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PSEG
Nuclear LLC

Order EA-12-051

LR-N15-0239
JAN 25 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Salem Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: Salem Generating Station Unit 2 Compliance with March 12, 2012 NRC Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) and Responses to Requests for Additional Information for Salem Units 1 and 2

References:

1. NRC Order Number EA-12-051, "Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012

2. PSEG Letter LR-N14-0237 dated January 15, 2015, "Salem Generating Station Unit 1 Compliance with March 12, 2012 NRC Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) and Responses to Requests for Additional Information for Salem Units 1 and 2"

3. NRC Letter, "Salem Nuclear Generating Station, Units 1 and 2 - Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC NOS. MF0913 AND MF0914)," dated October 17, 2013

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Order EA-12-051 (Reference 1), Attachment 2 of which establishes requirements for reliable spent fuel pool level instrumentation (SFPLI) for operating reactors and construction permit holders. PSEG affirmed NRC Order EA-12-051 compliance for Salem Generating Station (SGS) Unit 1 by letter dated January 15, 2015 (Reference 2).

Attachment 1 provides a summary of SGS Unit 2 compliance with the requirements of NRC Order EA-12-051 in accordance with Condition IV.C.3 of the Order. Attachment 2 provides responses to NRC requests for additional information in Reference 3, consistent with implementation of NRC Order EA-12-051 at SGS Units 1 and 2.

There are no regulatory commitments contained in this letter.

If you have any questions or require additional information, please do not hesitate to contact Ms. Tanya Timberman at 856-339-1426.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on January 25, 2016
(Date)

Sincerely,

John F. Perry
Site Vice President
Salem Generating Station

Attachment 1 – Salem Generating Station Unit 2 Compliance with NRC Order EA-12-051 Requirements for Reliable Spent Fuel Pool Level Instrumentation

Attachment 2 – Salem Generating Station Units 1 and 2 Response to Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation

cc: Mr. Daniel Dorman, Administrator, Region I, NRC
Ms. Carleen Parker, Project Manager, NRC
Mr. John Boska, Project Manager, NRC
Mr. Patrick Finney, NRC Senior Resident Inspector, Salem
Mr. Patrick Mulligan, Chief, NJBNE
Mr. Thomas Cachaza, Salem Commitment Tracking Coordinator
Mr. Lee Marabella, PSEG Corporate Commitment Coordinator

(The bcc list should not be submitted as part of the DCD submittal - remove this page prior to submittal and make the bcc distribution accordingly)

bcc: President and Chief Nuclear Officer
Senior Vice President and Chief Operating Officer
Site Vice President - Salem
Plant Manager - Salem
Executive Director – Corporate Services
Director - Nuclear Oversight
Director - Regulatory Affairs
Director – Regulatory Compliance
BDB Response Manager
Manager - Licensing
Document Control

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Attachment 1

Salem Generating Station Unit 2 Compliance with NRC Order EA-12-051 Requirements for Reliable Spent Fuel Pool Level Instrumentation

Salem Generating Station Unit 2 Compliance with NRC Order EA-12-051 Requirements for Reliable Spent Fuel Pool Level Instrumentation

Order Requirement

"All licensees identified in Attachment 1 to this Order 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 spent fuel pool operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred."

Salem Unit 2 Compliance

Salem Unit 2 has installed instrumentation to provide reliable indication of spent fuel pool (SFP) water level. The instrument range encompasses the three levels cited above in the Order requirement.

Order Requirement

1. "The spent fuel pool level instrumentation shall include the following design features:"

1.1 "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. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool."

Salem Unit 2 Compliance

The spent fuel pool level instrumentation (SFPLI) consists of a primary and backup channel, both of which are permanent, fixed instrument channels.

Order Requirement

1.2 "Arrangement: The spent fuel pool 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 spent fuel pool. 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 spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure."

Salem Unit 2 Compliance

The SFPLI is provided with reasonable protection from missiles that may result from damage to the structure over the SFP. Protection is provided by separation and inherent protection within the Seismic Class I Fuel Handling Building (FHB).

Order Requirement

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

Salem Unit 2 Compliance

The SFPLI mounting has been designed using the Salem Generating Station (SGS) criteria for Seismic Category I components.

Order Requirement

1.4 "Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool 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)."

Salem Unit 2 Compliance

The SFPLI is designed to provide reliable operation at temperature, humidity and radiation levels consistent with beyond design basis (BDB) conditions using the NRC-endorsed guidance of NEI 12-02, and is subject to the SGS augmented quality process.

Order Requirement

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

Salem Unit 2 Compliance

Each SFPLI channel is independent of the other, consisting of separate sensor probes and electronics packages.

Order Requirement

1.6 "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."

Salem Unit 2 Compliance

The SFPLI primary and backup channels are permanently installed and powered from separate power supplies. Each channel is powered from a separate vital instrument bus with uninterruptible power supply (UPS). Each channel has replaceable battery backup in the event of a loss of vital instrument bus or UPS. The SFP level instrument system provides at least seven days of battery life assuming typical use and accounting for postulated post-event environmental conditions.

Order Requirement

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

Salem Unit 2 Compliance

The SFPLI channels maintain their accuracy following the transition from normal AC power to the battery backup, as demonstrated by power interruption testing.

Order Requirement

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

Salem Unit 2 Compliance

The SFPLI design supports routine testing and calibration.

Order Requirement

1.9 "Display: Trained personnel shall be able to monitor the spent fuel pool 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 spent fuel pool water level."

Salem Unit 2 Compliance

The SFPLI primary and backup instrument channel displays are located in the Auxiliary Building Relay Room, which is located one elevation below the Main Control Room (MCR) and is easily accessible. The SFPLI is designed to provide continuous or on-demand indication of SFP water level.

Order Requirement

2. "The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:"

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

Salem Unit 2 Compliance

SGS personnel participated in training provided by the SFPLI vendor, and applied the systematic approach to training for operations, maintenance, and technical staff.

Order Requirement

2.2 "Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup spent fuel pool instrument channels."

Salem Unit 2 Compliance

The SFPLI is subject to SGS procedures and processes for the testing, calibration, and use of the primary and backup channels.

Order Requirement

2.3 "Testing and Calibration: Processes shall be 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."

Salem Unit 2 Compliance

The SFPLI primary and backup channels are subject to SGS preventive maintenance (PM) processes for scheduling and implementing testing and calibration activities to maintain the channels at their design accuracy.

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Attachment 2

Salem Generating Station Units 1 and 2 Response to Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, "Reliable Spent Fuel Pool Instrumentation"

SGS Units 1 and 2 Response to Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, "Reliable Spent Fuel Pool Instrumentation"

Section 3.2 Spent Fuel Pool Water Levels

Background to RAI #1

The Interim Staff Evaluation (ISE) states, in part,

> The NRC staff notes that the licensee provided information indicating that the selection of Level 1 at 124 ft. 8 in. is the level at which reliable suction loss occurs. The staff also notes that the licensee stated that the current elevation for Level 1 is greater than the level where the NPSHA equals NPSHR, which is sufficient for ensuring NPSH for the coolant pumps. However, the licensee did not provide the basis for its assertion that 124 ft. 8 in. represents an elevation that is greater than the elevation corresponding to the 16 ft. of net positive suction head required at saturated conditions for these pumps. The staff has identified this request as:

RAI #1

> Please provide the elevation obtained as a result of the NPSHA calculation derived from Reference 8 to the August 12, 2013, letter (S-C-SF-MDC-1040- "NPSH for Spent Fuel Pool Pumps - SF [spent fuel] System (Salem 1 and 2)").

PSEG Response to RAI #1

> For Salem Generating Station (SGS) Units 1 and 2, the selection of level 1 is based on the level at which reliable suction loss occurs due to uncovering of the coolant suction pipe. The centerline of the spent fuel pool (SFP) cooling pump suction pipe where it enters the pool is at elevation 124 ft. 8 in. and the centerline of the pump suction is at elevation 85 ft. 6 1/4 in. This represents a static head of 39 ft. 1 3/4 in. At saturated conditions, with SFP water level at centerline of the suction pipe, the lowest available NPSH ($NPSH_A$) is calculated to be 25.1 ft., which is greater than the minimum required NPSH ($NPSH_R$) of 16 ft. as specified by the pump manufacturer.

Section 3.4 Design Features: Arrangement

Background to RAI #2

The ISE states, in part,

> The licensee's proposed location of the primary and backup level instruments for both of its SFPs appears to be consistent with the guidance.
>
> In its letter dated August 12, 2013, the licensee provided a figure RAI-2, "Salem Unit 2 Spent Fuel Pool Level Sketch Plan View," depicting the approximate locations for both the primary and backup channel level sensors and the routing of the cables from the SFP to the Main Control Room (MCR). The licensee stated in this letter that Salem Unit 1 is similar to Unit 2. Based on the review of this figure, the NRC staff has concerns regarding the routing of these two channels in accordance with the guidance on channel separation as described in NEI 12-02. The routing of the cables within one corner of the SFP area appears to be in close proximity to one another. The staff has identified this request as:

RAI #2

> Please provide additional information describing how the proposed arrangement of the SFP instrumentation and routing of the cabling between the level instruments, the electronics, and the displays in the MCR meets the Order requirement to arrange the SFP level instrument channels 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.

PSEG Response to RAI #2

> The Salem Unit 2 Spent Fuel Pool Level Sketch Plan View provided in the SGS RAI Response letter dated August 12, 2013 (Reference 1), depicts the approximate locations for both the primary and backup level probes. For SGS Units 1 and 2, both the primary and backup channels are physically separated in accordance with the guidelines provided in NEI 12-02 Revision 1. Specifically, the probes are in different locations of the SFP and separated by a distance comparable to the shortest side of the pool.
>
> The design utilizes standard Salem separation criteria for safety related instruments by following the requirements of the PSEG Technical Standard, “Salem Generating Station Physical Separation Requirements (Electrical)” (Reference 2). The interconnecting cables for the primary and backup channel that extend from the sensor toward the location of the electronics enclosure are installed by routing the cables in separate conduit to a location in the SFP area that allows transitioning from the SFP operating deck to existing conduit embedded in the fuel handling floor concrete. For SGS Units 1 and 2, each Fuel Handling Building is a Seismic Class I structure designed to withstand seismic, flooding and wind events and therefore will inherently provide reasonable protection against external missiles. Additionally, Seismic II/I criteria are applied to components in the Fuel Handling Buildings, providing reasonable protection from internal missiles. The cable is attached to existing Seismic Class I mounting brackets using Seismic Class I supports (not shown on the sketch provided in the

August 12, 2013 letter). The cable is routed in conduit along a concrete wall directly below Seismic Class I ductwork which provides an additional layer of physical protection.

Section 3.5 Design Features: Mounting

Background to RAI #3

The ISE states, in part,

> The NRC staff notes that the licensee's final design is not available for review and that the licensee will provide further information during the August 2014, six-month Overall Integrated Plan (OIP) update. The staff has identified these requests as:

RAI #3

Please provide the following:

a) The design criteria that will be used to estimate the total loading on the mounting device(s), including static weight loads and dynamic loads. Describe the methodology that will be used to estimate the total loading, inclusive of design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.

b) A description of the manner in which the level sensor (and stilling well, if appropriate) will be attached to the refueling floor and/or other support structures for each planned point of attachment of the probe assembly. Indicate in a schematic the portions of the level sensor that will serve as points of attachment for mechanical/mounting or electrical connections.

c) A description of the manner by which the mechanical connections will attach the level instrument to permanent SFP structures so as to support the level sensor assembly.

PSEG Response to RAI #3

a) The design criteria used to estimate total loading, including static and dynamic loads are the SGS safety related design basis for Seismic Category I components in accordance with PSEG Technical Standard “Salem Structural Design Criteria” (Reference 3). The SGS Units 1 and 2 Structural Design Criteria provide both the criteria and the methodology used for determining total loading. The loading on the probe mount and probe body includes both seismic and hydrodynamic loading by utilizing seismic response spectra that bound SGS design maximum seismic loads applicable to the installed locations. The static weight load is accounted for in the analytical model performed by the instrument vendor using the methodology provided in IEEE 344-2004.

b) Each level sensor is mounted to a support structure that is designed to Seismic Category I requirements. Salem is using the Mohr EFP-IL design, which does not include a stilling well. The support structure is anchored to the concrete curb around the SFP above the refueling deck as shown in Figure 1. The anchorage of the level probe mount is analyzed for Seismic Category I requirements in accordance with the SGS Units 1 and 2 structural design criteria (Reference 3), and documented in SGS calculation 6S0-2345 (Reference 4).

c) The level sensor is designed to be attached near its upper end to the Seismic Category I support structure designed specifically to fit the SGS Unit 1 and 2 SFPs as shown in Figure 1.

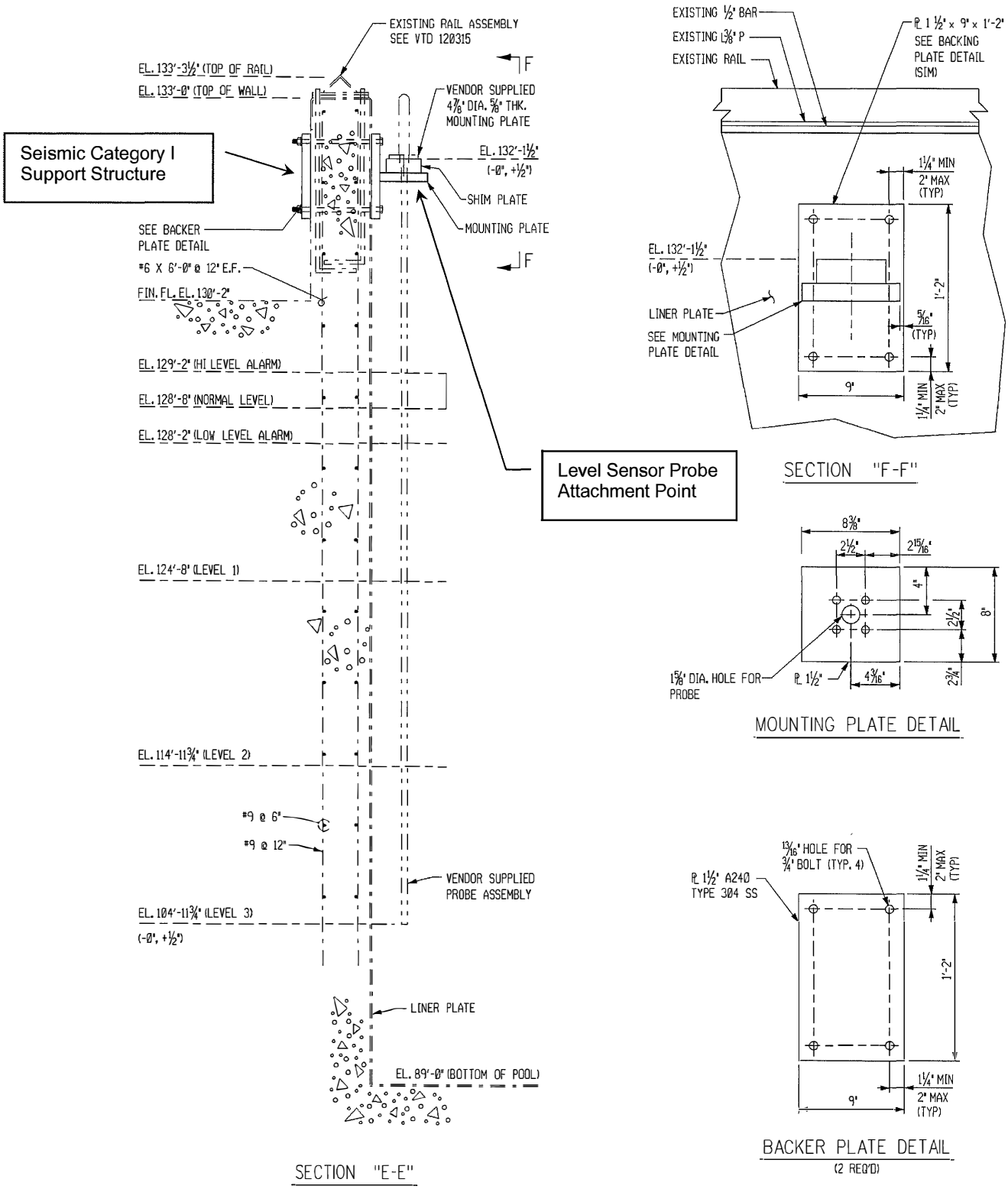

Figure 1 - Typical Mounting Sketch (Not to scale)
Ref: PSEG Drawing 606366

Background to RAI #4 and #5

The ISE states, in part,

> In addition, the staff plans to verify the results of the licensee's seismic testing and analysis when it is completed based on the licensee's response to the following RAI.

RAI #4

> For RAI 3(a) above, please provide the analyses used to verify the design criteria and methodology for seismic testing of the SFP instrumentation and the electronics units, including, design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.

RAI #5

> For each of the mounting attachments required to attach SFP Level equipment to plant structures, please describe the design inputs, and the methodology that was used to qualify the structural integrity of the affected structures/equipment.

PSEG Response to RAI #4

The seismic qualification of the probe has been performed by analysis and testing in accordance with IEEE 344-2004. The results of the analysis and testing are provided by the vendor in their Level Probe Assembly Seismic Analysis Report (Reference 5). The analysis performed in Reference 5 utilized an ANSYS finite element model to dynamically analyze the response of the probe to seismic loads and to determine the loads that will be transmitted to the probe mounting. A detailed computational SFP hydrodynamic model using the GOTHIC computational fluid dynamics code was also used to determine the hydrodynamic loading from pool sloshing.

The electronics and battery packages have been tested to Seismic Category I requirements in accordance with IEEE 344-2004. The spectra used for this testing are substantially greater than the spectra for the Auxiliary Building Relay Room where these packages are installed. The test results are presented in the vendor's EFP-IL SFPI System Seismic Test Report (Reference 6).

PSEG Response to RAI #5

For each mounting attachment required to affix SFP Level equipment to plant structures, the seismic response spectra bounding the SGS design maximum seismic loads applicable to the installed locations are used as the design input to perform the analysis. The SFP level probe assembly is supported by a bracket bolted to the edge of the SFP. SGS calculation 6S0-2345 (Reference 4) demonstrates that the mounting configuration is structurally adequate to meet seismic design requirements, including structural adequacy of the bracket when subjected to seismic and hydrodynamic loads. The electronics, power supply enclosure, and battery boxes are column mounted and the mounting is shown to be structurally adequate in SGS calculation 6S0-2346 (Reference 7).

Section 3.6 Design Features: Qualifications
3.6.2 Post Event Conditions

Background to RAI #6

The ISE states, in part,

> The NRC staff has concerns with the licensee's lack of information regarding radiological conditions where the instrument and its electronic components are going to be installed. The staff has identified this request as:

RAI #6

> Please provide a description of the specific method or combination of methods that will be used to demonstrate the reliability of the permanently installed equipment under BDB radiation conditions. Also, please provide analysis of the maximum expected radiological conditions (dose rate and total integrated dose) to which the equipment located within the Auxiliary Building will be exposed.

PSEG Response to RAI #6

A radiation dose rate analysis was performed to support the radiological assessment requirements defined by NEI 12-02 for the SFP area (Reference 8). The results of the analysis provided dose rates and integrated doses for seven days post-event with SFP water level at NEI 12-02 level 3. The analysis also provided dose rates and integrated doses for 40-year normal operation. The 7-day integrated doses were based on the 100-hour old shutdown core inventories (spent fuel sources) as defined in NEI 12-02. The results from the dose rate analysis (dose rate and total integrated dose) were used as the design criteria supplied to the vendor as part of the PSEG Procurement Specification (Reference 9). Information supplied from the vendor in a material qualification report (Reference 10) was compared to the radiation conditions provided in the dose rate analysis and used as the basis to demonstrate reliability of the permanently installed equipment located in the SFP and surrounding area under the BDB radiation conditions.

The electronic equipment is mounted within the Auxiliary Building Relay Room which is located one elevation below the Main Control Room; this location is also below the elevation of the operating deck in the Fuel Handling area. The maximum post-event dose rates and integrated doses for the SGS postulated Design Basis Accidents (DBA) are assumed to bound any BDB post-event radiation levels (dose rate and total integrated dose) due to the inherent shielding provided from the structures (concrete floors and walls) between the Fuel Handling Building and the Auxiliary Building Relay Room. The maximum post-DBA dose rate of 4.64 rad/hr and total integrated dose of 380 rad is used as the design criteria for the equipment located in the relay room per Table A of the SGS Environmental Design Criteria (Reference 11). The SFP level instrumentation (SFPLI) electronics utilize Commercial-off-the-Shelf (COTS) components containing Complementary Metal Oxide Semiconductor (CMOS) devices which have been found to be capable of withstanding ionizing dose radiation levels of up to 1,000 rad as described in EPRI 1021067 “Nuclear Power Plant Equipment Qualification Reference Manual” Revision 1, and discussed in NRC Regulatory Guide (RG) 1.209, “Guidelines for Environmental Qualification of Safety-Related Computer Based Instrumentation and Control Systems in Nuclear Power Plants.” The

limit of 1,000 rad is used as the basis to demonstrate reliability of the permanently installed electronic equipment located within the Auxiliary Building Relay Room under post-event radiation conditions. With a focus on potential radiation degradation, RG 1.209 indicates that low levels of radiation (< 1000 rads gamma), will not degrade the MOS or integrated circuit family of components. From a hardware standpoint, the radiation susceptibility encompasses the entire electronics of the component, with an emphasis on the weak-link component, in this case both the semi-conductors and the electronics. The SFPLI electronics will be subject to a total integrated dose well below the 1000 rads gamma dose threshold specified in RG 1.209.

Background to RAI #7

The ISE states, in part,

While addressing post-event temperature conditions, the licensee stated in its OIP that post-event temperature at sensors and for cabling located above the SFP is assumed to be 212°F. In its letter dated August 12, 2013, the licensee stated that all equipment located in the fuel handling building will be certified for use, by the manufacturer, for survivability under post-event conditions including temperatures of at least 100°C (212°F). The licensee also stated on this letter that new electronics enclosures will be installed in the Auxiliary Building Relay Room, which is considered a mild environment.

The NRC staff has concerns with the lack of information regarding the ambient temperature in the vicinity where the electronics equipment will be located under normal and worst case postulated conditions. The staff has identified this request as:

RAI #7

Please provide information addressing the maximum expected ambient temperature in the room in which the sensor electronics will be located under BDB conditions in which there is no ac power available to run heating ventilation and air conditioning (HVAC) systems.

PSEG Response to RAI #7

The electronic equipment will be mounted within the Auxiliary Building Relay Room which is located one elevation below the Main Control Room. The Auxiliary Building Relay Room is classified as a mild environment in accordance with SGS Environmental Design Criteria (Reference 11). The maximum temperatures for SGS postulated BDB conditions in which there is no ac power available to run heating ventilation and air conditioning (HVAC) system were calculated utilizing GOTHIC computational code and documented in Vendor Technical Document (VTD) 903061, Attachment A, “Salem Unit 1 and 2 Control Room GOTHIC Model Run to 7 Days,” (Reference 12). The maximum expected ambient temperature in the room where the electronics will be located is not expected to exceed 100° F within three days of an Extended Loss of AC Power (ELAP) event and is not expected to exceed 116° F within seven days of an ELAP.

Information supplied in a system temperature and humidity test report provided by the vendor (Reference 13) was compared to the temperatures resulting from the postulated BDB calculation and used as the basis to demonstrate reliability of the permanently

installed electronic equipment located within the Auxiliary Building Relay Room under the BDB post-event temperature conditions.

Background to RAI #8

The ISE states, in part,

> In its OIP, the licensee stated that post-event humidity in the fuel pool floor area near and above the SFP is assumed to be 100% with condensing steam. In its letter dated August 12, 2013, the licensee stated that all equipment located in the fuel handling building will be certified for use, by the manufacturer, for survivability under post-event conditions including 100 percent condensing atmosphere. Additionally, the licensee stated in this letter that the electronic enclosures will be qualified by the manufacturer for use at temperatures, humidity and integrated radiation doses consistent with other electronic devices containing digital components and located in mild environments. The NRC staff has concerns with the lack of information regarding whether the sensor electronics is capable of continuously performing its required functions under the expected humidity condition. The staff has identified this request as:

RAI #8

> Please provide information indicating the maximum expected relative humidity in the room in which the sensor electronics will be located under BDB conditions, in which there is no ac power available to run HVAC systems, and whether the sensor electronics is capable of continuously performing its required functions under this expected humidity condition.

PSEG Response to RAI #8

The electronic equipment will be mounted within the Auxiliary Building Relay Room located one elevation below the Main Control Room. The Auxiliary Building Relay Room is classified as a mild environment in accordance with SGS Environmental Design Criteria (Reference 11). The maximum post DBA humidity level of 90% for the SGS postulated events bound the BDB post-event humidity levels since the maximum humidity in the room where the electronics will be located is not expected to exceed DBA conditions during an ELAP event.

Information supplied in a system temperature and humidity test report provided by the vendor (Reference 13) was compared to a humidity level of 90% and used as the basis to demonstrate reliability of the permanently installed electronic equipment located within the Auxiliary Building Relay Room under the post-event humidity conditions.

3.6.3 Shock and Vibration

Background to RAI #9

The ISE states, in part,

> The NRC staff notes the results of the testing and/or analysis of the installed equipment's reliability under BDB conditions is not currently available for review. As stated by the licensee, the reliability of the permanently installed equipment under BDB conditions will be demonstrated by the manufacturer, as specified in the licensee's procurement specifications. The NRC staff has identified this request as:

RAI #9

> Please provide the results of the testing and/or analysis of the installed equipment's reliability under BDB ambient temperature, humidity, shock, vibration, and radiation conditions as specified in the PSEG procurement specification. Provide the results of your analysis that demonstrates that the vendor's qualification testing and analysis envelopes the plant environmental conditions considered for the specific locations where the equipment will be installed.

PSEG Response to RAI #9

> Temperature, humidity, shock, vibration and radiation test results are provided in vendor test reports. The results demonstrate that the vendor's qualification testing and analysis envelopes SGS Units 1 and 2 environmental conditions considered for the specific locations where the equipment will be installed. In the Mohr audit report (Reference 14), the NRC identified the test in Mohr document No. 1-0410-16, "Mohr SFP-1 Level Probe Assembly Shock and Vibration Test Report" (Reference 15) as satisfactory and sufficient to close the open item on shock and vibration.

3.*6.4 Seismic Reliability*

Background to RAI #10

The ISE states, in part,

> The NRC staff notes that the licensee plans to demonstrate the reliability of the seismic design and installation in accordance with the guidance in the ISG. The licensee's planned approach with respect to the seismic reliability of the instrumentation appears to be consistent the guidance. However, the staff plans to verify the results of the licensee's seismic test when it is completed. The staff has identified this request as:

RAI #10

> Please provide the results and the basis of your analysis of the seismic testing results showing that the instrument performance reliability, following exposure to simulated seismic conditions representative of the environment anticipated for the SFP structures at SGS, has been adequately demonstrated.

PSEG Response to RAI #10

The results and basis of the vendor testing and analysis described in PSEG's responses to RAIs #3 and #4 show instrument performance reliability following exposure to simulated seismic conditions representative of the environment anticipated for the SFP structures at the specific locations where the equipment will be installed. The vendor testing and analysis bound the SGS seismic test criteria.

Section 3.7 Design Features: Independence

Background to RAI #11

The ISE states, in part,

> The NRC staff has determined that the licensee's planned implementation of such provisions with respect to independence appears to be consistent with the NEI 12-02, as endorsed by the ISG. The staff also notes that implementing this design would allow the electrical functional performance of each level measurement channel to be independent of the other channel. If completed as described, this independence would result in a reliable SFP level measurement. However, the NRC staff plans to review the final electrical power supply design information to complete its review. The NRC staff has identified this request as:

RAI #11

> Please provide the NRC staff with the final configuration of the power supply source for each channel so that the staff may conclude that the two channels are independent from a power supply assignment perspective.

PSEG Response to RAI #11

The power supply source for each channel uses separate station 115-VAC vital instrument buses for both Unit 1 (1B, 1C) and Unit 2 (2B, 2C) which receive power from independent Uninterruptible Power Supply (UPS) channels. Each vital instrument bus UPS receives normal power from separate 230-VAC vital power. In the event of a 230-VAC power loss or a UPS malfunction, independent 125-VDC vital station battery power will automatically supply power to the UPS's inverter from separate station batteries.

Section 3.8 Design Features: Power Supplies

Background to RAI #12

The ISE states, in part,

> The NRC staff notes that information on system power consumption is not available for review and will be provided to the staff in the August 2014, six-month OIP update. The staff has identified this request as:

RAI #12

> Please provide the result of the calculation depicting the battery backup duty cycle requirements demonstrating that its capacity is sufficient to maintain the level indication function until offsite resource availability is reasonably assured.

PSEG Response to RAI #12

> The SFP level instrument system provides at least seven days of battery life assuming typical use and accounting for postulated post-event environmental conditions. Details of the system battery life and duty cycle testing are provided in the vendor's system battery life report (Reference 16).

Section 3.9 Design Features: Accuracy

Background to RAI #13

The ISE states, in part,

> The NRC staff notes that additional information on design accuracy for the SFP instrumentation is not available for review and will be provided to the staff in the August 2014, six-month OIP update. The staff has identified this request as:

RAI #13

> Provide the following information:
>
> a) An estimate of the expected instrument channel accuracy performance (e.g., in % of span) under both a) normal SFP level conditions (approximately Level 1 or higher) and b) at the BDB conditions (i.e., radiation, temperature humidity, post-seismic and post-shock conditions) that would be present if the SFP level were at the Level 2 and Level 3 datum points.
>
> b) A description of the methodology that will be used for determining the maximum allowed deviation from the instrument channel design accuracy that will be employed under normal operating conditions as an acceptance criterion for a calibration procedure to flag to operators and to technicians that the channel requires adjustment to within the normal condition design accuracy.

PSEG Response to RAI #13

a) The guidance in NEI 12-02 requires the accuracy for the SFP level indication between levels 1 and 2 to be better than 1 foot. Between levels 2 and 3 the accuracy is to be better than 3.5 feet. The instrument vendor identified the accuracy as better than ± 3 inches and that accuracy was demonstrated at the factory acceptance test. The instrument vendor also identified that the presence of boric acid precipitate on the probe's active electrode surfaces above the water level produces a fixed measurement error with characteristic lowering of the apparent water level. The worst-case level measurement error due to this effect is estimated to be 2.5 inches.

b) The maximum allowable deviation was selected to be well within the required accuracy while allowing tolerance for the vendor's advertised inaccuracy and the potential effect of the boron precipitation.

Background to RAI #14

The ISE states, in part,

> Further, the NRC staff plans to verify that the channels will retain these accuracy performance values following a loss of power and subsequent restoration of power. The staff has identified this request as:

RAI #14

> Please provide analysis verifying that the proposed instrument performance is consistent with these estimated accuracy normal and BDB values. Please demonstrate that the channels will retain these accuracy performance values following a loss of power and subsequent restoration of power.

PSEG Response to RAI #14

> Power interruption testing has been performed on the EFP-IL signal processor and backup battery power source. Test results indicate that no deficits were identified with respect to maintenance of reliable function, accuracy, or calibration as a result of power interruption. The results of testing provided evidence of reliable transition from the normal AC power source to the backup battery without affecting accuracy or calibration. The results of the tests are provided by the vendor in their EFP-IL SFPI System Power Interruption Report (Reference 17).

Section 3.10 Design Features: Testing

Background to RAI #15

The ISE states, in part,

> The NRC staff notes that the information regarding the capability and provisions for the proposed level sensing equipment as well as specific periodic testing and calibration capabilities enabling the equipment to be tested in-situ; the specific details of the functional and calibration test program, including frequencies; and, the specific details of

the preventative maintenance program, including maximum frequencies is not available for review and will be provided to the staff during the August 2014, six-month OIP update. The NRC staff has identified this request as:

RAI #15

Please provide the following:

a) A description of the capability and provisions the proposed level sensing equipment will have to enable periodic testing and calibration, including how this capability enables the equipment to be tested in-situ.

b) A description of how such testing and calibration will enable the conduct of regular channel checks of each independent channel against the other, and against any other permanently-installed spent fuel pool level instrumentation.

c) A description how functional checks will be performed and the frequency at which they will be conducted. Describe how calibration tests will be performed, and the frequency at which they will be conducted. Provide a discussion as to how these surveillances will be incorporated into the plant surveillance program.

d) A description what preventative maintenance tasks are required to be performed during normal operation, and the planned maximum surveillance interval that is necessary to ensure that the channels are fully conditioned to accurately and reliably perform their functions when needed.

(This information was previously requested as RAI-8 in NRC letter dated July 11, 2013)

PSEG Response to RAI #15

a) Standard measurement and test equipment (M&TE) is used to confirm normal operation of the signal processor using a calibration procedure provided by the vendor. During planned periodic calibration checks, time-domain reflectometry (TDR) is used to demonstrate the impedance waveform through the transmission cable and connectors from the signal processor to the probe is unchanged when compared with the as-installed configuration. During normal operation, the level instrument automatically monitors the integrity of its level measurement system. All testing is performed using in-situ capability.

b) Regular channel checks can be performed by comparing the level measurements displayed by the primary and backup channels directly to each other and to other permanently installed spent fuel pool instrumentation without the use of any measurement and test equipment (M&TE). This includes the ability to check the primary and backup displays in the Auxiliary Relay Room against the SFP local indicator displays. The level measurement system logs data that can be reviewed to evaluate consistency of level measurement over time.

c) As described in response to RAI #15b, the channel level measurements can be directly compared to each other (e.g. regular channel cross comparisons). The two displays are installed in close proximity to each other, thereby simplifying the channel checks. Visual observation of the SFP level can be used for diagnostic purposes.

SGS Units 1 and 2 have included the SFPLI displays in the Auxiliary Relay Room and MCR in daily plant logs.

d) The following maintenance activities and frequencies have been identified for the SFPLI:

6-month activities:

- Diagnostics test
- Memory test
- Battery test
- Temperature compensation test

2-year activities:

- Battery replacement
- Memory card replacement
- Transmitter Calibration checks (TDR calibration check, probe and transmission cable health checks)
- Clock calibration
- Visual inspection of repairable head
- Inspect probe tube for boric acid buildup (can be seen on TDR scans)

These activities have been developed using the PM process and vendor recommendations, and are subject to change using PSEG's administrative controls.

Section 3.11 Design Features: Display

Background to RAI #16

The ISE states, in part,

> The NRC staff reviewed the figure included in the letter dated August 12, 2013, and noted that the primary level instrument and the backup level instrument level indications are to be displayed in the MCR. However, in its letter dated August 12, 2013, the licensee stated that the electronics enclosure provide both a local display and a retransmitted signal to a remote display located in the main control room. The staff had concerns with the lack of specificity regarding the location of the instrument displays. The staff has identified this request as:

RAI #16

Please provide the following:

a) The specific location for the primary and backup instrument channel display.

b) Please describe the evaluation used to validate that the display location can be accessed without unreasonable delay following a BDB event. Include the time available for personnel to access the display as credited in the evaluation, as well as the actual time (e.g., based on walk-throughs) that it will take for personnel to access the display. Additionally, please include a description of the radiological and

environmental conditions on the paths personnel might take. Describe whether the display location remains habitable for radiological, heat and humidity, and other environmental conditions following a BDB event. Describe whether personnel are continuously stationed at the display or monitor the display periodically.

(This information was previously requested as RAI-9 in NRC letter dated July 11, 2013)

PSEG Response to RAI #16

a) The primary and backup instrument channel displays are located in the Auxiliary Building Relay Room which is located one elevation below the MCR and is easily accessible. Displays are also located in the MCR but the MCR displays are not provided with battery backup power and are therefore not credited for compliance with NRC Order EA-12-051.

b) The displays can be promptly accessed and viewed by emergency response staff using a stairwell located immediately outside the MCR. The display location was selected due to its proximity to other equipment that would require manual operation or require operator actions in support of BDB mitigating strategy implementation and anticipated BDB mitigating strategy access paths. Radiological habitability at this location has been evaluated against the SGS Unit 1 and 2 Environmental Design Criteria (Reference 11) for postulated DBA radiological events and used as a basis to determine radiological conditions for this location. The estimated doses obtained from SFP drain down conditions at Level 3 (Reference 8) and exposure to personnel monitoring SFP levels from this location are bounded by the DBA radiological conditions. Heat and humidity have been evaluated for this location, and the location of the displays in the Auxiliary Building Relay Room, one elevation below the MCR, is sufficiently separated from the SFP and therefore heat and humidity from a boiling SFP will not compromise habitability.

Due to the location of the displays, the design can accommodate either periodic or continuous monitoring based on the requirements of the implementing BDB mitigating strategy. Travel time from the control room to the level displays is less than 5 minutes based on an informal walk through. Radiological, heat and humidity for the transit route has been evaluated and habitability is not compromised.

Communication remains available between the display location and the MCR or other emergency response locations within the power block where decision makers are located.

Section 3.12 Programmatic Controls: Training

Background to RAI #17

The ISE states, in part,

The NRC staff has concerns regarding the lack of information on the training of personnel for activities such as use of the instrument channels, provisions for alternate power, and calibration and surveillance of the SFP instrumentation. Another staff concern is the lack of information on the licensee's approach to training on the use of the SFP instrumentation. The staff has identified this request as:

RAI #17

Please describe the activities for which personnel will be trained, such as use of the instrument channels, provision of alternate power, calibration and surveillance. Describe the approach to training used to identify the population to be trained and determined the initial and continuing elements of the required training.

PSEG Response to RAI #17

A systematic approach to training (SAT) was used for the new SFPLI equipment as part of the PSEG design change process. Training of on-site staff by PSEG training personnel was determined via SAT for the Operations and Maintenance training populations, in accordance with the SAT model of Analysis, Design, Development, Implementation, and Evaluation (ADDIE). The Analysis process of SAT identifies the population to be trained and the Design process determines the initial and continuing elements of the training. These processes are governed by station approved training procedures as a part of the National Academy for Nuclear Training accredited training programs. The National Academy for Nuclear Training operates under the auspices of the Institute of Nuclear Power Operations (INPO).

SGS maintenance technicians and supervisory personnel completed instructor-led classroom training. The vendor provided “train-the-trainer” training and supporting materials during the development of the maintenance training. The focus of training was to prepare personnel for the safe handling, installation, testing, operation, and maintenance activities. The training consists of the following units of instruction:

1. Theory of operation
2. Equipment locations
3. Components of the instrumentation
4. Power supplies (including provisions for alternate power)
5. System operation and testing

Over an 11 month period the operators received three sessions of training on all elements of FLEX strategies, including SFPLI, during the development of the strategies and plant design changes. Upon final installation and approval of the SFPLI instrumentation and related procedures, operators received just-in-time gap training on the final installed instrumentation and approved procedures. Specifically, SGS operations personnel, including non-licensed operators, licensed operators, and operations supervisors, received training on the operations and use of SFPLI equipment and related procedures. The training consists of the following units of instruction:

1. Theory of operation
2. Equipment locations
3. Components of the instrumentation
4. Power supplies (including provisions for alternate power)
5. System operation and readings
6. Alarm response procedures and SFPLI related implementing procedures

Section 3.13 Programmatic Controls: Procedures

Background to RAI #18

The ISE states, in part,

> The NRC staff notes that the information regarding procedures for operation (both normal and abnormal response), calibration, testing, maintenance, inspection, and administrative controls associated with the SFP level instrumentation are not available for review and will be provided to the staff during the August 2014, six-month OIP update. The NRC staff has identified this request as:

RAI #18

> Please provide a list of the procedures addressing operation (both normal and abnormal response), calibration, test, maintenance, and inspection procedures that will be developed for use of the SFP instrumentation. The licensee is requested to include a brief description of the specific technical objectives to be achieved within each procedure.

PSEG Response to RAI #18

> The SGS Unit 1 and 2 SFPLI has been installed using PSEG's design change process and is subject to PSEG procedures and processes to address operation (both normal and abnormal response), calibration, test, maintenance, and inspection. The specific technical objectives are addressed as follows:
>
> 1) Operation (Both Normal and Abnormal Response)
>
> SGS Unit 1 and 2 control room logs (References 18 through 21) and the primary plant log (References 22 and 23) have been revised to include daily checks of the primary and backup displays in the Auxiliary Building Relay Room, and both channel displays in Main Control Room (MCR). These logs establish a normal range of SFP water levels above NEI 12-02 Level 1 value, consistent with normal operation. The logs also establish a maximum deviation of 0.5 ft. between channels and include requirements to check battery status indication, check for error messages, and initiate corrective actions for unsatisfactory readings.
>
> For operator response to abnormal conditions, the SGS Unit 1 and 2 alarm response procedures for SFP level alarms (References 24 and 25) have been revised to provide direction to the operator to check SFP level using the SFPLI displays in the Main Control Room or the Auxiliary Building Relay Room. Guideline SC.OP-AM.TSC-0008 (Reference 26), which addresses NRC Order EA-02-026 Section B.5.b mitigating strategies, has been revised to include a precaution against using radios in the vicinity of the SFP to avoid potentially adverse effects of electromagnetic interference on the SFPLI. Similar precautions are being included In FLEX Support Guidelines that direct actions in the vicinity of the SFP during beyond-design-basis conditions (References 27 through 30).

2) Calibration

PSEG has vendor documents that include guidance for preventive and corrective maintenance of the SFPLI. These documents are available to PSEG personnel and are approved for use at SGS Units 1 and 2. The SFPLI is included in the PSEG PM process, which includes instrument calibration based on vendor recommendations.

3) Test

Testing of the SFPLI electronics and batteries are included in the SFPLI PM process.

4) Maintenance

PM process administrative controls are applicable to the SGS Unit 1 and 2 SFPLI. PM activities include testing, calibration, replacement (e.g., batteries and memory cards) and visual inspection of the probe and head.

Corrective maintenance administrative controls are also applicable to the SGS Unit 1 and 2 SFPLI. This includes administrative controls developed to determine corrective actions and compensatory measures to address the unavailability of SFPLI and FLEX equipment.

5) Inspection

SFPLI inspections of the sensor probe tube and repairable head and are part of the PM process. Vendor documents include guidance for performing inspections as PM activities or as needed to support corrective maintenance.

Section 3.14 Programmatic Controls: Testing and Calibration

Background to RAI #19

The ISE states, in part,

> The NRC staff notes that further information regarding the testing and calibration of the equipment associated with the SFP level instrumentation is not available for review and will be provided to the staff during the August 2014, six-month OIP update. The staff has identified these requests as:

RAI #19

> Please provide a description of the preventive maintenance, testing and calibration program, and the provisions associated with out of service or inoperable equipment including out of service times and compensatory actions.

PSEG Response to RAI #19

The SFP level instrument channel maintenance and testing program requirements to ensure design and system readiness are established in accordance with PSEG process and procedures, with consideration of vendor recommendations. The program ensures appropriate testing, channel checks, functional checks, periodic calibration and maintenance are performed.

Both the primary and backup SFP level instrument channels incorporate permanently installed equipment with no reliance on portable post-event equipment or installation requirements. The equipment is relatively simple and robust and is provided under augmented quality requirements. Permanent installation coupled with vendor support and spare parts reasonably diminishes the likelihood of a single channel being out of service greater than 90 days, and greatly reduces the likelihood that both channels would be out of service for an extended period of time.

Provisions associated with out of service or inoperable equipment including out of service times and compensatory actions are in accordance with NEI 12-02 Section 4.3, "Testing and Calibration."

References:

1) PSEG letter LR-N13-0156 dated August 12, 2013, "PSEG Nuclear LLC's Response to Request for Additional Information for the Salem Generating Station's Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)" (ADAMS Accession No. ML13225A363)
2) PSEG Technical Standard SC.DE-TS.ZZ-2032(Q), "Salem Generating Station Physical Separation Requirements (Electrical)"
3) PSEG Technical Standard SC.DE-TS.ZZ-4201(Q), "Salem Structural Design Criteria"
4) PSEG Calculation 6S0-2345, "Instrument Mounting for Spent Fuel Pool Level Instrumentation Modification"
5) Vendor Technical Document (VTD) 432306 Volume 19, 1-0410-9 – "Mohr SFP-1 Level Probe Assembly Seismic Analysis Report"
6) VTD 432306 Volume 10, 1-0410-6 – "Mohr EFP-IL SFPI System Seismic Test Report"
7) PSEG Calculation 6S0-2346, "Conduit and Electronic Box Supports for Spent Fuel Pool Level Instrumentation Modification"
8) VTD 432315 Volume 1, SL-012006 – "NEI 12-02 Spent Fuel Pool Doses"
9) PSEG Specification A-5-SF-EC-CDS-0517, "Spent Fuel Pool Level Instrumentation Detailed Specification"
10) VTD 432306 Volume 7,1-0410-2, "Mohr SFP-1 Level Probe Assembly Materials Qualification Report"
11) PSEG Calculation S-C-ZZ-SDC-1419(Q), "Salem Generating Station Environmental Design Criteria"
12) VTD 903061 Attachment A, "Salem Unit 1 and 2 Control Room GOTHIC Model Run to 7 Days,"
13) VTD 432306 Volume 6, 1-0410-1 – "Mohr EFP-IL SFPI System Temperature and Humidity Test Report"
14) NRC Letter dated August 27, 2014, "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)" (ADAMS Accession No. ML14216A362)
15) VTD 432306 Volume 17, 1-0410-16, "MOHR SFP-1 Level Probe Assembly Shock and Vibration Test Report"
16) VTD 432306 Volume 11, 1-0410-7 – "Mohr EFP-IL SFPI System Battery Life Report"

17) VTD 432306 Volume 13, 1-0410-10 - “Mohr EFP-IL SFPI System Power Interruption Report”
18) S1.OP-DL.ZZ-0002(Q), “Control Room Log - Modes 5, 6 and Defueled”
19) S2. OP-DL.ZZ-0002(Q), “Control Room Log - Modes 5, 6 and Defueled”
20) S1. OP-DL.ZZ-0003(Q), “Control Room Log - Modes 1-4”
21) S2. OP-DL.ZZ-0003(Q), “Control Room Log - Modes 1-4”
22) S1.OP-DL.ZZ-0006-F1(Q), “Unit 1 Primary Plant Log”
23) S2.OP-DL.ZZ-0006-F1(Q), “Unit 2 Primary Plant Log”
24) S1.OP-AR.ZZ-0003(Q), “Overhead Annunciators Window C”
25) S2.OP-AR.ZZ-0003(Q), “Overhead Annunciators Window C”
26) SC.OP-AM.TSC-0008, “Emergency Fill to Spent Fuel Pool”
27) S1.OP-FS.FLX-0005(Q), “Initial Assessment and FLEX Equipment Staging”
28) S2.OP-FS.FLX-0005(Q), “Initial Assessment and FLEX Equipment Staging”
29) S1.OP-FS.FLX-0011(Q), “Alternate Spent Fuel Pool Makeup and Cooling”
30) S2.OP-FS.FLX-0011(Q), “Alternate Spent Fuel Pool Makeup and Cooling”