

Enclosure 2

MFN 10-285

GEH Licensing Topical Report NEDO-33516-A

**“ESBWR Qualification Plan Requirements for a 72-Hour Duty
Cycle Battery”**

Revision 2, September 2010

Public Version



HITACHI

GE Hitachi Nuclear Energy

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Licensing Topical Report

**ESBWR QUALIFICATION PLAN REQUIREMENTS FOR A
72-HOUR DUTY CYCLE BATTERY**

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Public Information Notice

This is a public version of NEDE-33516P-A Rev 2, from which the proprietary information has been removed. Portions of the document that have been removed are indicated by white space within double square brackets, as shown here [[]].

IMPORTANT NOTICE REGARDING THE CONTENTS OF THIS REPORT

Please Read Carefully

The information contained in this document is furnished as reference to the NRC Staff for the purpose of obtaining NRC approval of the ESBWR Certification and implementation. The only undertakings of GEH with respect to information in this document are contained in contracts between GEH and participating utilities, and nothing contained in this document shall be construed as changing those contracts. The use of this information by anyone other than that for which it is intended is not authorized; and with respect to any unauthorized use, GEH makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

SUMMARY OF CHANGES

Location	Comment
All	“-A” is added to the document number for this revision denoting NRC acceptance of this revision for ESBWR design certification.
Attachment 1	Added the NRC letter describing the acceptance of this revision of this Licensing Topical Report. The NRC letter as well as Enclosure 1 of the letter, which contains the Final Safety Evaluation for this Licensing Topical Report, has been added to the end of this document.

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Abbreviations And Acronyms List

Term

vpc

Definition

Volts Per Cell

Abstract

This document presents the generic ESBWR's equipment qualification process for batteries and includes evaluation of significant aging mechanisms that are related to failure mechanisms from radiation exposure, time-temperature aging, and cycle aging; age testing for significant aging mechanisms for a 20-year qualified life; seismic test; and performance testing for the 72-hour duty cycle.

This document will be a purchase request attachment to the selected vendor for the ESBWR safety-related 72-hour duty cycle batteries. This document will be the basis for the battery vendor to develop the equipment qualification data package per the GEH equipment qualification specification that includes [two 250 VDC batteries per division, (two parallel strings of 120 lead acid cells per string and 240 cells per battery) 6000 Ah. per battery, (8 hour rate to 1.75 V/cell @77°F) and qualified to a 72 hour duty cycle].

1. ESBWR QUALIFICATION PLAN REQUIREMENTS FOR A 72- HOUR DUTY CYCLE BATTERY

ESBWR's equipment qualification process for batteries includes evaluation of significant aging mechanisms that are related to failure mechanisms from radiation exposure, time-temperature aging, and cycle aging; age testing for significant aging mechanisms for a 20-year qualified life; seismic test; and performance testing for the 72-hour duty cycle.

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2. REFERENCES

- 1-1 IEEE-323-1974 "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."
- 1-2 IEEE Std 535-1986 (R1994) "Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations."
- 1-3 IEEE Std 450-2002 "Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead Acid batteries for Stationary Applications."
- 1-4 IEEE Std 344-1987 (R1993) "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

Attachment 1

**NRC SAFETY EVALUATION
ESBWR QUALIFICATION PLAN REQUIREMENTS FOR
A 72-HOUR DUTY CYCLE BATTERY**

**SAFETY EVALUATION
GE-HITACHI NUCLEAR ENERGY
TOPICAL REPORT NEDE-33516P
QUALIFICATION PLAN REQUIREMENTS
FOR 72-HOUR DUTY CYCLE BATTERIES
FOR THE ECONOMIC SIMPLIFIED BOILING-WATER REACTOR DESIGN**

1.0 Introduction

In a letter dated April 17, 2009 (Reference 1), supplemented by letters dated July 27, 2009, September 15, 2009, and December 12, 2009 (References 2-4), GE-Hitachi Nuclear Energy (GEH) submitted its plan for qualifying 72-hour duty cycle batteries, detailed in NEDE-33516P, "ESBWR Qualification Plan Requirements for a 72-hour Duty Cycle Battery," (Reference 5) for review by the U.S. Nuclear Regulatory Commission (NRC) staff. NEDE-33516P is a proprietary report that provides GEH's process for qualifying long duty cycle batteries for the economic simplified boiling-water reactor (ESBWR) passive design. It will serve as the basis for the battery vendor to develop the equipment qualification data package in accordance with the GEH equipment qualification specification, which calls for two 250-volt direct current batteries per division; two parallel strings of 120 lead acid cells per string and 240 cells per battery; and 6,000 amp-hours per battery (8-hour rate to 1.75 volts per cell (vpc) at 77 degrees Fahrenheit and qualified to a 72-hour duty cycle).

2.0 Regulatory Criteria

The applicable regulatory requirements, guidelines, and related acceptance criteria for the qualification of long duty cycle Class 1E batteries are General Design Criterion (GDC) 2, "*Design Bases for Protection against Natural Phenomena*," and GDC 4, "*Environmental and Dynamic Effects Design Bases*," in Appendix A, "*General Design Criteria for Nuclear Power Plants*," to Title 10 of the Code of Federal Regulations (10 CFR) Part 50, "*Domestic Licensing of Production and Utilization Facilities*."

At present, no regulatory guides (RGs) or industry standards are available that provide procedures or assessment methods to qualify a battery for the 72-hour duty cycle duration. However, in reviewing this report, the staff considered applicable sections of guidance related to the qualification of batteries for 8-hour duty cycles. The staff used the following related RGs:

- RG 1.89, Revision 1, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," issued June 1984, endorses the Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) 323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," dated February 28, 1974 (References 6-7).
- RG 1.100, Revision 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," issued June 1988, endorses IEEE Std 344, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," dated August 3, 1987 (References 8-9).

Enclosure 1

- RG 1.129, Revision 2, "Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," issued February 2007, endorses IEEE Std 450, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead Acid Batteries for Stationary Applications," dated April 3, 2003 (References 10-11).
- RG 1.158, Revision 0, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants," issued February 1989, endorses IEEE Std 535, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," dated June 25, 1986. IEEE reaffirmed IEEE Std 535 in 1994 with no changes (References 12-13).
- RG 1.212, Revision 0, "Sizing of Large Lead-Acid Storage Batteries," issued November 2008, endorses IEEE Std 485, "IEEE Recommended Practice for Sizing of Lead-Acid Batteries for Stationary Applications," dated September 3, 1997 (References 14-15).

Since ESBWR design duty cycles are significantly longer than 8-hour duty cycles, and IEEE Std 535 was written under the assumption of an 8-hour duty cycle, it was not clear how the standard would apply. Therefore, the IEEE Std 535 Stationary Battery Subcommittee working group proposed a test plan to include the qualification of vented lead-acid batteries for extended duty cycles (i.e., those that go beyond 8 hours). The test plan outlines the qualification process for 72-hour duty cycle batteries. The qualification process incorporates the proposed test plan specification for passive plant design developed by several industry members in various meetings sponsored by the Electric Power Research Institute (EPRI), which calls for the testing to meet the provisions of IEEE Std 535, which states that "[t]he 3-hour rate shall be used because it provides a uniform basis for qualification by all manufacturers for all types." Additional testing using an 8-hour performance test as a standard rating is more indicative of a deeper discharge and will be used to allow for comparison to the IEEE Std 535 performance test requirements. The proposed test plan requires type testing to generally follow IEEE Std 535. Testing should be performed that is equivalent to one test each year for the desired qualification duration plus 10 percent, with an additional discharge test after seismic testing. Testing should follow the IEEE Std 450 schedule for performance testing at 2 years and every 5 years thereafter.

Additionally, the proposed test plan requires that a simulated service test should be conducted any year that a performance test is not undertaken. The simulated service test should be discharged at 80 percent of the cell rating. The simulated service test is based on a battery sized in accordance with IEEE Std 485, which recommends an aging factor of 1.25. The test just before seismic testing will always be a performance test. Post-seismic testing involves two tests. The first test will be an 8-hour rate performance test that includes the service test's depth of discharge. The second test will be a 4-hour rate performance test for the cells. The test should include at least three cells or three multiple cell units with the electrical connections of middle and end or row connections simulated. The acceptance criteria call for no failures during seismic testing, and the batteries need to deliver at least 80 percent rated capacity in the post-seismic capacity discharge test.

The NRC staff will use the proposed plan recommended by the IEEE Std 535 working group members as guidance for evaluating the qualification of extended duty cycle batteries for passive designs.

3.0 Summary of Technical Information

NEDE-33516P provides the test plan for qualifying 72-hour duty cycle batteries for ESBWR plants. The objective of this qualification plan is to demonstrate that the Class 1E batteries and racks used in the ESBWR design, as installed, will perform their required safety function throughout their qualified life. The batteries are sized in accordance with the aging factor of 1.25 recommended by IEEE Std 485, which corresponds to 80 percent of the manufacturer's rating at the end of life. [[

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4.0 Staff Evaluation

The GEH qualification test plan is based on the recommendations in IEEE Std 323, IEEE Std 344, IEEE Std 450, IEEE Std 485, and IEEE Std 535 (with the exception that the duty cycle is 72 hours). The 72-hour duty cycle batteries are sized in accordance with IEEE Std 485, which is consistent with the guidance in RG 1.212. The qualified life of the batteries will be based on 20 years. Qualification of the batteries will be performed by type testing. The objective of the qualification plan is to demonstrate that the batteries and racks used in the ESBWR design, as installed, will perform their required safety-related Class 1E function throughout their 20-year qualified life. This demonstration includes the evaluation for potential failure mechanisms stemming from radiation exposure, time-temperature aging, and cycle aging. GEH stated that the ESBWR safety-related battery qualification meets IEEE Std 535, [[

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The NRC staff has compared the test plan provided in NEDE-33516P for ESBWR battery qualification against the EPRI-sponsored proposed test plan and finds that the test plan in NEDE-33516P is more conservative than the battery working group's proposed test plan in the following areas:

- The battery working group's proposed test plan recommends that testing should follow the IEEE Std 450 schedule for performance testing at 2 years and every 5 years. A simulated service test will be conducted any year that a performance test is not undertaken. [[

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- The battery working group's proposed test plan recommends that the testing performed after seismic testing should include an 8-hour rate performance test that envelops the service test's depth of discharge and a 4-hour rate performance test for the cells. [[

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The 20-year battery cells are then mounted in the ESBWR battery rack and seismically tested in accordance with IEEE Std 344 and IEEE Std 535 to the required response spectra plus margin.

[[]] tests are performed after seismic testing to ensure that before reaching 1.75 vpc the battery delivers at least 80-percent rated capacity. This satisfies the requirements of GDC 2 and the guidance of RGs 1.100 and 1.129.

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In the course of its review of the GEH test plan, the NRC staff found that some definitions needed clarification in terms of the type of test to be performed, as well as the frequency with which each test will be performed. In Request for Additional Information (RAI) 8.3-64 S02 (Reference 16), the NRC staff asked the following:

In regards to the Topical Report NEDE-33516P, please clarify test definitions and frequencies as follows:

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In a letter dated December 12, 2009 (Reference 4), GEH responded to the RAI and [[

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This submission clarified the testing to be performed and enabled comparison with the EPRI-sponsored proposed test plan. These changes were incorporated into NEDE-33516P Revision 2. Based on the applicant's response, RAI 8.3-64 S02 was resolved.

5.0 Conclusion

The staff finds that the test plan provided in NEDE-33516P to qualify 72-hour duty cycle batteries satisfies the requirements of GDC 2 and GDC 4 and the applicable guidance of RGs 1.89, 1.100, 1.129, 1.158, and 1.212. Therefore, the staff concludes that the GEH qualification test plan provides reasonable assurance that qualified ESBWR batteries and racks will perform their required safety function throughout their qualified life.

6.0 References

1. Letter from R.E. Kingston (GEH) to NRC, MFN 09-187, "Supplemental Response to Portion of NRC Request for Additional Information Letter No. 296 Related to ESBWR Design Certification Application - Qualification of batteries for 24 and 72 hour duty cycles - RAI 8.3-64," April 17, 2009 (ADAMS Accession No. ML091110418)
2. Letter from R.E. Kingston (GEH) to NRC, MFN 09-503, "Response to NRC Request for Additional Information Letter No. 349 Related to ESBWR Design Certification Application - Qualification of Batteries- RAI 8.3-64 S01," July 27, 2009 (ADAMS Accession No. ML092100216)
3. Letter from R.E. Kingston (GEH) to NRC, MFN 09-531, "Response to NRC Request for Revision of Licensing Topical Report NEDE-33516P, "ESBWR Qualification Plan Requirements for a 72-Hour Duty Cycle Battery," September 15, 2009 (ADAMS Accession No. ML092590284)
4. Letter from R.E. Kingston (GEH) to NRC, MFN 09-785, "Response to a Portion of NRC Request for Additional Information Letter No. 399 Related to ESBWR Design Certification Application - Qualification of Batteries- RAI 8.3-64 S02," December 12, 2009 (ADAMS Accession No. ML093491006)
5. NEDE-33516P, Revision 2, "ESBWR Qualification Plan Requirements for a 72-hour Duty Cycle Battery," December 2009 (ADAMS Accession No. ML093491007)
6. Regulatory Guide 1.89 "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, June 1984 (ADAMS Accession No. ML003740271)
7. Institute of Electrical and Electronics Engineers (IEEE) Standard 323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," New York, February 28, 1974.
8. Regulatory Guide 1.100, Revision 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, June 1988 (ADAMS Accession No. ML003740293)
9. Institute of Electrical and Electronics Engineers Standard 344, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," New York, August 3, 1987.

10. Regulatory Guide 1.129, Revision 2, "Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, February 2007 (ADAMS Accession No. ML063490110)
11. Institute of Electrical and Electronics Engineers Standard 450, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead Acid Batteries for Stationary Applications," New York, April 3, 2003.
12. Regulatory Guide 1.158, Revision 0, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, February 1989 (ADAMS Accession No. ML003740047)
13. Institute of Electrical and Electronics Engineers Standard 535, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," New York, June 25, 1986.
14. Regulatory Guide 1.212, Revision 0, "Sizing of Large Lead-Acid Storage Batteries," U.S. Nuclear Regulatory Commission, November 2008 (ADAMS Accession No. ML082740047)
15. Institute of Electrical and Electronics Engineers Standard 485, "IEEE Recommended Practice for Sizing of Lead-Acid Batteries for Stationary Applications," New York, September 3, 1997.
16. Letter from D.J. Galvin (NRC) to J.G. Head (GEH), "Request for Additional Information Letter No. 399 related to Design Certification Document Revision 6," December 7, 2009 (ADAMS Accession No. ML093370504)

Enclosure 3

MFN 10-285

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, **Mark J. Colby**, state as follows:

- (1) I am the Manager, New Plants Engineering, GE Hitachi Nuclear Energy ("GEH"), have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.
- (2) The information sought to be withheld is contained in Enclosure 1 of GEH letter MFN 10-285, Mr. Richard E. Kingston to U.S. Nuclear Regulatory Commission, entitled "*Transmittal of GEH Licensing Topical Reports NEDE-33516P-A, "ESBWR Qualification Plan Requirements for a 72-Hour Duty Cycle Battery," Revision 2, September 2010 and NED0-33516-A, "ESBWR Qualification Plan Requirements for a 72-Hour Duty Cycle Battery," Revision 2, September 2010."* The GEH proprietary information in Enclosure 1, which is entitled "*LTR NEDE-33516P, ESBWR Qualification Plan Requirements for a 72-Hour Duty Cycle Battery,"* is considered GEH Proprietary Information and is delineated by a [[dotted underline inside double square brackets⁽³⁾]]. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation ⁽³⁾ refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.
- (3) In making this application for withholding of proprietary information of which it is the owner, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret," within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).
- (4) Some examples of categories of information which fit into the definition of proprietary information are:
 - a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH competitors without license from GEH constitutes a competitive economic advantage over other companies;

- b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;
- c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;
- d. Information, which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

- (5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements, which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.
- (6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited on a "need to know" basis.
- (7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.
- (8) The information identified in paragraph (2), above, is classified as proprietary because it identifies detailed GE ESBWR design information. GE utilized prior design information and experience from its fleet with significant resource allocation in developing the system over several years at a substantial cost.

The development of the evaluation process along with the interpretation and

application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

- (9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

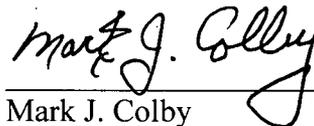
The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 1st day of October, 2010.



Mark J. Colby
GE-Hitachi Nuclear Energy Americas LLC