UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 18, 2014

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3D-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 - REPORT FOR THE WESTINGHOUSE AUDIT IN SUPPORT OF RELIABLE SPENT FUEL INSTRUMENTATION RELATED TO ORDER EA-12-051 (TAC NOS. MF0951 AND MF1178)

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation," (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A679). The order requires holders of operating reactor licenses and construction permits issued under Title 10 of the *Code of Federal Regulations* Part 50 to submit for review, Overall Integrated Plans (OIPs), including descriptions of how compliance with the requirements of Attachment 2 of the order will be achieved.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A440), Tennessee Valley Authority (TVA, the licensee) submitted its OIP in response to the March 12, 2012 Commission order for Watts Bar Nuclear Plant (WBN), Units 1 and 2. By letter dated August 2, 2013 (ADAMS Accession No. ML13204A231), the NRC staff sent a Request for Additional Information (RAI) to the licensee. By letters dated September 6, 2013 and August 28, 2013 TVA provided its response to the RAIs and first six month update (ADAMS Accession Nos. ML13254A065 and ML13254A297, respectively). By letter dated October 24, 2013 (ADAMS Accession No. ML13275A373), the NRC staff issued its Interim Staff Evaluation and RAI necessary for the NRC to complete its review. TVA provided its response to the RAIs by letters dated November 22, 2013, January 10, 2014 and February 28, 2014 (ADAMS Accession Nos. ML13333B282, ML14014A137, and ML14064A238).

As part of the WBN OIP, the licensee identified Westinghouse, LLC as their provider for SFP instrumentation. During the weeks of February 2, 2014; February 9, 2014; and April 2, 2014; the NRC staff audited Westinghouse's SFP instrumentation design verification analyses and performance test results in support of the NRC staff review of the WBN OIP in response to the Reliable SFP Instrumentation order (Order EA-12-051).

The enclosed audit report provides a summary of the NRC staff activities and the documents reviewed related to Westinghouse's SFP instrumentation design, as it applies to WBN and other licensees using the Westinghouse technology to comply with the requirements of Order EA-12-051.

If you have any questions, please contact me at 301-415-5888 or by e-mail at Jason.paige@nrc.gov.

Sincerely,

Jason Paige, Project Manager
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos.: 50-390 and 50-391

Enclosure:
Audit Report

cc w/encl: Distribution via Listserv

AUDIT REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-12-051 MODIFYING LICENSES

WITH REGARD TO REQUIREMENTS FOR

RELIABLE SPENT FUEL POOL INSTRUMENTATION

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-390 and 50-391

BACKGROUND

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A679), to all power reactor licensees and holders of construction permits in active or deferred status. This order requires, in part, that all operating reactor sites have a reliable means of remotely monitoring wide-range Spent Fuel Pool (SFP) levels to support effective prioritization of event mitigation and recovery actions in the event of a Beyond-Design-Basis external event (BDBEE). The order required all holders of operating licenses issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," to submit to the NRC an Overall Integrated Plan (OIP) by February 28, 2013.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A440), Tennessee Valley Authority (TVA, the licensee) submitted its OIP for Watts Bar Nuclear Plant, Units 1 and 2 (Watts Bar, WBN), describing how it will achieve compliance with Attachment 2 of Order EA-12-51 prior to November 5, 2015, for Unit 1, and prior to initial startup, for Unit 2. By letter dated August 2, 2013 (ADAMS Accession No. ML13204A231), the NRC staff sent a Request for Additional Information (RAI) to the licensee. By letters dated September 6, 2013 and August 28, 2013 TVA provided its response to the RAIs and first six month update (ADAMS Accession Nos. ML13254A065 and ML13254A297, respectively). In its letter dated August 28, 2013, the licensee revised its target completion date to August 31, 2014, for full site implementation.

By letter dated October 24, 2013, (ADAMS Accession No. ML13275A373), the NRC staff issued an Interim Staff Evaluation (ISE) and RAI to the licensee. The licensee provided its response to the RAIs, as well as their second six-month update, by letters dated November 22, 2013 (ADAMS Accession No. ML13333B282), January 10, 2014 (ADAMS Accession No. ML14014A137), and February 28, 2014 (ADAMS Accession No. ML14064A238). In addition, the staff met with TVA on January 22, 2014 at the Westinghouse Electric Corporation Automation and Field Services facility in Waltz Mill, PA to observe operation of the proposed spent fuel pool instrumentation (SFPI) system in a full-scale simulated SFP environment, and to prepare for an audit of Westinghouse, LLC.

AUDIT ACTIVITIES

The onsite audit was conducted at the Westinghouse, LLC, Rockville facility. The audit began the week of February 2, 2014, with subsequent audit follow-ups on the week of February 9, 2014 and concluded on April 2, 2014. The NRC audit team staff was as follows:

Carla P. Roque-Cruz	NRR/JLD
David Rahn	NRR/DE
Rossnyev Alvarado	NRR/DE
Samir Darbali	NRR/DE
Steven Wyman	NRR/DE
Gursharan Singh	NRR/JLD

During the audit, the NRC staff performed a review of the SFPI technical and design information. Activities that were performed in support of the above included detailed analysis and calculation discussions, equipment demonstration and discussions with the vendor staff on specific topics.

AUDIT SUMMARY

1. Temperature, Humidity and Radiation (Environmental Conditions) Qualification – ISE RAI #8, RAI #9, RAI #10, RAI #11 and RAI #12

Temperature and Humidity Qualification

The audited documents summarize the tests and evaluations, acceptance criteria and test results performed to demonstrate that the SFPI meets the conditions to operate under normal and beyond-design-basis (BDB) conditions. The temperature and humidity tests were performed in accordance with Institute of Electrical and Electronics Engineers (IEEE) IEEE-323-2003 and described in EQ-TP-328, "Environmental Adequacy Test Procedure for the Spent Fuel Pool Instrumentation System," August 2013.

Section 5.5 of EQ-QR-269, "Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation System," Rev. 1, states that all electrical connections were routed outside the environmental chamber to control power and allow monitoring without opening the chamber door. To perform the temperature and humidity tests, Westinghouse exposed equipment under test (EUT) to the cycles identified in Section 4 of EQ-QR-269.

Westinghouse recorded its test results in WNA-TR-03149-GEN, "Spent Fuel Pool Instrumentation System Standard Product Final Summary Design Verification Report," Rev. 1; EQLR-305B, "Environmental Test Report for the Level Sensor Electronics Housing for the Spent Fuel Instrumentation System," Rev. 0; EQLR-274, "Environmental Test Report for the Spent Fuel Instrumentation System," Rev. 0; and EQ-QR-269. Westinghouse noted the coaxial cable jacket is rated for temperatures up to 150° C (302° F) and thus is able to withstand expected conditions of saturated steam in the SFP area, which exceeds those outside the SFP area. Westinghouse concluded that the probe, coaxial cable, 90° and straight connector, and

stainless steel coupler are able to perform in abnormal conditions in the SFP area for up to seven days. In addition, Westinghouse tests demonstrated that the level sensor electronics with the coupler and the coaxial cable attached performs accurately when the probe, coupler, and coaxial cable are exposed to a temperature range of 10 to 100 °C (50 – 212 °F) and up to 100 percent Relative Humidity (RH).

Westinghouse performed the steam test with the SFPI coaxial cable and connectors exposed to 100 percent saturated steam at 212 °F (±18 °F) for 185 hours. Westinghouse identified the following EUT:

- Straight connector with coupling – EUT1
- 90° connector with coupling – EUT2

While performing the steam test, Westinghouse identified problems with the EUTs and the steam generator, which required retesting and reconfiguration of the EUTs. Westinghouse tested both pieces of EUT for 7 days using the recommended processes and the results showed that coaxial cable, connector and coupler functioned as required. The steam test report indicated that EUT1 remained within the specified measurement range for the entire steam test. In addition, the connectors were splash tested to determine the appropriate torque level and sealing. All test results were satisfactory. Westinghouse also noted that the production connectors are rated IP67 per EPSILON 08 TEST 2373.

Functional tests were performed every 24 hours during the environmental qualification tests with satisfactory results recorded in Appendix C of ELQR-305B. Additional margin in test duration time was used to account for any variations in temperature and humidity variations during the test. Westinghouse also performed post-baseline performance testing and all results were acceptable.

Since the SFPI level sensor electronics could be mounted in locations outside the SFP area, that see higher temperature and humidity other than those originally tested, Westinghouse performed additional testing for temperature and humidity testing for the level sensor electronics. The conditions for qualification under the higher temperature and humidity are described in WNA-TR-03149-GEN where Westinghouse addressed environmental testing for coaxial cable and level sensor electronics. Due to the sensor electronics bracket construction material and the fact that it is a passive component not impacted by these environmental conditions, no environmental testing was performed on the bracket.

Regarding components outside the SFP area, Westinghouse concluded the aggregate of the environmental verification activities for the SFPI demonstrate that the instrumentation operates reliably in accordance with the service environmental requirements specified for the both, the harsh and outside SFP area conditions. The level sensor electronics housing was also verified to meet IP67 rating per EPSILON 08 TEST 2373, which will prevent water ingress and withstand 100 percent humidity.

Radiation Qualification

In EQ-PP-8, "Seismic, Environmental, EMC Test Plan for Spent Fuel Instrumentation System," Rev. 0, Westinghouse indicated that the radiation aging will be applied after the mechanical

preconditioning to the seismic and environmental test specimens. The Westinghouse radiation analysis is documented in Westinghouse letter, LTR-REA-13-85, "Summary of Discussions Regarding Radiation Levels at Radiation Detector Locations in the Spent Fuel Pit." This is a conservative analysis because it assumes the same dose rate at the top of the pool and when the water is at Level 3, right above the SFP racks.

The coaxial cable and coupler underwent radiation aging in accordance with IEEE Std. 323-2003 for service in post-accident radiation conditions. The coaxial cable and coupler were visually inspected after radiation aging. It was identified that a lock washer was missing from the probe attachment point of the coupler. Westinghouse noted that the absence of this lock washer had no effect on the thermal or radiation aging performed, and that the inspection did not reveal any noticeable degradation. A baseline functional test was also performed upon completion of radiation aging and did not show any change in performance as a result of the radiation aging. In WNA-TR-03149-GEN, Westinghouse notes that the probe, optional stilling well, and the pool-side bracket are inherently resistant by design to radiation effects.

Regarding SFPI Components Outside of the SFP Area, WNA-TR-03149-GEN, states that the level sensor electronics and the electronics enclosure of both the wired and wireless configuration with and without the optional temperature option are qualified to withstand a total integrated does (TID) up to 1E03 rads. Based on research and historical data, radiation is not considered an aging mechanism for equipment subject to TID less than 1E4 rads. In Reference to WNA-TR-03149-GEN, Westinghouse also concludes that the aggregate of the radiation aging verification and testing activities for the SFPI demonstrate that the instrumentation operates reliably per the service dose requirements specified Westinghouse documents.

During the audit, the NRC staff reviewed TVA Calculation MDQ0000782013000405 which contains the applicable required dose rate and TID for the specific SFPI level element and sensor electronics locations at WBN. For WBN, the sensor electronics will be located outside of the SFP area. The TID for the WBN SFPI sensor electronics locations are bounded by the Westinghouse analyzed radiation conditions for components outside of the SFP area. Similarly, the TID for the WBN SFPI sensor probe locations is bounded by the as-tested Westinghouse radiation conditions for components in the SFP area.

2. <u>Seismic Qualification - RAI #11 and RAI #12</u>

The audited documents summarize the tests and evaluations, acceptance criteria and test results performed to demonstrate the SFPI meets the conditions to operate under normal and BDB conditions, including seismic conditions.

WNA-TR-03149-GEN and EQ-QR-269 describe the seismic testing performed to demonstrate the SFPI is seismically qualified and meets Westinghouse's design specifications described in WNA-DS-02957-GEN. In particular, tests that were performed in accordance with IEEE 344-200 and the required response spectra (RRS) included a 10 percent margin, as recommended by IEEE 323-2003.

Westinghouse performed seismic testing of the following SFPI components: electronics enclosure, level sensor electronics, level sensor electronics bracket, coaxial cable, coupler, probe, connectors and launch plate. Separate seismic analysis was performed for the SFPI

mounting bracket. The Safe Shutdown Earthquake (SSE) response spectra utilized is defined in WNA-DS-02957-GEN. A minimum of five successful Operating Basis Earthquake (OBE) runs were required, followed by two successful SSE runs and one successful Hard Rock High Frequency (HRHF) spectra run. The results obtained were found acceptable, and the test response spectra fully enveloped the SSE RRS. The OBE and SSE test response spectrum (TRS) acceleration levels enveloped the RRS by 10 percent within the limitations of IEEE 344-2004. In addition, Westinghouse performed one HRHF test run, which enveloped the HRHF RRS. Westinghouse also found the system maintained its accuracy after the five OBE test runs. Westinghouse summarized its seismic test results in EQLR-281, "Seismic Test Report for the Spent Fuel Instrumentation System," Rev. 0, EQ-QR-269 and WNA-TR-03149-GEN.

Westinghouse performed functional testing of the equipment before and after each SSE and HRHF runs; and the equipment maintained its functionality. In addition, Westinghouse inspected the equipment after the seismic testing and no damage was found. Westinghouse concluded that the system met all requirements, maintained structural integrity during and after all OBEs, SSEs and HRHF tests.

3. Boron Concentration Effect on SFP Instrumentation – ISE RAI#15

The audited documents describe the Westinghouse evaluation to determine the effect boron concentration can have on the accuracy of the SFPI level instrumentation.

The pool-side bracket, probe, and coupler will be exposed to the chemistry of the SFP water. Westinghouse stated that the materials in the probe and pool-side bracket are inherently resistant to the chemistry in the water. However, since boron concentration and buildup could impact the functionality of these components, this was evaluated. Since water inventory could be reduced due to sloshing out of the pool during an earthquake or lost through ventilation ducts, Westinghouse calculated the concentration of boric acid that would result if the Watts Bar SFP boils or otherwise evaporates from the normal water level down to the level of the top of the fuel rods. The results showed that the requirements for accuracy, as defined in WNA-DS-02957-GEN, were maintained.

Additionally, in Reference LTR-CDM-13-78, "Concentration of Boric Acid in the Watts Bar Spent Fuel Pool Due to Boiling and its Effects on Level Instrumentation Cables," Rev. 0, Westinghouse states that while some accumulation of crystallized boric acid on the probe could occur at the water level of the SFP, it will not have a significant effect on level measurement accuracy. The rate of accumulation is anticipated to be such that cleaning or removing the buildup during periodic calibration verification will be sufficient. Frequency of cleaning/removing the boron buildup is to be based on operating experience. For a BDBEE no additional testing is required because it's only a onetime event. Based on the test results, Westinghouse concludes the boric acid build up on the probe's cabling won't affect the accuracy performance requirement for level measurement.

4. SFPI Mounting Bracket Structural Analysis – ISE RAI#5 and RAI#6

The audited documents summarize the analyses performed for the specific WBN site locations for the primary and back-up mounting brackets for each of the SFPI level measurement probes.

The purpose of these calculations is to evaluate the structural integrity of the mounting brackets under the probable maximum conditions for which they are required to function. For WBN, one bracket is mounted on the SFP peninsula knee wall, and cantilevered over the pool, and the other bracket is mounted on the SFP deck and cantilevered over the pool. Since the bracket designs are different to accommodate this spatial arrangement, two separate calculations were prepared.

The bracket designs consist of a support steel tube with plates welded to the top and bottom. There are two top plates—one plate serves as a base plate that is mounted to the permanent pool structure, and the other is used to facilitate performance of a two point functional calibration check. The bracket analysis was performed using a Georgia Tech Research Corporation, Georgia Institute of Technology, 2012 (GT STRUDL) model.

Using the loads and bracket materials, the GT STRUDL model was made of both the primary and back-up probes. The loads assumed were the bracket component self-weights, the dead load of the instrumentation, and the SSE response spectra curves for WBN Spent Fuel Floor elevation. The seismic analysis used the SSE in-structure response spectra with 3 percent damping for Floor Elevation 755.50 ft. in the WBN Auxiliary Building. The OBE loads were not used in this evaluation since the SSE is considered to be bounding. For this analysis, additional forces on the mounting brackets due to pool sloshing effects were not included. Westinghouse and WBN staff present during the audit explained that bounding pool sloshing wave effects were calculated and it was found that for the geometry of the WBN SFP, the wave heights generated by the pool sloshing effects were not sufficiently high to reach the height where the primary and secondary probe support brackets will be mounted. The Maximum frequency for the site is greater than 33 Hz so the assembly is considered to be rigid and the interference response were less than 1.0 and considered adequate.

5. Shock and Vibration - ISE RAI #11 and RAI #12

The audited document describes the Westinghouse rationale for not performing shock and vibration testing to the SFPI.

Westinghouse analysis shows that the SFPI mounting configurations are designed such that each component is rigidly mounted to Seismic Category I concrete structures. In particular, the structural analyses of the mounting bracket at the pool side determined that when the anchor bolts are properly torqued, the natural frequency of the assembly is greater than 33 Hz. With this configuration, the components are "inherently resistant" to shock and vibration load effects.

6. Instrument Accuracy, Calibration and Testing – ISE RAI #15, RAI #16, RAI #17 and RAI #18

The audited documents summarize the calculations performed for instrument accuracy of the SFPI. Westinghouse identified that the SFPI channel accuracy should be within ±3 in. of the entire range which is from normal water level to the top of the fuel racks under all environmental conditions in accordance with WNA-DS-02957-GEN. For the wired SFPI configuration, Westinghouse's calculated accuracy is within the acceptance criteria of ±3 in.

WBN documents reviewed by NRC staff note that the Westinghouse accuracy calculation, WNA-CN-00301-GEN, "Spent Fuel Pool Instrumentation System Accuracy Analysis," Rev. 0, bounds the instrument loops for normal and BDB conditions. For WBN, the Loop Accuracy Indication Function for both primary and backup channels were found to be ±1.741 in. WBN staff concluded that the total loop uncertainty for the primary and backup channels are less than the required 12 in. and are therefore acceptable.

Westinghouse verified the SFPI accuracy under mild environmental conditions, seismic and BDB conditions. During each cycle, functional tests were conducted which verified that the EUT was functioning with the required accuracy at three points (minimum, middle, and maximum span), as well as confirmed that the display on the exterior of the enclosure correctly identified the simulated pool level. Westinghouse noted that the system maintained accuracy after the five successful OBE level tests and no loss of power was noted during the test runs.

Westinghouse's SFPI provides for a sliding bracket calibration or fixed bracket calibration methods.

There are two Westinghouse SFPI bracket designs, each with its own method for calibration described in WNA-TP-04709-GEN. If the sliding bracket or fixed bracket method for calibration falls within the required calibration tolerance of ±3", the calibration verification is successful and the equipment can be returned to the normal operating setup.

Westinghouse noted that as part of the calibration verification, standard checks shall be completed to ensure the system is in proper operating condition. Westinghouse recommends that the maintenance verification be performed once per reloading cycle and that residual boron that has built up along the probe cable be removed before completing a calibration verification or adjustment.

7. Power Consumption – ISE RAI #14

The audited documents summarize the analyses performed to calculate the power consumption of the SFPI. Westinghouse performed power consumption calculations for different SFPI configurations. The power consumption was tested for the worst case scenario load on the various options of the SFPI system.

Wired Level SFPI Configuration (3-day dc power)

Westinghouse identified the power consumption of the SFPI components, including the radar level sensor, the uninterruptible power supply, and the digital display. The SFPI configuration used at WBN is wired, measures level, does not contain a remote display, and is designed to provide direct current (dc) power for 3-days at full battery charge. This configuration uses one 26 Amp-Hr battery. Westinghouse also incorporated design and aging margins, as well as a temperature correction factor; referencing IEEE 485-2010, sections 6.2.1, 6.2.2, and 6.2.3. The power consumption, including design margins, of the wired SFPI configuration is 0.257 Amps, which results in a battery life (from full charge) of more than 3-days. Although the Watts Bar configuration does not include a remote display, the calculation notes that to maintain a dc battery charge of 3-days, any externally powered remote display connected to the SFPI shall consume no more than 0.064 Amps.

Wired Level and Temperature SFPI Configuration (3-day dc power)

The staff also reviewed the power consumption calculation for the SFPI wired level and temperature configuration, with a dc 3-day battery life. Westinghouse identified the power consumption of the components in this configuration, including the radar level sensor, the temperature sensor, the uninterruptible power supply, and the digital display. The power consumption, including design margins, of the wired level and temperature SFPI configuration is 0.427 Amps, which results in a battery life (from full charge) of more than 3-days.
To maintain a dc battery charge of 3-days, any externally powered remote display connected to the SFPI shall consume no more than 0.09 Amps each. Westinghouse also incorporated design and aging margins, as well as a temperature correction factor; and referenced IEEE 485-2010, sections 6.2.1, 6.2.2, and 6.2.3.

During testing of both configurations, the alternating current (ac) power was removed from the SFPI system approximately 15 seconds into the run. The power was removed by manually removing the ac plug from the 120 VAC/60 Hz wall outlet. This operation was performed to ensure that the uninterruptible power supply was able to switch from line power to battery power during a seismic event. Westinghouse notes that the system performed without issue.

8. Electro-Magnetic Compatibility (EMC) Testing – Vendor Audit RAI

The Westinghouse SFPI design proposed for implementation at WBN employs an "advanced technology" that should be evaluated for possible adverse interaction with other plant systems. At a minimum, the equipment must not adversely impact the operations of other equipment in the SFP area during normal modes of operation, and per the order requirement, it should remain reliable for an extended period under the BDB conditions for which it is intended.

Westinghouse document WNA-TR-03149, "EMC Verification Summary," Section 2.1, states that EMC testing was completed on SFPI components. Westinghouse determined that one method of demonstrating EMC with other equipment in the SFP area was to apply the criteria and guidance contained in NRC Regulatory Guide 1.180, Rev. 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety Related Instrumentation and Control Systems." During the February 11, 2014 follow-up audit, Westinghouse staff informed the NRC that all tests were complete, with the exception of the electrostatic discharge test (usually saved for last in the event of potential damage occurrence). Vendor staff summarized the testing results and status of the progress for completion of the testing performed for EMI/RFI emissions/susceptibility. At that time, the following results were discussed:

Electronics Enclosure (Display Panel)

Electronic Emissions: Meets Regulatory Guide 1.180 Rev 1 limits for emissions tests conducted using the IEC 61000 Series standards.

Susceptibility: Meets Performance Criterion B of the IEC 61000-4 standard

Electronics Module (Sensor/Transmitter), Probe, and Coaxial Cable

Emissions: Meets Regulatory Guide 1.180 Rev 1 Limits

Susceptibility: Meets Performance Criterion B (with IEC 61000-4-2 (ESD)

IEC61000-4 Criteria

Criterion A: Equipment continues to perform within the specification limits identified by the manufacturer before, during, and after the EMC event

Criterion B: Equipment functions as specified by the manufacturer before and after a test EMC event (but not during the events). No degradation of performance found below the specification limits identified by the manufacturer.

Criterion C: Temporary loss of function—Equipment requires operator intervention to reset, using its normal controls following an EMC event

Criterion D: Equipment loses function, and is not capable of being reset using its normal controls following an EMC event

As a result of the NRC staff's evaluation of the EMC testing results, the staff identified a generic open item applicable to all licensees using this technology to identify any additional measures, site-specific installation instructions or position taken to address the potential effect of an EMC event on the SFPI equipment.

Exit Meeting (Tuesday, April 22, 2014)

The NRC staff audit team conducted an exit meeting with Westinghouse, TVA and Nuclear Energy Institute staff following the closure of audit review activities. The NRC staff highlighted items reviewed and noted that a detailed summary of the audit activities will be documented in this report.

Conclusion

The NRC staff completed the Westinghouse SFPI audit in support of the staff's review of WBN integrated plan in response to Order EA-12-051. The review of the audit activities and results summarized in this report apply to WBN and other licensees using Westinghouse's level measurement technology. If additional vendor information is needed by the licensees, based on their site-specific installation of the SFPI and response to the staff's RAIs, then the information can be provided to the staff via the licensees' e-portals, conference calls with the staff or site visits.

Based on this audit, the NRC staff gained an understanding of, and verified the design and qualification process used by the vendor to confirm the reliability of the SFPI. The staff found the SFPI design and qualification process reasonable. The information and calculations provided by the vendor allowed the staff to identify licensee information that will require docketing to confirm that the installation of the instrumentation at the site is enveloped by the SFPI's design.

In support of the continuing audit process, as TVA proceeds towards compliance with the orders for the WBN, "Watts Bar Nuclear Plant, Units 1 and 2 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Instrumentation Related to Orders EA-12-049 and EA-12-051" dated May 15, 2012 (ADAMS Accession No. ML14128A129) provides information on the remaining TVA open items related to the SFPI.

Documents Reviewed

1. Westinghouse Document WNA-TR-03149-GEN, "Spent Fuel Pool Instrumentation System Standard Product Final Summary Design Verification Report," Rev. 0.

2. Westinghouse Document WNA-TR-03149-GEN, "Spent Fuel Pool Instrumentation System Standard Product Final Summary Design Verification Report," Rev. 1.

3. Westinghouse Report EQ-QR-269, "Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation System," Rev. 0.

4. Westinghouse Report EQ-QR-269, "Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation System," Rev. 1.

5. Westinghouse Document EQ-PP-8, "Seismic, Environmental, EMC Test Plan for Spent Fuel Instrumentation System," Rev. 0.

6. Westinghouse Document EQ-TP-351, "Environmental Qualification Test Procedure for the Spent Fuel Instrumentation System Coaxial Cable and Connectors Inside the Spent Fuel Pool Area," Rev. 0.

7. Westinghouse Report EQLR-305B, "Environmental Test Report for the Level Sensor Electronics Housing for the Spent Fuel Instrumentation System," Rev. 0.

8. Westinghouse Report EQLR-274, "Environmental Test Report for the Spent Fuel Instrumentation System," Rev. 0.

9. Westinghouse Document EQ-EV-196, "Pre-conditioning, Thermal Aging and Radiation Aging of the Coaxial Cable and Couplers for the Spent Fuel Pool Instrumentation System," Rev. 0.

10. Westinghouse Sweden Report SEC 13-233, "Evaluation of Design Adequacy of Coaxial Cable Manufactured by Habia Cable AB, Sweden – Drawing No. 370005002, Rev. 1," Rev. 0.

11. Westinghouse Document WNA-DS-02957, "Design Specification for the Spent Fuel Instrumentation System," Rev. 3.

12. Westinghouse Letter LTR-SFPIS-13-35, "Attachment A: Explanation of Basis for Radiation Dose Requirement and Clarification of Production Equivalency of Electronics Enclosure Used for Seismic Testing."

13. Westinghouse Letter LTR-REA-13-35, "Summary of Discussions Regarding Radiation Levels at Radiation Detector Locations in the Spent Fuel Pit."

14. Westinghouse Letter LTR-SFPIS-13-001, "SFPIS: Environmental and Test / Qualification Requirements (Interim Release)."

15. TVA Calculation MDQ0000782013000405, "Environmental Conditions for Spent Fuel Pool Level Instrumentation during Extended Station Blackout Conditions," Rev. 0.

16. Westinghouse Report EQLR-281, "Seismic Test Report for the Spent Fuel Instrumentation System," Rev. 0.

17. Westinghouse Document EQ-TP-338, "Seismic Test Procedure for the Spent Fuel Instrumentation System," Rev. 0.

18. Westinghouse Document CN-PEUS-13-24, "Seismic Analysis of the Spent Fuel Pool Mounting Bracket at Byron and Braidwood Nuclear Stations," Rev. 2.

19. Westinghouse Document WNA-TP-04752-GEN, "Spent Fuel Pool Instrumentation System Standard Product Integrated Functional Procedure," Rev. 1.

20. Westinghouse Letter CN-SEE-II-12-40, ""Determination of the Time to Boil in the Watts Bar Spent Fuel Pool after Earthquake," Rev. 0.

21. Westinghouse Letter LTR-SFPIS-13-026, Rev. 0, "SFPIS: Level Sensor Demonstration of Boron Plating Effects."

22. LTR-CDM-13-78, "Concentration of Boric Acid in the Watts Bar Spent Fuel Pool Due to Boiling and its Effects on Level Instrumentation Cables," Rev. 0.

23. Westinghouse Calc Note CN-PEUS-13-20, Rev. 1 SFPIS—Watts Bar Units 1 & 2, "Seismic Analysis of the SFP Primary Mounting Bracket at WBN I & II (Electronically Approved in Electronic Document Management System (EDMS) on November 4, 2013)

24. Westinghouse Calc Note CN-PEUS-13-21, Rev. 1 SFPIS—Watts Bar Units 1 & 2, "Seismic Analysis of the SFP Back-up Mounting Bracket at WBN I & II (Electronically Approved in Electronic Document Management System (EDMS) on November 4, 2013)

25. Westinghouse Document WNA-CN-00301-GEN, "Spent Fuel Pool Instrumentation System Accuracy Analysis," Rev. 0.

26. Westinghouse Report WNA-TP-04709-GEN, "Calibration Procedure," Rev. 2.

27. TVA Calculation 0-L-78-42, "Watts Bar Nuclear Plant Engineering and Materials Setpoint and Scaling Document Cover Sheet," Rev. 0.

28. TVA Calculation 0-L-78-43, "Watts Bar Nuclear Plant Engineering and Materials Setpoint and Scaling Document Cover Sheet," Rev. 0.

29. Westinghouse Document WNA-CN-00300-GEN, "Spent Fuel Pool Instrumentation System Power Consumption Calculation," Rev. 0.

30. TVA Calculation WBT-D-4405, ""Watts Bar SFPIS Back-up Battery Life Final Calculation," dated July 12, 2013.

31. Westinghouse Letter to file, LTR-EQ-14-32, Rev. 1, dated March 10, 2014. Subject: "Spent Fuel Pool Instrumentation System – Hardware Configuration for EMC Testing to Satisfy Performance Criterion B". (Contained as Appendix C, pages C-2 to C-5, of Westinghouse report WNA-TR-03149, Rev. 1)

The enclosed audit report provides a summary of the NRC staff activities and the documents reviewed related to Westinghouse's SFP instrumentation design, as it applies to WBN and other licensees using the Westinghouse technology to comply with the requirements of Order EA-12-051.

If you have any questions, please contact me at 301-415-5888 or by e-mail at Jason.paige@nrc.gov.

Sincerely,

/RA/

Jason Paige, Project Manager
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos.: 50-390 and 50-391

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