "Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations."

c. IEEE-383-2003, "Standard for Qualifying Class 1E Electric Cable and Field Splices for Nuclear Power Generating Stations."

d. IEEE-420-2001, "Standard for the Design and Qualification of Class 1E Control Boards, Panels and Racks Used in Nuclear Power Generating Stations".

NRC RAI 3.11-31

NRC Summary:

Revise the statement for equipment qualification program.

NRC Full Text:

On Page 3.11-11, the statement, "The ESBWR equipment qualification program meets the requirements of RG 1.89 for safety-related electrical equipment in harsh environment" should be modified to read as "The ESBWR equipment qualification program meets the guidance of RG 1.89 for electric equipment important to safety."

GEH Response

GEH will revise the statement to read, "The ESBWR equipment qualification program meets the guidance of RG 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants.""

DCD Impact

DCD Tier 2, Subsection 3.11.4.1 will be revised as noted in the attached markup.

EQ safety-related mechanical equipment qualified by analysis is consistent with ASME B&PV Code Section III-2001, "Rules for Construction of Nuclear Power Plant Components."

Active EQ safety-related mechanical equipment is qualified by the qualification methods of IEEE 323.

EQ equipment located in harsh environments may be qualified by combinations of type test, operating experience, and analysis. For example, if a type test of a complete assembly is not possible, component testing supplemented by analysis may be used.

The ESBWR equipment qualification program meets the guidance of RG 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants." ~~The ESBWR equipment qualification program meets the requirements of RG 1.89 for safety-related electrical equipment in harsh environments.~~ RG 1.89 endorses IEEE 323-1974. EQ equipment is qualified using the qualification methods of IEEE 323-1974.

The effects of chemical spray must be addressed. Containment spray, emergency core cooling initiation, and recirculation system operation are included in the qualification tests. The ESBWR SLCS injects borated water into the Reactor Pressure Vessel (RPV) during DBA LOCA. Containment spray is not caustic; therefore the effect of the demineralized water spray is included in the equipment qualification.

The equipment qualification program includes safety-related mechanical equipment, in harsh environment areas and verifies that they are designed to be compatible with postulated environmental conditions, including those associated with LOCA. Active safety-related mechanical equipment is qualified using test, analysis, or a combination of test and analysis.

In some instances, mechanical equipment loading under normal service is more severe than loading under DBA. The loading under normal service is documented with test and/or analysis. The loading and capability under DBA conditions is analyzed in the equipment qualification process to establish the suitability of materials, parts, and equipment needed for safety-related functions, and to verify that the design of such materials, parts, and equipment is adequate. The qualification of mechanical equipment includes materials that are sensitive to environmental effects (e.g., seals, gaskets, lubricants, fluids for hydraulic systems, and diaphragms), required operating time, non-metallic subcomponents of such equipment; the environmental conditions and process parameters for which this equipment must be qualified; non-metallic material capabilities; and the evaluation of environmental effects.

The EQ equipment in a harsh environment has a qualified life of 60-years. The qualified life is verified using methods and procedures of qualification and documentation as stated in IEEE-323 and as addressed herein.

3.11.4.2 Mild Environment Qualification

EQ safety-related equipment located in a mild environment is qualified as follows:

To assure EQ safety-related equipment located in a mild environment meets its safety-related functional requirements during normal environmental conditions and AOOs, the environmental design basis for normal environmental conditions and AOO requirements is specified in the design/purchase specifications. A qualified life is not required for equipment located in a mild environment that has no significant aging mechanisms.

NRC RAI 3.11-33

NRC Summary:

In Table 3.11-1, identify the mild environment equipment, either by Section 3.11.4.2 or Section 3.11.4.3.

NRC Full Text:

On Page 3.11-12, Section 3.11.4.2 describes safety-related equipment in a mild environment and Section 3.11.4.3 describes computer-based I&C systems in a mild environment. Since computer-based I&C systems present unique characteristics that must be considered in the qualification process as described in Regulatory Guide 1.209, it is recommended that the equipment listed in Table 3.11-1 that are located in the mild environment be designated as 'Mild Environment Qualification' or 'Computer-Based I&C Systems' as defined in Sections 3.11.4.2 and 3.11.4.3, respectively.

GEH Response

Agree. Table 3.11-1 will be revised to include a category for "Computer-Based I&C Systems", as defined in Subsection 3.11.4.3. This will provide three distinct categories of equipment – Mechanical, Electrical, and Computer-Based I&C. Table 3.11-1 includes a designation for harsh environment, and Note 4 of Table 3.11-1 states that omission of a designation for harsh, indicates mild environment. A distinct category for "Mild Environment" is not necessary.

DCD Impact

DCD Tier 2, Table 3.11-1 will be revised as noted in the attached markup.

Table 3.11-1

Electrical and Mechanical Equipment for Environmental Qualification

Components	Quantity	Location (note 1)	Function (note 2)	Required Operation Time (note 3)	Qualification Program (note 4)
Electrical Modules and Cable	All	CV, RB	ESF	72 hr	EH
C21 Leak Detection and Isolation System					
Pressure Transmitters	All	CV, RB, CB	ESF	100 Days	EH
Temperature Sensors	All	CV, RB, CB	ESF	100 Days	EH
Electrical Modules and Cable	All	CV, RB, CB	ESF	100 Days	EH
C51 Neutron Monitoring System					
Detector and Tube Assembly	81	CV	ESF	72 hr	MH
Electrical Modules and Cable	All	CV, RB, CB	ESF	100 Days	EH
C61 Remote Shutdown Panel					
Electrical Panels, Modules and Cable	All	RB	ESF	100 Days	CE
C63 Safety-Related DCIS					
Electrical Modules and Cable	All	RB, CB	ESF	100 Days	CE
C71 Reactor Protection System					
Electrical Modules and Cable	All	CB, RB	ESF	100 Days	EH
C74 Safety System Logic and Control					
Electrical Modules and Cable	All	CB, RB	ESF	100 Days	EH
C41 Standby Liquid Control System					
RPV Isolation Valve	2	CV	PB	72 hr	MH

Table 3.11-1

Electrical and Mechanical Equipment for Environmental Qualification

Components	Quantity	Location (note 1)	Function (note 2)	Required Operation Time (note 3)	Qualification Program (note 4)
CIV - Process Sampling Line -Outboard	2	RB	PB/PAMS	100 Days	MH
CIV - Process Sampling Line -Inboard Operator	2	CV	PB/PAMS	100 Days	EH
CIV - Process Sampling Line -Outboard Operator	2	RB	PB/PAMS	100 Days	EH
Return Line Shutoff Valve	2	RB	ISOL	72 hr	MH
Check Valve to Feedwater	4	RB	ISOL	72 hr	MH
Mid-vessel Flow Instrumentation	2	CV	ISOL	100 Days	EH
Mid-vessel Temperature Instrumentation	4	CV	ISOL	100 Days	EH
Bottom Drain Flow Instrumentation	2	CV	ISOL	100 Days	EH
Bottom Drain Temperature Instrumentation	4	CV	ISOL	100 Days	EH
Return Line Flow Instrumentation	2	RB	ISOL	100 Days	EH
Return Line Temperature Instrumentation	4	RB	ISOL	100 Days	EH
Overboard Flow Instrumentation	2	RB	ISOL	100 Days	EH
Overboard Temperature Instrumentation	4	RB	ISOL	100 Days	EH
Electrical Modules and Cables	All	CV, RB	ESF	100 Days	EH
H11 Main Control Room Panels					
Panels, Modules and Cables	All	CB	ESF	100 Days	CB

Table 3.11-1

Electrical and Mechanical Equipment for Environmental Qualification

Components	Quantity	Location (note 1)	Function (note 2)	Required Operation Time (note 3)	Qualification Program (note 4)
H12 MCR Back Room Panels					
Panels, Modules and Cable	All	CB	ESF	100 Days	~~CB~~
H21 Local Panels and Racks					
Panels, Modules and Cable	All	ALL	ESF	100 Days	EH
P10 Makeup Water System					
Isolation Valves	All	CV, RB	ISOL	72hr	MH
P25 Chilled Water System					
Isolation Valves	8	CV, RB	ISOL	72hr	MH
P51 Service Air System					
Isolation Valves	4	CV, RB	ISOL	72hr	MH
P54 High Pressure Nitrogen Supply System					
Isolation Valves	4	CV, RB	ISOL	72hr	MH
R10 Electrical Power Distribution System (EPDS)					
Cable and Supports	All	CB, FB, RB	ESF	100 Days	EH
R11 Medium Voltage Distribution System					
Medium Voltage Components	All	TB	ESF	100 Days	E
R13 Uninterruptible AC Power Supply					
Electrical Modules and Cable	All	CV, CB, RB	ESF	100 Days	EH
R16 Direct Current Power Supply					
Division 250 VDC Battery	8	RB	ESF	100 Days	E
Division 250 VDC Normal/Standby Battery Charger	12	RB	ESF	100 Days	E

Table 3.11-1

Electrical and Mechanical Equipment for Environmental Qualification

Components	Quantity	Location (note 1)	Function (note 2)	Required Operation Time (note 3)	Qualification Program (note 4)
Electrical Modules and Cable	All	FB	ESF	100 Days	EH

Note 1: CV – Containment Vessel
ST – Steam Tunnel
RB – Reactor Building
FB – Fuel Building
CB – Control Building
TB – Turbine Building
OO – Outdoors Onsite

Note 2: ESF – Engineered Safeguard Feature
PAMS – Post Accident Monitoring
ISOL – Isolation
PB – Pressure Boundary

Note 3: The period of time which the equipment must remain available or operational.

Note 4: E – Electrical Equipment Program
M – Mechanical Equipment Program
C – Computer Based I&C System Program
H – Harsh Environment (Omission of H indicates Mild Environment)

NRC RAI 3.11-35

NRC Summary:

Include Mil Std. 461E and IEC 61000-4 in Section 3.11.1.1, "Applicable Regulations and Standards".

NRC Full Text:

Since EMI qualification follow the requirements defined in Mil Std. 461E and IEC 61000-4, include Mil Std. 461E and IEC 61000-4 in Section 3.11.1.1, "Applicable Regulations and Standards"

GEH Response

Agree. References to Mil Std. 461E and IEC 61000-4 will be added to Subsection 3.11.1.1, "Applicable Regulations and Standards."

DCD Impact

DCD Tier 2, Subsection 3.11.1.1 will be revised as noted in the attached markup.

b. Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants."

c. Regulatory Guide 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants."

d. Regulatory Guide 1.131, "Qualification Tests of Electric Cables, Field Splices and Connections for Light-Water-Cooled Nuclear Power Plants."

e. Regulatory Guide 1.153, "Criteria for Safety Systems."

f. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactor."

g. Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."

h. Regulatory Guide 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems."

i. Regulatory Guide 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer Based Instrumentation and Control Systems in Nuclear Power Plants."

j. Regulatory Guide 1.40, "Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants."

k. Regulatory Guide 1.100, "Seismic Qualification of Electrical and Mechanical Equipment for Nuclear Power Plants."

l. Regulatory Guide 1.156, "Environmental Qualification Connection Assemblies for Nuclear Power Plants."

m. Regulatory Guide 1.158, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants."

(5) Department of Defense (DOD) Military Standards (MIL-STD)

a. MIL-STD 461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment."

(6) International Electrotechnical Commission (IEC)

a. 61000-4, "Electromagnetic Compatibility (EMC): Testing and Measurement Techniques."

3.11.1.2 General Requirements

Environmental design and qualification used to implement the relevant requirements of 10 CFR 50.49; General Design Criteria (GDC) 1, 2, 4 and 23; and Quality Assurance Criteria III, XI, and XVII are as follows:

(1) The equipment is designed to have the capability of performing its design safety-related functions under all anticipated operational occurrences (AOOs) and normal, accident, and post-accident environments and for the length of time for which its function is required.

NRC RAI 3.11-38

NRC Summary:

Environments for Qualification of Mechanical Equipment.

NRC Full Text:

Subsection 3.11.3.1, "General Requirements," in Section 3.11.3, "Environmental Conditions," in ESBWR DCD (Revision 5) Tier 2 discusses the environments to be included in the environmental design basis for electrical and mechanical equipment within the scope of the Environmental Qualification (EQ) program. The additional discussion of certain environments (such as temperature, pressure, humidity, chemical effects, and radiation) in Revision 5 to the ESBWR DCD does not address mechanical equipment. GEH is requested to clarify the consideration of applicable environments for the qualification of mechanical equipment in the ESBWR.

GEH Response

Agree. GEH will clarify the consideration of applicable environments. DCD Tier 2, Subsection 3.11.3.1 will state that the environments are considered for electrical and mechanical equipment in the EQ program.

All environments discussed in DCD Tier 2 Subsection 3.11.3 are applicable to all of the EQ equipment including mechanical equipment in the EQ program. The additional discussion of certain environments (such as temperature, pressure, humidity, chemical effects, and radiation) provides additional clarification of environments for only instances needing clarification. Further, only equipment that is specifically subject to certain environments is discussed within each subsection. As an example, mechanical equipment is not discussed in mild environments, since there is no mechanical equipment subject to environmental qualification in a mild environment.

DCD Impact

DCD Tier 2, Subsection 3.11.3.1 will be revised as noted in the attached markup.

Qualified Life – The period of time, prior to the start of a design basis event, for which the equipment was demonstrated to meet the design requirements for the specified service conditions.

Service Conditions – Environmental, loading, power, and signal conditions expected as a result of normal operating requirements, expected extremes (abnormal) in operating requirements, and postulated conditions appropriate for the design basis events of the station.

Significant Aging Mechanism – An aging mechanism that, under normal and abnormal service conditions, causes degradation of equipment that progressively and appreciably renders the equipment vulnerable to failure to perform its safety-related function(s) during the design basis event conditions.

3.11.2 Equipment Identification

The equipment qualification program generates and maintains a list of EQ equipment located in harsh and mild environments. The systems containing EQ equipment are identified in Table 3.11-1.

The Environmental Qualification Document (EQD) summarizes the qualification results for all EQ equipment in the equipment qualification program. The EQD is current and in an auditable form for the entire period during which the covered item is installed or is stored for future use to permit verification that each item meets the equipment qualification requirements.

3.11.3 Environmental Conditions

3.11.3.1 General Requirements

Environmental Design Bases: Analysis is performed to identify the environmental design bases including the definition of AOO and normal, accident, and post-accident environments. DBA and AOO define the temperature and pressure time-dependent information for areas subject to accidents and AOOs.

EQ equipment is qualified to the worst-case environmental conditions for the areas in which they are located for the duration that they are required to perform their safety-related function.

The environmental design basis includes the safety-related function for each item of safety-related equipment and its acceptance criteria; Electromagnetic interference/radio frequency interference (EMI/RFI) and Voltage Surges; environmental conditions including temperature, equipment heating, Heating, Ventilation and Air Conditioning (HVAC) and lack of HVAC, inside and outside maximum and minimum temperatures, and time dependency of temperatures.

The safety-related functions are either functional performance requirements or fail-safe requirements. A fail-safe safety-related function consists of not failing in a manner detrimental to plant safety, accident mitigation, or prevention of a safety-related function. The basis for the safety-related function is included in the qualification documentation.

The following provides detailed information on each environment included in the environmental design basis. The environments are considered for electrical and mechanical equipment in the EQ program.