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RBG-47570

May 18, 2015

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

SUBJECT: Completion of Required Action by NRC Order EA-12-051
Reliable Spent Fuel Pool Level (SFP) Instrumentation
River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

REFERENCE: NRC Order Number EA-12-051, *Order to Modify Licenses with Regard to Reliable SFP Instrumentation*, dated March 12, 2012 (0CNA031207) (ML12054A679)

RBF1-15-0071

Dear Sir or Madam:

On March 12, 2012, the NRC issued Order EA-12-051, *Order Modifying Licenses with Regard to Reliable SFP Instrumentation*, to Entergy Operations, Inc. (Entergy). This Order was effective immediately and directed Entergy to install reliable SFP instrumentation as outlined in Attachment 2 of the Order at River Bend Station (RBS). This letter, along with its enclosures, provides the notification required by Section IV.C.3 of the Order that full compliance with the requirements described in Attachment 2 of the Order has been achieved for RBS.

This letter contains no new regulatory commitments. Should you have any questions regarding this submittal, please contact Joey Clark at 225-381-4177.

I declare under penalty of perjury that the foregoing is true and correct; executed on May 18, 2015.

Sincerely,

Eric W. Olson

EWO/dhw

Attachments: 1. Compliance with Order EA-12-051
2. NRC Requests for Information

ADD1
NRR

cc: Regional Administrator
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NRC Senior Resident Inspector
River Bend Station

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Attachment 1 to
RBG-47570

Compliance with Order EA-12-051

Compliance with Order EA-12-051

Background

On March 12, 2012, the NRC issued Order EA-12-051, *Order Modifying Licenses with Regard to Reliable Spent Fuel Pool (SFP) Instrumentation* (Reference 1 to Entergy Operations, Inc. (Entergy). This Order was effective immediately and directed Entergy to install reliable SFP instrumentation as outlined in Attachment 2 of the Order at River Bend Station (RBS). The information provided herein documents full compliance for RBS in response to the Order.

Compliance

Entergy has installed two independent full-scale level monitors on the RBS spent fuel pool in response to Reference 1.

Entergy submitted RBS' Overall Integrated Plan (OIP) by Reference 2. By Reference 3 the NRC provided requests for additional information (RAIs) for the OIP. Entergy provided responses to the RAIs by Reference 4 and this submittal. By Reference 6, the NRC provided its interim staff evaluation (ISE) and requested additional information necessary for completion of the review. Entergy provided responses and/or updates to these ISE RAIs by Reference 7, 8, 9, and this submittal (by inclusion in Attachment 2 the bridging document between vendor technical information and licensee as requested by NRC based on NRC vendor audit).

Actions Completed

Engineering Change EC-44964 has been implemented to provide SFP water level monitoring capability at a remote, protected location in the main control building.

The RBS SFP level instrument channels incorporate two permanently installed, physically independent, and physically separated channels (with channel separation in accordance with existing plant design basis requirements). Sensors at the SFP are spatially separated in opposite corners of the SFP with cables maintaining separation out to the display unit and protected in metal cable trays. The remote display panel is installed in the main control building in the vicinity of the safety-related switchgear rooms. Power sources include (1) independent AC power sources, (2) channel-specific stand-alone replaceable battery power with a minimum seven-day reserve capacity, and, (3) connections and cables for an external DC alternate power source. Equipment and raceway are mounted and installed to RBS seismic category 1 requirements.

Training has been conducted on the use of the new components. A new section has been added to the Technical Requirements Manual (TRM) to control functionality and actions for non-functionality along with implementation of a TRM channel functional test procedure and a preventive maintenance (PM) task to control maintenance scheduling. Continuous monitoring is implemented in the plant operator logs.

Milestone	Completion Date
Design Modification Package Developed/Issued (EC-44964)	February 21, 2014
SFPI Installed	March 9, 2015
NRC RAI response issued	February 25, 2015
Refueling outage no. 18 completed	March 27, 2015

RBS achieved compliance with Order EA-12-051 on March 27, 2015. A summary of compliance actions is as follows:

Compliance Elements Summary

In accordance with NRC Order EA-12-051, Entergy shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel:

(1) level that is adequate to support operation of the normal fuel pool cooling system,

(2) level that is adequate to provide substantial radiation shielding for a person standing on the SFP operating deck, and

(3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

Three key SFP water levels, including the critical levels defined in Nuclear Energy Institute (NEI) 12-02, Revision 1, were identified. Both the primary and backup instrument level channels are permanently mounted within the SFP, and both channels measure water level over a single continuous span from above Level 1 down to below the upper limit of Level 3. Access to the SFP area is not required to operate the instrument channels or obtain level data. Displays and signal processors are located in the main control building. The three critical levels for RBS are as follows:

Level 1 (plant elevation 110' 0"): Level 1 is that level adequate to support operation of the normal SFP cooling system, and is the level below which loss of pump suction loss occurs due to uncovering the coolant inlet pipe vacuum breakers.

Level 2 (plant elevation 107' 10-5/16"): Level 2 is that level adequate to provide substantial radiation shielding for a person standing on the SFP operating deck.

Level 3 (plant elevation 85' 10-5/16"): Level 3 is the level where fuel remains covered. It is defined as the highest point of any fuel rack, plus one foot.

1. In accordance with NRC Order EA-12-051, the SFP level instrumentation shall include the following design features:

   a. Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable.

   The new SFP level probes provided with the MOHR Level Indication System operates by electric field perturbation (EFP) technology. The probes are submerged in the SFP such that the indicated range will span from the SFP High Level Alarm setpoint [setpoint] to 3 inches below Level 3 (EL. 85' 7-5/16") in order to envelope the three critical SFP water levels.

   b. Arrangement: The SFP level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the SFP. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the SFP area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the SFP structure.

   The probes are seismically mounted in the northeast corner (primary Channel "A") and the southeast corner (back-up Channel "B") of the SFP in order to reduce the probability that both channels could be damaged by debris caused by a beyond design basis external event (BDBEE). The probe assemblies are also qualified to withstand the harsh environments created in a BDBEE.

   Each level indicator is powered from electrically-independent 120VAC lighting panels. Hard-wired conditioners (isolation transformers) are installed in the power feed from the lighting panels to the level indicators, based upon recommendation from MOHR Test and Measurement, LLC.

   Each level indicator is also provided with a dedicated battery enclosure to provide back-up battery power. The level indicator will automatically switch to the back-up battery upon loss of normal AC power without any adverse effect on instrument calibration or accuracy. The batteries are sized to provide at least seven days of operation. The system will automatically transfer back to normal AC power when restored, and the level indicator will automatically recharge the batteries.

   c. Mounting: Installed instrument channel equipment within the SFP shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the SFP structure.

   This modification was classified as Quality Related due to (1) the installation of equipment in the SFP, (2) the installation of the instrumentation cable in Class 1E raceways,(3) the installation of equipment in the control building, and (4) seismic mounting of the probes near the safety-related SFP pool liner. The equipment uses non-safety related power, but the probes, display units, and other support equipment are considered augmented quality because they fulfill an NRC regulatory requirement. They are also augmented quality because the equipment is mounted using seismically-qualified designs so that new equipment (and its supporting conduits) cannot damage seismic category 1 structures, systems, or components (SSCs).

d. Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the SFP water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

Engineering Report RBS-IC-13-00002 was developed by the instrumentation vendor (MOHR Test and Measurement, LLC) to qualify the probe assembly for the conditions of the SFP - temperature, humidity, water chemistry, and radiological - for a component service life of 40 years. RBS engineering calculations were developed to quantify radiological conditions of the SFP, considering normal operational, event, and post-event conditions for no fewer than seven days post-event. These calculations review the analysis presented in RBS-IC-13-00002 in order to confirm the acceptability of the probe assembly, including the hard-line cable system and the coaxial cable, for the specific radiological conditions of the RBS SFP. In addition, report RBS-IC-13-00002 documents the qualification of the probe assembly for temperatures of 212°F at 100% humidity, boiling water, and/or steam environment, and SFP water chemistry in accordance with NEI 12-02, Rev. 1 Section 3.4. Note that the RBS SFP does not use borated water chemistry. However, RBS-IC-13-00008 qualifies the SFP level instrument system performance and accuracy when used in borated water.

The remote level indicator panel, battery enclosures, and power conditioners are installed in the 98' elevation of the control building. According to the RBS Environmental Design Criteria Database, the environmental conditions in this area are as follows: 90% relative humidity, 104°F (40 °C) maximum temperature for all design basis conditions. BDBEE conditions were evaluated by the FLEX bases calculations, and it was determined that temperatures in the control building 98'-0" switchgear rooms during a BDBEE will not exceed 130°F for the first 72 hours post-event. Following the initial 72 hour period, offsite resources are credited by FLEX bases for mitigating heat-up in these rooms. Since the new level indicators, battery enclosures, and power conditioners are just outside of the Division 1 switchgear room, and since there are no significant heat loads in this area; it is concluded that the ambient temperatures post-event would not exceed 130°F.

The new level indicator panel and battery enclosure are rated to operate in temperatures of 14°F to 131°F (-10 °C to 55 °C) and 5% to 95% relative humidity, as confirmed by RBS-IC-13-00003. Therefore, the level indicator and battery enclosure will remain operable for the maximum temperature (130°F) and maximum humidity (90%) conditions in the control building.

The power conditioner is rated for ambient temperatures of 32°F to 86°F (0°C to 30°C) and 0% to 90% relative humidity. The power conditioner is not needed for instrument system operation during or following a BDBEE. Therefore, the design basis environmental conditions are applicable for this component; i.e. 90% relative humidity and 104°F (40 °C) maximum temperature are applicable for this component. The vendor has confirmed that the power conditioner is qualified to operate up to a 104°F (40 °C) temperature environment if the unit's power output is de-rated by 20%. De-rating of this component is documented in electrical evaluations within the SFPI design modification. Therefore, the power conditioner is acceptable for use in this environment.

The hard-line cable system is 10 ft. in length per EC markups 0244.600-013-025 and 0244.600-013-026, has a stainless steel outer jacket, and is radiation-hardened and suitable for the harsh environments in the vicinity of the SFP, as evaluated in Calculation G13.18.9.4-064. Nuclear-grade Raychem heat shrink tubing is used at the transition between the SiO2 cable and the coaxial cable in order to environmentally protect the mating TNC connectors from conditions near the SFP at the new junction box.

The new coaxial cable specified by MOHR Test and Measurement, LLC is a Rockbestos product qualified for Class 1E installations. The cable qualification report concludes the cable is suitable for normal operation and a design basis (LOCA) event at any time throughout its 40 year design life. The environmental conditions this cable has been qualified to envelope the SFP conditions during normal operation, event, and post-event environments and is therefore acceptable.

e. The SFP level instrumentation shall be reliable at the radiation levels expected during normal, event, and post-event conditions for no fewer than seven days post-event or until off-site resources can be deployed according to the mitigating (FLEX) strategies resulting from NRC Order EA-12-049 (Ref. NEI 12-02).

Two calculations were performed to ensure the new SFP level instrumentation will be reliable in the specified post-event radiological environments. Calculations determined the source terms for the radiation sources that are located in the SFP. A shielding evaluation using the calculated source terms derived the dose to the radiation-sensitive components (i.e. probe assembly, hard-line cable system, and the coaxial cable) of the SFP level instrument, and compares this dose to material limits.

f. Independence: The primary instrument channel shall be independent of the backup instrument channel.

The new SFP level instrument channels have cable and raceway that are physically separated from each other according to minimum separation criteria applied for Class 1E redundant circuits as defined in Electrical Independence Design Criteria 240.200 and Electrical Installation Specification 248.000. The new instrumentation is not Class 1E, but the Class 1E separation criteria is applied per the independence requirement of NRC Order EA-12-051 and the guidance in NEI 12-02, Rev. 1 Section 3.5.

The level probes are physically separated from each other at the SFP. The new probes are located adjacent to existing Class 1E narrow-range SFP level instruments. Signals are carried via coaxial cables that share the raceway route of the existing divisional instrument cables from the SFP, through the fuel building, and into the associated divisional piping tunnel. New and existing divisional raceway is used to route the coaxial cables from the piping tunnels, into the control building, and back to the level indicators. The routing of the divisional raceway away from the SFP provides adequate physical separation in accordance with Design Criteria 240.200 and Specification 248.000.

g. Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication

function until offsite resource availability is reasonably assured.

The new SFP level instrumentation is powered from 120/240VAC lighting panels. Each lighting panel is powered from a separate distribution transformer and upstream 480VAC bus. The loss of one instrument's primary power supply will not result in loss of power to both channels in accordance with the guidance provided in NEI 12-02, Rev. 1 Section 3.6. Upon a loss of AC power, both channels will automatically switch power to their permanently installed backup battery supplies; one independent battery enclosure for each channel. The battery supplies are sized to provide power for at least seven days until either normal power can be restored or another source is connected to the system. The batteries are replaceable, and their enclosures are located in close proximity to their respective level indicator panel.

h. Accuracy: The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration.

MOHR Test and Measurement, LLC has developed Engineering Report RBS-IC-13-00009 (Attachment 6.009) to demonstrate by testing that the new SFP level instrumentation will function reliably, without degradation to instrument accuracy and calibration, following a power interruption or change in power source to the backup batteries. The test procedure involved simulating faults and loss of power on the normal 120VAC power input. The Engineering report documents that the MOHR Level Indication System upon power interruption and change to alternate power source (battery enclosure) does not impact the instrument's measurement accuracy or calibration. Therefore, new instrument Channels A and B are in compliance with the regulatory requirements of NRC Order EA-12-051, Section 1.7.

i. Testing: The instrument channel design shall provide for routine testing and calibration.

The MOHR Level Indication System is a microprocessor based instrument (signal processor is located within the level indicator) that performs continuous system auto-calibration. The system includes diagnostic and calibration features that are accessible at the level indicator. Instructions for performing routine testing and calibration of the level instrumentation have been provided by the vendor. The instrument probes are capable of being calibrated without being removed from the fuel pool. The new SFP level instrumentation is installed in accordance with the testing guidance provided in NEI 12-02, Rev. 1 Section 3.8, and the system is in compliance with the regulatory requirements of NRC Order EA-12-051, Section 1.8.

j. Display: Trained personnel shall be able to monitor the SFP water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of SFP water level.

The remote SFP level indicators are located adjacent to each other in the control building (98'-0" elevation). This location is not within the main control room or at the remote shutdown panels. However, the location selected is appropriate and accessible based on the guidance provided and is evaluated as follows:

- The location was been approved by Operations. The SFP displays are located in the vicinity of the Division 2 remote shutdown panel, and are thus promptly accessible.

- The control building is a seismic category 1 structure that provides robust engineered barriers to the external environment. It is widely separated from the fuel building.
- The control building is outside the radiologically controlled area of the plant during normal operation.

The new SFP level instrumentation is, thus, installed in accordance with the display guidance provided in NEI 12-02, Rev. 1 Section 3.9, and is in compliance with the regulatory requirements of NRC Order EA-12-051, Section 1.9.

2. In accordance with NRC Order EA-12-051, the SFP instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:

   a. Training: Personnel shall be trained in the use and the provision of alternate power to the primary and backup instrument channels.

   Operations personnel have been trained in the use of the primary and backup instrument channels, including the provision for connecting alternate power, in accordance with the requirements of NRC Order EA-12-051, Section 2.1 and the guidelines presented in NEI 12-02, Section 4.1.

   b. Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup SFP instrument channels.

   Procedures have been developed for the testing, calibration, and use of the primary and backup instrument channels in accordance with the requirements of NRC Order EA-12-051, Section 2.2 and the guidelines presented in NEI 12-02, Section 4.2. These procedures were developed considering the relationship to existing beyond-design-basis procedures such as AOP-0050 and new BDBEE mitigation (FLEX) procedures. Also, the new SFP level instrument procedures specify the use of a portable power source for the instruments as required by Section 1.6 of NRC Order EA-12-051. Vendor instructions for connecting the portable power source have been provided.

   c. Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup SFP level instrument channels to maintain the instrument channels at the design accuracy.

   Processes have been established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy in accordance with the requirements of NRC Order EA-12-051, Section 2.3 and the guidelines presented in NEI 12-02, Section 4.3. Vendor instructions for testing and calibration have been provided in the Operators Manual and/or Technical Service Manual.

References

1. NRC Order Number EA-12-051, Order Modifying Licenses with Regard to Reliable SFP Instrumentation, dated March 12, 2012 (ML12054A682)

2. OIP in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable SFP Instrumentation (Order Number EA-12-051), dated February 28, 2013 (RBG-47328) (ML13066A509)

3. RAI for the OIP in Response to the Commission Order Modifying Licenses with Regard to Requirements for Reliable SFP Instrumentation (Order Number EA-12-051), dated July 3, 2013, (ML13179A193)

4. Response to RAI, dated July 25, 2013 (RBG-47374)(ML13217A092)

5. First Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable SFP Instrumentation (Order Number EA-12-051), dated August 28, 2013 (RBG-47385)(ML13247A416)

6. River Bend Station – Unit 1, ISE and RAI Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable SFP Instrumentation (TAC NO. MF0953), dated November 25, 2013 (ML13316C065)

7. Second Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable SFP Instrumentation (Order Number EA-12-051), dated February 26, 2014 (RBG-47444) (ML14064A263)

8. Third Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable SFP Instrumentation (Order Number EA-12-051), dated August 28, 2014 (RBG-47501)(ML14253A209)

9. Fourth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable SFP Instrumentation (Order Number EA-12-051), dated February 25, 2015 (RBG-47543)(ML15062A031)

10. NRC Order Number EA-12-049, Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for BDBEEs, dated March 12, 2012 (ML12054A736)

11. River Bend Station, Unit 1 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (TAC No. MF0952 and MF0953) (ML15026A645)

12. RBS-IC-13-00002, MOHR SFP-1 Level Probe Assembly Materials Qualifications Report

13. RBS-IC-13-00008, MOHR EFP-IL SFPI System Boric Acid Deposition Report

14. RBS-IC-13-00003, MOHR EFP-IL SFPI System Temperature and Humidity Test Report

15. RBS-IC-13-00009, MOHR EFP-IL SFPI System Power Interruption Report

Attachment 2 to
RBG-47570

NRC Requests for Information

NRC Requests for Information

As stated in Attachment 1, Entergy submitted the Overall Integrated Plan (OIP) for River Bend Station by Reference 2 of this attachment.

By Reference 3 of Attachment 1 the NRC provided requests for additional information (RAIs) for the OIP. Entergy provided responses to the RAIs by Reference 4.

By Reference 6 of Attachment 1, the NRC provided its interim staff evaluation (ISE) and requested additional information necessary for completion of the review. Entergy provided responses to these ISE RAIs by References 7, 8, and 9 of Attachment 1 with Reference 8 of Attachment 1 referring to a preliminary bridging document on the ePortal and Reference 9 of Attachment 1 referring to a final bridging document uploaded to the ePortal September 30, 2014. This final bridging document uploaded to the ePortal on September 4, 2014 is being provided below.

One exception to a previous RAI response is being taken. On July 3, 2013, NRC issued RAI for the OIP in Response to the Commission Order Modifying Licenses with Regard to Requirements for Reliable SFP Instrumentation (Order Number EA-12-051), dated July 3, 2013, (ML13179A193). Item No. 11.b of that request for additional information was "Please provide a description of how the guidance in NEI 12-02 Section 4.3 regarding compensatory actions for one or both non-functioning channels will be addressed." The RBS response, submitted on July 25, 2013 (ML13217A092), was as follows:

> "Both primary and backup SFPI channels incorporate permanent installation (with no reliance on portable, post-event installation) of relatively simple and robust augmented quality equipment. Permanent installation coupled with stocking of adequate spare parts reasonably diminishes the likelihood that a single channel (and greatly diminishes the likelihood that both channels) is (are) out-of-service for an extended period of time. Planned compensatory actions for unlikely extended out-of-service events are summarized as follows:

No. of channels out of service	Required Restoration Action	Compensatory Action if Required Action Not Completed Within Specified Time
1	Restore channel to functional status within 90 days (or if channel restoration not expected within 90 days, then proceed to Compensatory Action	Immediately initiate action in accordance with Note below.
2	Initiate action within 24 hours to restore one channel to functional status, and restore one channel to functional status within 72 hours.	Immediately initiate action in accordance with Note below.

> NOTE: Present a report to the on-site safety review committee within the following 14 days. The report shall outline the planned alternate method of monitoring, the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status."

The RBS Technical Requirements Manual has been revised to add a new section for the spent fuel pool instrumentation. The final form of that TRM does not include the Note regarding a report to the on-site safety review committee. The TRM revision was developed in conformance with the guidance of NEI 12-02, which does not include such a requirement.

RBS Bridging Document Between Vendor Technical Information and Licensee Use Based on NRC Staff Requests for Additional Information (RAIs) and NRC Vendor Audit

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
1	Design Specification	SFPI Requirements derived from References 1, 2, and 3	References 4-13, 18, 19, 28, 32, and 37			Evaluation of vendor information is within the scope of engineering change (EC) package 44964 (Reference 35).
2	Test Strategy	Per Requirements in References 1, 2, and 3	References 4, 6-13, 18, 19, 28, 32, and 37			The equipment testing performed for the SFPI has been found to be acceptable based on the current design requirements.
3	Environmental Qualification for Electronics Enclosure with Display	60-130°F (References 1, 2, and 29)	Reference 4		14-131°F	The display/processors will be located on the 98' elevation in the Control Building. Calculation G13.18.12.4-038 (Reference 29) credits operator actions to open the switchgear room doors to allow heat to dissipate throughout the 98' elevation of the Control Building. The maximum temperature in any of the switchgear rooms is 130°F. The temperature in the areas outside the switchgear rooms is bounded by the maximum switchgear room temperature, so 130°F is a conservative exposure temperature for the sensor electronics. The SFPI vendor, MOHR, has successfully tested its sensor electronics to a nominal temperature range of 14°F to 131°F. The sensor electronics is capable of continuously performing its required function under the expected temperature conditions. Results of the vendor testing are available in proprietary MOHR Report 1-0410-1 Rev. 0 (Reference 4), MOHR EFP-IL SFPI System Temperature and Humidity Report.

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
		5-95% RH	Reference 4		5-95% RH	The SFPI vendor, MOHR, has successfully tested its system electronics to operate in a humidity range of 5% to 95% relative humidity. Results of the vendor testing are available in proprietary MOHR Report 1-0410-1, MOHR EFP-IL SFPI System Temperature and Humidity Report (Reference 4). Humidity on the Control Building 98' elevation is normally regulated by the Control Building HVAC system. During an extended loss of AC power, the Control Building HVAC system is no longer available. In this situation the relative humidity is expected to drop, because the heat loads in the Control Building 98' elevation are dominated by the sensible heat of electrical equipment. According to a psychrometric chart, an increase in the dry bulb temperature (due to sensible heat gain) results in a decrease in relative humidity, given a constant mass of water per mass of air (humidity ratio). Because the FLEX strategy does not require outside air to be circulated into the Control Building 98' elevation level (Reference 29) the humidity is not expected to rise to levels that challenge the operation of the SFPI instrumentation. Therefore, the operational humidity range of 5% to 95% encompasses all expected conditions for the SFPI display location. The sensor electronics is capable of continuously performing its required function under the expected humidity conditions.
		No radiation effects			N/A	Acceptable, the 98' elevation of the Control Building is considered a mild environment with no expected radiation. According to calculation G13.18.9.4*022 Rev. 2 (Reference 41, Table 77 and Table 80), the

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
						current Environmental Design Criteria (EDC) normal dose conditions to the switchgear area where the display will be located are identical to the conditions in the control room. No additional testing is required per NRC Audit Report for MOHR (Reference 40).
4	Environmental Testing for Level Sensor components in SFP area-Submerged Portion of Probe Body	40-212°F (References 1, 2, and 14)	Reference 5	RAD TID is the total 40 yr dose plus the 7 day worst case accident dose at the lowest spacer location on the Probe body	480°F long-term for PEEK Insulators	The NRC Audit Report for MOHR (Reference 40) concludes that the SFP-1 probe is suitable for operation in the SFP environment. The SFP is expected to remain at or above the minimum ambient temperature of the Fuel building (40°F) as called out in UFSAR (Reference 15) Table 9.4-1. Maximum accident condition of the spent fuel pool is taken to be 212°F boiling water/steam at atmospheric pressure. Based on the vendor analysis results, the sensitive materials in the probe body will not be challenged under the required conditions of References 1, 2, and 14, and are acceptable.
		Submerged Component (References 1 and 2)	Reference 5		PEEK Insulators capable of long term submergence	
		1.23E9 rad TID (References 1, 2, and 16)	Reference 5		10 Grad for PEEK Insulators	The NRC Audit Report for MOHR (Reference 40) concludes that the SFP-1 probe is suitable for operation in the SFP environment. Calculation G13.18.9.4-064 (Reference 16) defines the worst case dose of approximately 1.23E9 rad to the probe via the applicable requirements of References 1 and 2. As such, the PEEK spacers are suitable for the application.
5	Environmental Testing for Level Sensor Electronics Housing-Probe	40-212°F (References 1, 2, and 14)	Reference 5	Rad TID is the total 40 yr dose plus the 7 day worst case accident	PEEK: 480°F EPDM: 194°F long-term, 12 day @ 311°F Sylgard 170:	The NRC Audit Report for MOHR (Reference 40) concludes that the SFP-1 probe is suitable for operation in the SFP environment. The SFP area is expected to remain at or above the

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
	Head located Above the SFP			dose at the location	392°F long-term	minimum ambient temperature of the Fuel Building (40°F) as called out in the UFSAR (Reference 14) Table 9.4-1. Maximum accident condition temperature and humidity directly above the spent fuel pool is taken to be a condensing steam environment which conservatively will be no greater than 212°F, the temperature of boiling water at atmospheric pressure. Based on the vendor analysis results the sensitive materials in the probe head will not be challenged under the required conditions of References 1, 2, and 14, and are acceptable. For coaxial transmission cable beyond the Probe Head, MOHR uses Class 1E Nuclear Safety Related RSCC Wire & Cable RSS-6-110A/LE which meets the requirements of Institute of Electrical and Electronic Engineers (IEEE) 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations" and is acceptable (Reference 40).
		0-100% RH Condensing (References 1 and 2)	Reference 5		0-100% RH for PEEK, EPDM and Sylgard 170	The NRC Audit Report for MOHR (Reference 40) concludes that the SFP-1 probe is suitable for operation in the SFP environment. 100% non-condensing RH is a conservative humidity range for normal operating conditions. Based on the vendor analysis results, the sensitive materials in the probe head will not be challenged under the required conditions of References 1 and 2 and are acceptable.
		9.25E+07 rad TID	Reference 5		PEEK: 10 Grad	The NRC Audit Report for MOHR (Reference 40) concludes that the SFP-1 probe is suitable for

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		(Reference 16)			EPDM: 2 Grad Sylgard 170: 200 Mrad	operation in the SFP environment. G13.18.9.4-064 (Reference 17) defines a worst case dose of approximately 9.25E+07 rad TID. Based on the vendor analysis results, the sensitive materials in the probe head will not be challenged under the required conditions of References 1, 2, and 16, and are acceptable.
6	Thermal and Radiation Aging-organic components in SFP area	See Topics #4 and 5 above	Reference 5		See above Topics #4 and 5	Acceptable, vendor test/analysis bound licensee parameters, see discussion above in Topics #4 and 5.
7	Basis for Dose Requirement	References 1 and 2	N/A			Entergy Calculation Procedure EN-DC-126 (Reference 15) was used to develop Calculation G13.18.9-4-063 (Reference 33) and G13.18.9-4-064 (Reference 16) based on the requirements of NEI 12-02 (Reference 2) and EA-12-051 (Reference 1). The calculations determine conservative source terms and dose rates at key instrument locations for both a 7 day accident scenario and 40-year TID.
8	Seismic Qualification	Seismic Class I (References 1, 2, 3, and 14)	References 8, 11, and 12		Seismic Class 1	Acceptable, MOHR has prepared a site specific seismic analysis which bounds RBS's seismic criteria. The qualification report envelops all components of the new SFP level instrumentation required to be operational during a BDBEE and post-event. This document is MOHR Report 1-0410-9.21 (Reference 12). MOHR Reports 1-0410-6 (Reference 8) and 1-0410-9 (Reference 11) are also available for review. Calculations G13.18.1.3-040 (Reference 30) and G13.18.1.3-041 (Reference 31) account for seismic

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						loads and show that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified as all Interaction Ratios (IR) are less than one (1.0).
9	Sloshing	Water induced motion from seismic event does not cause equipment structural failure	References 11, 12, 17, 18, and 19	See Topic #8		Acceptable, the MOHR seismic qualification reports (References 8, 11, and 12) in combination with NAI Report # NAI-1725-003 (Reference 17), NAI Report #NAI-1725-0004 (Reference 19) and RBS site specific NAI Report #NAI-1791-004 (Reference 18) adequately bound the hydrodynamic loads associated with sloshing for RBS. Calculation G13.18.1.3-041 (Reference 31) accounts for sloshing and shows that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified as all Interaction Ratios (IR) are less than one (1.0). The NAI documents (References 18 and 19) are used as input to the bracket design. Reference 31 is available on the e-portal for review.
10	Spent Fuel Pool Instrumentation System Functionality	System must allow for routine, in situ functionality	References 25, 26, and 27			The system features on board electrical diagnostics. SFPI channel/equipment maintenance/preventative maintenance and testing program requirements to ensure design and system readiness will be established in accordance with Entergy's processes and procedures and in consideration of vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance is performed (and available for inspection and audit). The instrument automatically monitors the integrity of its level measurement system using in-situ capability. Revision 0 of the manuals have been provided by the

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						vendor (References 25, 26, and 27) for use, although it is possible these could be amended in the future based on installation experience.
11	Boron Build-Up	Buildup cannot produce error greater than 1' including all other error source terms (References 1 and 2)	Reference 10		Boron buildup can produce a maximum error of 2.5 inches	Acceptable, MOHR Report 1-0410-8 (Reference 10) concludes that the presence of borated water and/or boric acid deposits will not significantly impair the ability of the MOHR EFP-IL SFPI system to accurately measure water level in the SFP environment. Regardless of these findings, RBS is a BWR and does not use borated water in their SFP. Previous Topic #10 already discusses maintenance / preventative maintenance requirements being established in consideration of vendor recommendations (which includes and bounds those associated with boron build-up). Similarly, Topic #20 below discusses overall calibration or channel functional testing methodology expected to be based on vendor stated accuracy along with comparison of SFPI channels to actual pool level (which would also bound boron build-up effects specified in Reference 40). Visual inspection and/or wash down of the probe assembly could be initiated by accuracy requirements or routine inspection. The probe head assembly includes a connection mechanism for flushing water to remove boron build-up as may be needed. Alternatively, the SFP water level can be raised until it covers and dissolves the boric acid deposit (Reference 27).
12	Pool-side Bracket Seismic Analysis	Seismic Class I (References 1, 2, and 14)	References 11 and 12	See Topic #8	Seismic Class I	Calculation G13.18.1.3-041 (Reference 31) shows that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified as all Interaction

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	(References 1, 2, and 14)					Ratios (IR) are less than one (1.0). Reference 31 is available on the e-portal for review.
13	Additional Brackets (Sensor Electronics and electronics Enclosure	Seismic Class I (References 1, 2, 3, and 14)	Reference 8	See Topic #8	Seismic Class I	Calculation G13.18.1.3-040 (Reference 30) shows that all electrical equipment supports have been qualified. Reference 30 is available on the e-portal for review.
14	Shock and Vibration	(References 1, 2, 3) MIL-STD-167-1 (Reference 23) for vibration and MIL-STD-901D (Reference 24) for shock	References. 7, 11, 12, and 37		IEC 60068-2-27 (2008-02) (Reference 20) IEC 60068-2-6 (2007-12) (Reference 21)	The NRC Audit Report for MOHR (Reference 40) concludes that the shock and vibration test results were satisfactory. The report also acknowledges that the testing performed in MOHR Report 1-0410-16 (Reference 37) is sufficient to close the open item identified during the MOHR audit. Acceptable, the vendor testing provided adequately addresses the requirements for general robustness of the enclosures. The probe and repairable head are essentially a coax cable system that is considered inherently resistant to shock and vibration. The probes and repairable head are evaluated to be adequately designed for resilience against shock and vibration (Reference 37). The new probe mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. The probes will be affixed to the bracket using a machine screw connection with proper thread engagement and lock washers. The indicator and battery enclosures will be mounted

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						on the 98' elevation in the Control Building. The equipment is not affixed or adjacent to any rotating machinery that would cause vibration effects in the area of installation. The new instrument mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. Similarly, the effects of shock on the supporting fixtures for the instruments is not a credible threat; all equipment is qualified seismically such that there are no expected impacts from adjacent objects during the BDBEE or design basis earthquake requirements imposed by NEI 12-02. Even though shock and vibration is not credible for this equipment, it is adequately addressed by vendor test reports.
15	Requirements Traceability Matrix	Software Traceability Matrix Required for Software Evaluation of equipment	Reference 28			The instrument software Verification and Validation was performed by MOHR per Revision 2 of MOHR Report 1-0410-11 (Reference 28).
16	Factory Acceptance Test	Must demonstrate functionality of full EFP-IL and SFP-1	MOHR FAT Procedure			Acceptable channel factory acceptance tests have been completed successfully.
17	Channel Accuracy	+- 1 foot (Reference 2)	References 25 and 38		3.0 in max, not including boric acid deposition or boiling effects	Appendix A of Reference 25 states that the absolute accuracy is 76.2 mm or 3.0 in, not including boric acid deposition effects. This error complies with the limit of ± 1 foot set by NEI 12-02 (Reference 2). See Topic #11 for boric acid deposition effects.

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						Additionally, the probe is designed to produce accurate level indication in boiling and frothing (multiphase) environments (Reference 38).
18	Power consumption	120 VAC, 60 Hz	References 9, 13, and 36		85-264 VAC 47-63 HZ Maximum 18.83 W, average 11.48 W	The NRC Audit Report for MOHR (Reference 40) concludes that no deficits were identified with respect to function reliability, accuracy, or calibration as a result of power interruption. Acceptable, the power requirements for the instrument are met by the power supplies that will provide normal AC power to the units.
		7 day battery life required	Reference 9		7 day battery life @ 15 samples per hour rate	The NRC Audit Report for MOHR (Reference 40) concludes that battery life capability is satisfactory. Acceptable, the instrument testing demonstrates the battery capacity is sufficient for the maximum duration required by References 1 and 2.
19	Technical Manual	N/A	References 26 and 27			Revision 0 of the manuals have been provided by the vendor (References 26 and 27) for use, although it is possible these could be amended by the vendor in the future based on installation experience.
20	Calibration	Must allow for in-situ calibration	References 25, 26, and 27	System is calibrated using CT-100 device and processing of scan files by vendor. Dry scan from original installation		Revision 0 of the manuals have been provided by the vendor (References 25, 26, and 27) for use, although it is possible these could be amended by the vendor in the future based on installation experience. Previous Topic #10 already discusses maintenance / preventative maintenance requirements being established in consideration of vendor recommendations. Overall calibration or channel functional testing

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				must be maintained		methodology is expected to be based on vendor stated accuracy and to incorporate a comparison of SFPI channels to actual pool level as well as a SFPI cross channel comparison.
21	Failure Modes and Effects Analysis (FMEA)	System provides reliable indication of fuel pool level, consistent with the requirements of References 1 and 2	Reference 39		SFPI system will meet requirements of References 1 and 2 when installed as required	Acceptable, the FMEA provided (Reference 39) adequately addresses failure modes and effects for the full instrument channel with credit taken for the use of two redundant channels provided the installation meets all requirements stipulated in References 1 and 2.
22	Emissions Testing	EPRI TR-102323, Rev 3 (Reference 22)	Reference 6		EPRI TR-102323, Rev 3 (Reference 22)	Acceptable, MOHR reports 1-0410-4 (Reference 6) and 1-0410-4-S1 (Reference 32) demonstrate the new SFPI satisfies the EMI/RFI compliance guidelines of Revision 3 of EPRI TR-102323 (Reference 22) in accordance with Entergy Engineering Standard EN-IC-S-004-MULTI (Reference 34). As demonstrated in the MOHR System EMC Test Report and Supplemental Information (References 6 and 32), the SFPI system passed the High Frequency Radiated and Conducted Emissions testing. FLEX Strategy Guidelines (FSG) governing the use of the SFPI are expected to include a cautionary statement to preclude radio usage within close proximity to the displays.

Spent Fuel Pool Instrumentation Order (EA-12-051)
Bridging Document Between Vendor Technical Information and Licensee Use
Based on NRC Staff Requests for Additional Information (RAIs) and NRC Vendor Audit

References:

1. ML12054A682, NRC Order EA-12-051, "ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE SPENT FUEL POOL INSTRUMENTATION", Nuclear Regulatory Commission, March 12, 2012
2. ML12240A307, NEI 12-02 (Revision 1, "Industry Guidance for compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" August, 2012.
3. ML12221A339, Revision 0, JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, August 29, 2012, Nuclear Regulatory Commission Japan Lessons-Learned Project Directorate.
4. 1-0410-1 "MOHR EFP-IL SFPI System Temperature and Humidity Test Report"
5. 1-0410-2 "MOHR SFP-1 Level Probe Assembly Materials Qualification Report"
6. 1-0410-4 "MOHR EFP-IL SFPI System EMC Test Report"
7. 1-0410-5 "MOHR EFP-IL SFPI System Shock and Vibration Test Report"
8. 1-0410-6 "MOHR EFP-IL SFPI System Seismic Test Report"
9. 1-0410-7 "MOHR EFP-IL SFPI System Battery Life Report"
10. 1-0410-8 "MOHR EFP-IL SFPI System Boric Acid Deposition Report"
11. 1-0410-9 "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report"
12. 1-0410-9.21 "MOHR SFP-1 Site-Specific Seismic Analysis Report: River Bend Station (RBS)"
13. 1-0410-10 "MOHR EFP-IL SFPI System Power Interruption Report"
14. UFSAR, Rev 24, "Riverbend Updated Final Safety Analysis Report"
15. EN-DC-126, Rev 5, "Engineering Calculation Process"
16. G13.18.9.4-064, Rev 0, "Beyond Design Basis Spent Fuel Pool Instrumentation Dose Calculation"
17. NAI-1725-003, Rev 0, "GOTHIC Verification and Sensitivity Studies for Predicting Hydrodynamic Response to Acceleration in Rectangular Shaped Pools"
18. NAI-1791-004, Rev 0 "RBS GOTHIC Hydrodynamic Analysis"
19. NAI-1725-004, Rev 3 "Seismic Induced Hydraulic Response in the CGS Spent Fuel Pool"
20. IEC 60068-2-27 (2008-02) "Environmental Testing-Part 2-27: Tests-Test Ea and Guidance: Shock"
21. IEC 60068-2-6 (2007-12) "Environmental Testing-Part 2-6: Tests-Test Fc: Vibration (sinusoidal)"
22. EPRI TR-102323, Rev. 3, "Guidelines for Electromagnetic Interference of Power Plant Equipment"
23. MIL-STD-167-1 "Mechanical Vibrations of Shipboard Equipment (Type 1-Environmentally and Type II-Internally Excited)"
24. MIL-S-901D "Shock Tests H.I.(High Impact) shipboard Machinery, Equipment, and Systems, Requirements for"

25. 1-0410-12 "EFP-IL Signal Processor Operator's Manual "
26. 1-0410-13 "EFP-IL Signal Processor Technical Manual"
27. 1-0410-14 "SFP-1 Level Probe Assembly Technical Manual"
28. 1-0410-11 "MOHR EFP-IL SFPI System Software Verification and Validation"
29. G13.18.12.4-038, Rev. 0, "River Bend Station Standby Switchgear Rooms: A, B, and C Heat up for Extended Loss of AC Power"
30. G13.18.1.3-040, Rev. 0, "SFPI Electrical Equipment Support Qualification"
31. G13.18.1.3-041, Rev. 0, "SFPI Probe Mounting Bracket Design"
32. 1-0410-4-S1 "MOHR EFP-IL SFPI Supplemental EMC Information"
33. G13.18.9.4-063, Rev. 0, "Beyond Design Basis Spent Fuel Pool Instrumentation Source Term Calculation"
34. EN-IC-S-004-MULTI, Rev. 001, "EMI/RFI Design Considerations"
35. EC 44964, Rev. 0
36. MOHR drawing 1-0430-20, "EFP-IL System Electrical Diagram"
37. 1-0410-16, "MOHR SFP-1 Level Probe Assembly Shock and Vibration Test Report
38. 1-0410-15, "MOHR-EFP-IL SFPI System Uncertainty Analysis"
39. EVAL-194-4812-01 "MOHR EFP-IL Liquid Level Measurement System Failure Modes and Effects Analysis (FMEA)"
40. Donald C. Cook Nuclear Plant, Units 1 and 2 - Report for the Onsite Audit of MOHR Regarding Implementation of Reliable Spent Fuel Pool Instrumentation Related to Order EA-12-051 (TAC NOS. MF0761 and MF0762) dated August 27, 2014 (ADAMS Accession No ML14216A362)
41. G13.18.9.4*022, Rev. 2, "Environmental Design Criteria (EDC) Radiation Zone Dose Rates and Doses (Normal, Abnormal, and Accident)"