# PUBLIC MEETING TO DISCUSS INDUSTRY RESPONSES TO INTERIM STAFF EVALUATIONS FOR SPENT FUEL POOL INSTRUMENTATION NOVEMBER 26, 2013

***The information provided below is a sample of some of the licensee's responses with the necessary level of detail the NRC staff has found to be consistent with the NEI guidance, as endorsed by the ISG.***

3.2 Spent Fuel Pool Water Levels

**Level 1 - Information needed by the staff**

Licensee should describe how Level 1 was selected to be consistent with NEI 12-02 guidance, or provide a justification as to why the guidance could not be met because of a plant-unique situation. In some cases, the results of a NPSHa calculation at saturation conditions needs to be updated or created. BWR plants with pool scupper arrangement should provide the elevation of the scupper weir.

**[Arkansas Nuclear One]**

Level 1 is the level adequate to support operation of the normal fuel pool cooling system. It is the higher of the following two points:

> (1) the level at which reliable suction loss occurs due to uncovering the coolant inlet pipe or any weirs or vacuum breakers associated with suction loss. This level, (1), is established for Unit 1 based on nominal coolant inlet pipe elevation [as it does not incorporate a vacuum (or siphon breaker)] and is established for Unit 2 based on nominal vacuum (or siphon) breaker elevation. The elevation associated with this level is 397 feet 5.21 inches for Unit 1. The elevation associated with this level is 401 feet 0 inches for Unit 2.
>
> (2) the level at which the normal fuel pool cooling pumps lose required NPSH assuming saturated conditions in the pool. It can be demonstrated that this elevation is below the elevation that defines Level 1 per (1) above. Unit 1 SFP Cooling pumps are at elevation 337'-0" with a required NPSH of 14 FT for suction temperatures up to 200°F. Unit 2 SFP Cooling pumps are at elevation 336'-2.5" with a required NPSH of 20 FT for suction temperatures up to 200°F.

The higher of the above points is (1). Therefore, LEVEL 1 is elevation 397 feet 5.21 inches for Unit 1 and LEVEL 1 is elevation 401 feet 0 inches for Unit 2.

**[Brunswick]**

As a result of responding to RAI-1, errors were identified in the Level 1, 2, and 3 values provided in BSEP's February 28, 2013, OIP. The original Level 1 value did not account for the minimum SFP operating water level. The original Level 2 and Level 3 values were based on highest point of any fuel assembly versus fuel rack.

| | Original Value | Corrected Value |
|---|---|---|
| Level 1 | 37 feet 9 inches (116 feet 4 inches plant elevation) | 37 feet 6 inches (116 feet 1 inches plant elevation) |
| Level 2 | 105 feet 7 ¾ inches plant elevation | 105 feet 3 inches plant elevation |
| Level 3 | 95 feet 7 ¾ inches plant elevation | 95 feet 3 inches plant elevation |

The minimum water level required in the skimmer surge tank, with an inlet temperature of 200ºF, for the fuel pool cooling pumps to maintain their minimum net positive suction head (NPSH) is at plant elevation 94 feet.

Section 3.7.7 of BSEP's Technical Specifications states that the spent fuel storage pool water level shall be > 19 feet 11 inches (i.e., 115 feet 8 ¾ inches plant elevation) over the top of the irradiated assemblies seated in the spent fuel storage racks. The normal operating SFP water level is 37 feet 9 inches from the bottom of the SFP (i.e., 116 feet 4 inches plant elevation).

Level 1, as defined in NEI 12-02, is "the level which reliable suction loss occurs due to uncovering of the coolant inlet pipe, weir, or vacuum breaker." During normal operation, the weir for the skimmer surge tanks and SFP is positioned to maintain the level at or above the minimum value of 37 feet 6 inches (i.e., 116 feet 1 inch plant elevation). This level provides sufficient makeup to the skimmer surge tank to maintain skimmer surge tank water level at 94 feet plant elevation, thereby ensuring adequate fuel pool cooling pump NPSH. Therefore, Level 1 shall be at a height of approximately 37 feet 6 inches from the bottom of the SFP (i.e., 116 feet 1 inches plant elevation).

**<u>Level 2 - Information needed by the staff</u>**

- Licensee should describe how Level 2 provides adequate radiation shielding, (e.g., 10 feet above fuel rack) or provides a justification as to why the guidance could not be met because of a plant-unique situation. In some cases, the results of a plant-specific radiation dose assessment based on plant-specific SFP loading worst-case assumptions are needed to verify the guidance is being met.
- The radiation dose from non-special nuclear material stored in the pool should also be described if it becomes limiting.
- Licensee should describe how adverse impacts with other material stored in the SFP (fuel handling equipment) will be prevented.

**[Level 2 identified using option 1]**

**[Arkansas Nuclear One]**

Level 2 is the level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck. Level 2 may be based on either of the following:

(1) 10 feet ± 1 foot above the highest point of any fuel rack seated in the spent fuel pool. The elevation associated with this level is 385 feet 11.5675 inches ± 1 foot for Unit 1. The elevation associated with this level is 388 feet 3.3125 inches ± 1 foot for Unit 2.

(2) A designated level that provides adequate radiation shielding to maintain personnel dose within acceptable limits while performing local operations in the vicinity of the pool. This level is based on plant-specific or appropriate generic shielding calculations. The elevation associated with this level is not calculated since item (1) is used to establish Level 2.

In lieu of plant specific dose calculations required by (2), (1) is used as the conservative accepted level as suggested by NEI 12-02 Revision 1. Therefore, LEVEL 2 is elevation 385 feet 11.5675 inches ± 1 foot for Unit 1 and LEVEL 2 is elevation 388 feet 3.3125 inches ± 1 foot for Unit 2 (i.e. 10 ± 1 feet above Top of Fuel Rack).

**[Level 2 identified using option 2]**

**[Calvert Cliffs]**

Level adequate to provide substantial radiation shielding for a person standing on the SFP operating deck - Indicated water level on either the primary or backup instrument channel of greater than elevation 50'-2" plus the accuracy of the SFP water level instrument channel, which will be determined during the engineering and design phase. This elevation' is approximately 5' above the top of the fuel racks and ensures a minimum water level of 5' above the top of the Fuel. Licensee determined that with 5' of water above the top of the racks, the largest calculated dose rate near the edge of the SFP would be well below 100 mrem/hr. Calculations to determine dose rates near the edge of the SFP with 5' of water above the top of the fuel racks were performed using SAS2H/ORIGEN-S or ORIGEN-ARP for source term calculations and MCNP5 code was used to Calculate gamma (primary and capture) and neutron dose rates at the locations of interest. MCNP5 is a general-purpose Monte-Carlo N-Particle code that can be used for neutron, photon, electron, or coupled neutron/ photon/ electron transport. This monitoring level ensures there is adequate water level to provide substantial radiation shielding for personnel to respond to Beyond-Design-Basis External Events and to initiate SFP makeup strategies.

**[Level 2 identified using option 2 and other irradiated material stored in the SFP]**

**[Ginna]**

Calculations for determination of the dose projected at the top edge of the SFP in the event of lowering SFP water level were performed using ORIGEN-ARP source term calculations and the MCNP5 code was used to calculate gamma dose rates at the perimeter of the SFP. Key assumptions for amount and location of source material and assumptions regarding future changes to amount of source material are provided below.

The SFP was assumed to contain all of the fuel discharged up to the capacity of the SFP. The Region 1, Type 3 racks are assumed to contain the most recent discharged fuel (starting at 100 hours per current plant limitations). Region 2, Type 2 is assumed to contain the discharges after Region 1, Type 3 is fully loaded. The remaining discharges are assumed to be loaded in Region

2, Type 1. Westinghouse Vantage 422V+ fuel is assumed for the entire pool. This fuel type has more uranium, has a higher top of active fuel and has a smaller top nozzle than other licensee's fuel types. These assumptions are conservative as they will result in peaking of the dose rates in the pool and at the deck.

Two discharge streams are assumed for the entire pool: (1) 4.6 weight percent (wt. %) U-235, 50,000 Megawatt-days/Metric Ton of Uranium (MWd/MTU) ("e46b50" run identification) and (2) 5.0 wt. % U-235, 55,000 MWd/MTU ("e50b55" run identification). This is expected to bound post-Extended Power Uprate (EPU) discharges and will dominate the dose rates in the period of extended operation.

These assumptions should conservatively represent older fuel as well. The e46b50 depletion models assume a two cycle burnup history at 50 MW/MTU. The e50b55 depletion models assume a three cycle burnup history at 50, 50 and 13.2 MW/MTU. Based on actual powers, these are conservative.

Cycle operation is assumed to consist of 532.86 Effective Full Power Days (EFPD) and 15 days coast down. This is a reasonable assumption for 18 month cycles and will have minimal impact on the source terms provided the desired burnup is achieved. It is assumed that 1/3 of the 45 discharges are e46b50 and 2/3 are e50b55. This is a reasonable representation of post-EPU operation and is expected to be conservative for future operation.

Top of the racks is assumed to be at plant elevation 251 '-5". SFP rack drawings reveal that there are two tops of racks. Region I is at plant elevation 251' 5", while Region 2 is approximately between 251'-I1.25" and 251'-1.5". These configurations result in the fuel assemblies sitting below the top of the racks in Region 1 and slightly above in Region 2, which complicates the MCNP modeling. To standardize the model, the top of the Region 1 racks was used uniformly as this is the one that the water level will reach first during a drain down. The top of the fuel assembly is modeled in MCNP as 1.775" below the top of the racks. The active fuel is modeled in MCNP as 14.3" below the top of the racks at plant elevation -250'-2.75". The air above the water in the SFP is assumed to be void in MCNP and the density of the water is assumed to be 1.0 grams per cubic centimeter (g/cc). The SFP is assumed to be surrounded by 3' of concrete to account for scatter.

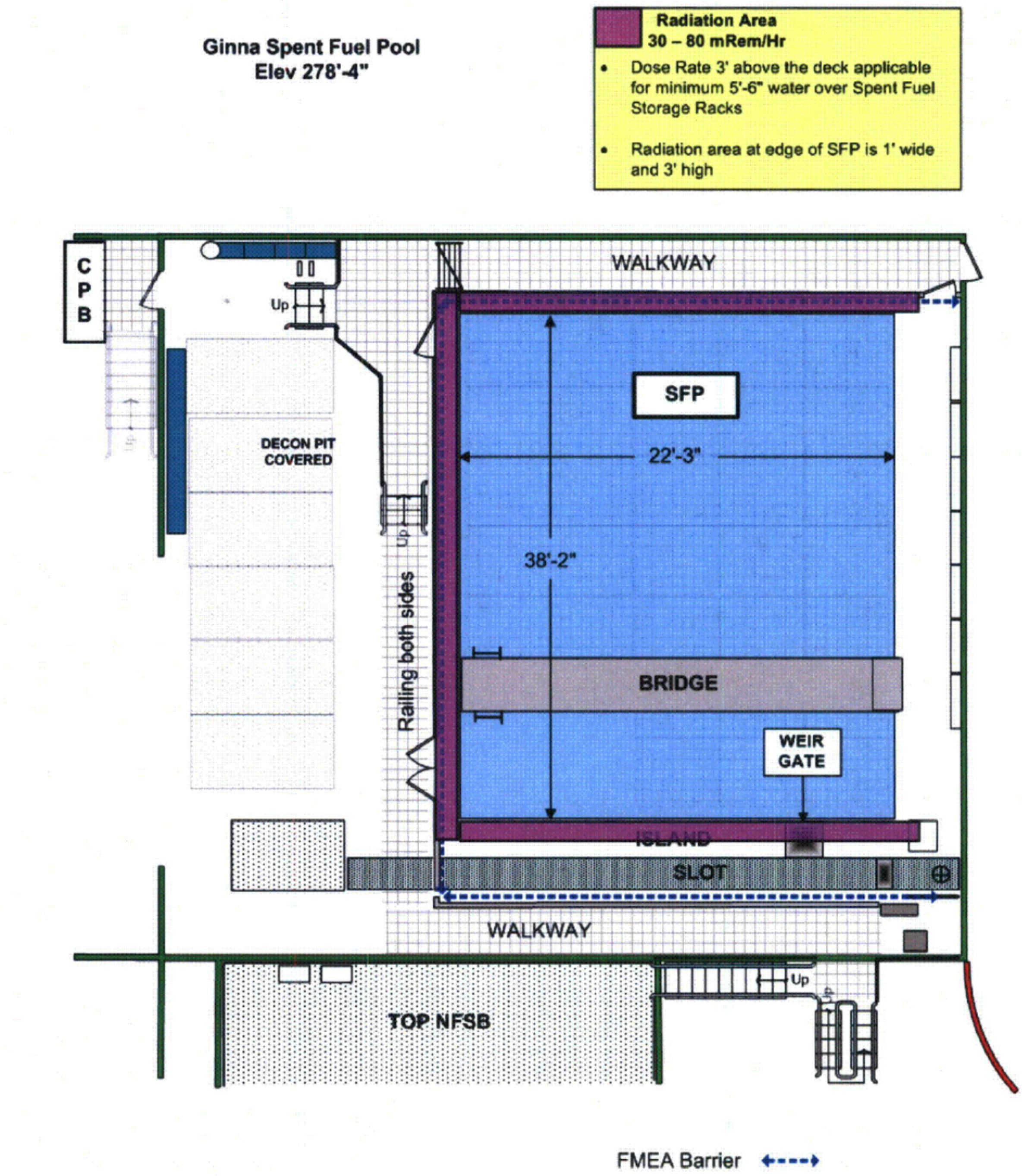
The axial burnup distribution is assumed to be the profile that corresponds to 40 to 50 Gigawatt-days (GWD)/MTU fuel without axial blankets. Using fuel without low enriched or natural uranium blankets is conservative as it maximizes the gamma source at the ends of the fuel assembly, which is conservative for dose rates above the racks.

The calculation indicates that water coverage of 5'-6" above the racks is sufficient to ensure dose rates around the SFP deck area meet the acceptance criterion of_< 100 milli-rem per hour (mrem/hr). The Level 2 value has been established at - 5'-7" above the racks to provide additional margin.

Dose rates in the SFP area are determined using tally volumes and meshes. Dose rates at the SFP edge utilize the maximum dose rate from each of the four edges of the SFP. These dose rates were calculated using tally meshes running the entire length of the SFP edge. Dose rates at the water surface are taken from a circular surface tally with a radius of 240 centimeters (cm) centered over the middle of the racks at 1-foot intervals in the water for the 5-foot case.

Based on the calculation performed, with 5'-6" of water above the top of the SFP racks, Figure 2 depicts the projected dose rate locations on a plan view sketch, from the edge of the SFP up to 1' back from the SFP edge, and from 3' to 6' above the deck elevation. All areas surrounding the SFP under this condition are calculated to be less than 100 mrem/hr as indicated by Figure 2.

The dose calculation assumes that there is no material stored above the SFP racks that contributes to the dose rate. If materials that can contribute to the dose rate are planned to be stored in the SFP in the future, additional analysis will be performed to determine the projected dose rate impact and the appropriate Level 2 value. The addition of irradiated materials to the SFP and any additional analysis will be controlled by a station procedure. Specific requirements of the procedure, including details of the analysis to be performed, will be developed and provided in a later status update.




**[Level 2 based on other irradiated material stored in the SFP]**

**[River Bend]**

The current Level 2 elevation is now 107'-10 5/16" El. The previous Level 2 elevation was 10 ft. above the top of the spent fuel rack at 94'-10 5/16" El. The Level 2 elevation is raised to 107'-10 5/16" to account for non-special nuclear material stored above 94'-10 5/16" in the Spent Fuel Pool.

**Level 3 – Information needed by the staff**

Licensee should demonstrate that Level 3 is within 1 foot above the top of the fuel racks, and that the proposed instrumentation can read this value, inclusive of any instrument measurement “dead zone.”

**[Arkansas Nuclear One]**

Level 3 is the level where fuel remains covered. It is defined as the highest point of any fuel rack seated in the spent fuel pool (within ± 1 foot).

The highest point (nominal) of any fuel rack seated in the spent fuel pool is 375 feet 11.5675 inches for Unit 1 and 378 feet 3.3125 inches for Unit 2. Therefore, LEVEL 3 is elevation 375 feet 11.5675 inches ± 1 foot for Unit 1 and LEVEL 3 is elevation 378 feet 3.3125 inches ± 1 foot for Unit 2.

**[Level 3 and SFP gate opening configuration for shared pools]**

**[Point Beach]**

The top of the fuel assemblies is located at plant elevation 37 feet 9 inches. The top of the east west oriented wall opening that separates the northern and southern areas of the SFP is at plant elevation 40 feet 8 inches. Once the water level drops below this point, the single SFP has effectively been segregated into two separate pools. Consequently, plant elevation 40 feet 8 inches is the level at which actions to initiate water make-up should not be further delayed. This setting is in compliance with the Order; however, it represents a slight variation to the NEI guidance. This is a conservative decision to treat plant elevation 40 feet 8 inches as the top of the fuel and necessary to ensure proper actions are taken in the event that one of the channels of SFP level instrumentation is lost or in the event that level is decreasing due to a breach in one of the pits.

**[Perry]**

The top of the highest point on the spent fuel racks is located at 591'-4'0. The top of the gate seat that separates the two pools containing spent fuel (the fuel storage and preparation pool and the spent fuel storage pool) from the fuel transfer pool is at elevation 594'-6'. Once the water drops below this point, the single SFP has effectively been segregated in to four separate pits. Consequently, 594-'6 " is the level at which actions to initiate water make-up will not be further delayed. This setting is in compliance with the Order; however, it represents a slight variation to the NEI guidance. The NEI guidance recommends using the top of the highest fuel rack in the spent fuel pool as level 3. The conditions described above make it undesirable to use top of the highest fuel rack as level 3. This is a conservative decision to treat 594'-6" as top of the fuel and necessary to ensure proper actions are taken in the event that one of the channels of SFP level instrumentation is lost or in the event that level is decreasing due to a hole in one of the pools.

**[Clearly labeled sketch with Levels 1, 2, and 3 and measurement range]**

**[Ginna]**

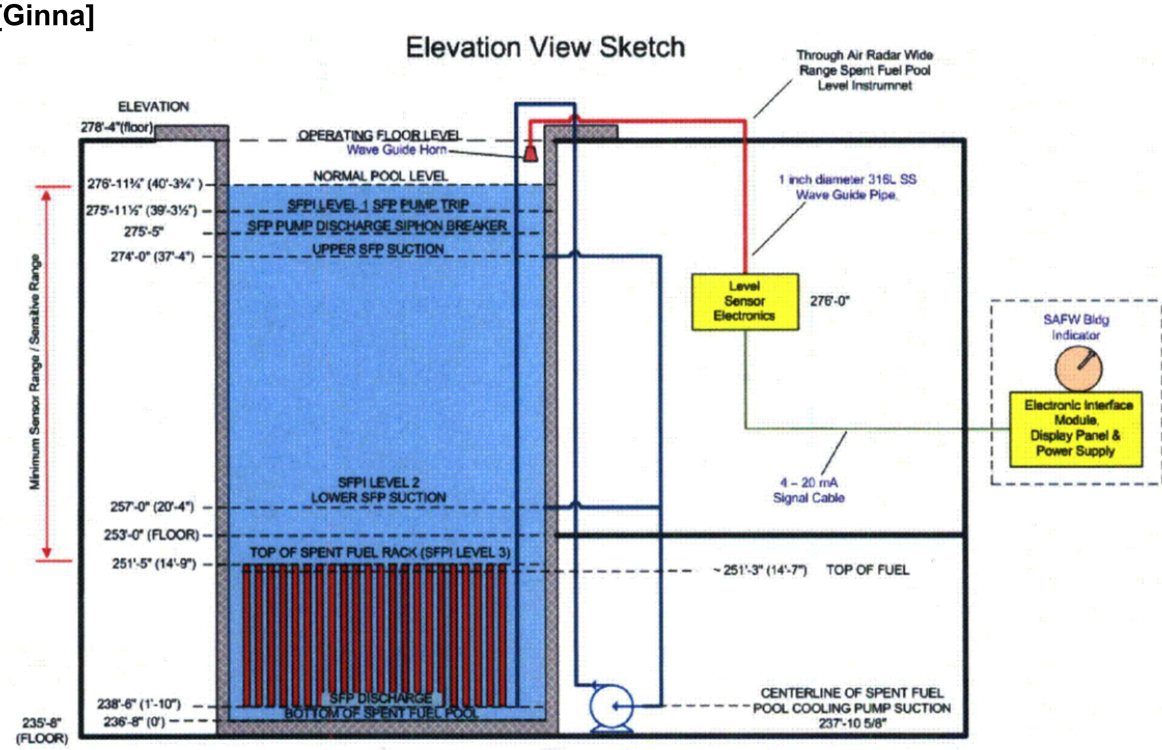



Figure 1

3.3 Design Features: Instruments

**Information needed by the staff:**

- Licensee should specify the number of channels proposed for each SFP pool to be monitored.
- Licensee should show that instrument measurement range overlaps Levels 1, 2, and 3.
- Licensee should provide description of the technology selected, and an evaluation of how that technology does not adversely impact normal SFP operations, nor is adversely impacted by normal or emergency SFP operations (e.g., EMI/RFI emissions or susceptibility, boric acid corrosion effects, etc.)
- If a portable level instrument is used, licensee should provide a description of its stored and installed locations and whether the instrument has the capabilities that enable plant personnel to install and operate it when continuous access to the SFP area is prohibited because of the harsh conditions expected.
- Licensee should provide a justification for the specific number of channels proposed for each SFP pool monitored. For SFPs that are interconnected, licensee should describe how both instruments can monitor the required levels in both pools, and show how Level 3 can be monitored by both primary and backup instruments if the level drops below the bottom of the interconnecting channel.
- Licensee should provide a description of the intended use of any gates between pools and interconnecting fuel transfer channels so that the staff has an understanding of the potential duration of such installation.
- If wireless has been proposed, licensee should describe the appropriate steps taken to evaluate for potential EMI/RFI and cyber security interactions.
- If intermittent operation has been credited, licensee should provide information indicating that instrument set-up can be accomplished in a timely manner, the power supply capacity has still been appropriately estimated inclusive of reasonable margin, and that operators can detect failures or excessive instrument drift in a timely manner.

**[Number of channels and instrument range]**

**[Brunswick]**

The instrumentation will consist of two separate permanent fixed instrument channels per pool to monitor the SFP water level continuously, from normal water level (approximately 116 feet 4 inches plant elevation) down to a level at the highest point of any fuel racks at approximately 95 feet 7¾ inches plant elevation.

**[Number of channels for gate configuration for shared pools]**

**[Harris]**

The installation and removal of SFP gates are controlled by plant procedures. Site procedures specify:

After an activity that requires an SFP gate to be installed, the gate should be deflated and removed to comply with the site-specific SFP mitigation strategy of B.5.b.

SFP gates can be installed in various combinations for various reasons. (e.g., refueling operations, maintenance, decontamination activities) For example, Gates 1 and 2 are installed as a prerequisite to refueling operations. (See Figure 1 in the February 28, 2013, submittal1 for gate locations relative to active SFPs A, B, and C.)

Depending on the activity, various combinations of gates can be installed for as little as hours or up to several weeks. Before the requirements of EA-12-051 are fully implemented at SHNPP, procedural controls will be enacted to track gate installation to ensure that a single active SFP is not isolated from another active SFP for greater than90-days.

Compensatory measures if an isolated active SFP's associated level channel fails comprise of:

- Expedited repair/replacement of the failed instrument.
- Removal of the gate(s) isolating the SFP from a functional level channel as soon as practicable.

## 3.4 Design Features: Arrangement

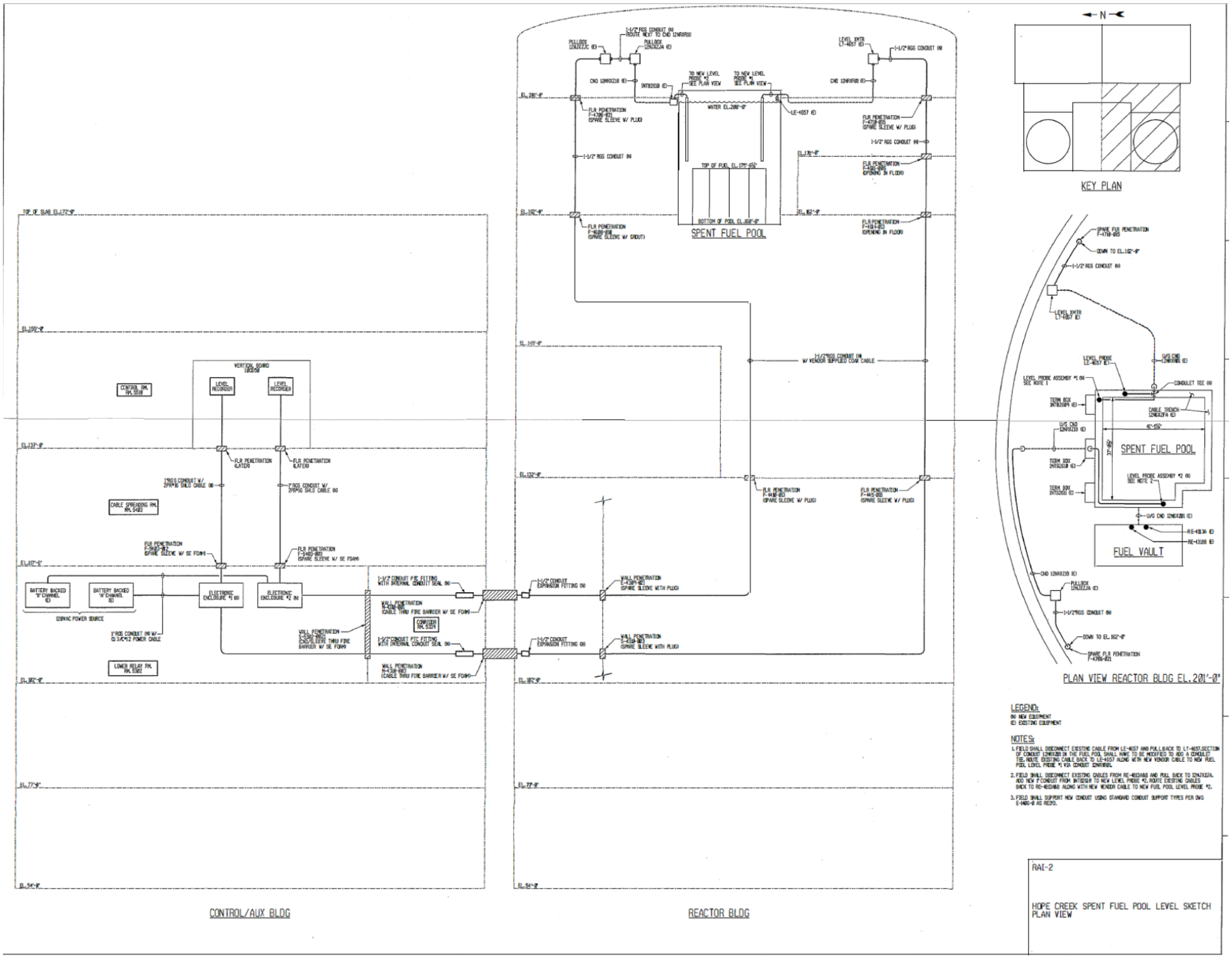
**Information needed by the staff:**

- Licensee should provide a reasonably detailed description of the location of the level instruments and the various instrument channel components.
- Licensee should describe the routing of cables as providing sufficient separation to ensure that the level measurement channels are protected against a common missile within the SFP area, and in other applicable areas where the potential for missiles is credible under BDB event conditions. (See also Slide 35—Independence)
- Licensee should provide a sketch depicting the location of sensors, local electronics panels, displays, and interconnecting cable routing to illustrate the planned location of the equipment.

**[Clearly labeled sketch and narrative of SFP level instrumentation arrangement]**

**[Hope Creek]**

Specifically, the sensors will be in different corners of the SFP and separated by a distance comparable to the shortest side of the pool. The interconnecting cables that extend from the sensors toward the location of the electronics enclosures will be installed using separate routes and separate but existing embedded conduits for transition from the SFP to the first junction point. The existing embedded conduits in the floor concrete provide a physical barrier to protect from potential missile hazards. From the first junction point until the cable leaves the Reactor Building, and transitions into the Auxiliary Building, separate conduit routes are used to protect the cable from potential missile hazards. In the Auxiliary Building, the cables will be routed using HCGS installation criteria for cable separation E-1408 “Wire Cable Notes and Details” over the entire length of the cable.




## 3.5 <u>Design Features: Mounting</u>

**<u>Information needed by the staff:</u>**

- Licensee should provide a description and specific location (e.g., curb, floor, etc.) of the sensor mounting mechanism.
- Licensee should provide a summary of its analysis of the results from seismic testing (if any) to seismic response spectra that envelope the maximum seismic ground motion for the installed location, verifying that the seismic testing of the sensor probe assembly and the electronics units, and the licensee's analysis of the combined maximum seismic and

hydrodynamic forces on the sensor probe assembly exposed to the potential sloshing effects, are within acceptable allowances. (See also Slide 26)

- The licensee should describe why there will be no adverse interactions between the SFP instrument and any equipment stored in the pool.
- If Licensee elects to describe its methodology for mounting as being the same as the methodology used for mounting safety related equipment, this would be acceptable, provided that they also describe how the additional forces due to hydrodynamic pool response have been addressed.
- If the licensee can show that they already have a description within their current licensing basis SAR as to how commercial grade equipment will be mounted to Class I structures, systems, and components, this would be acceptable, provided that they also describe how the additional forces due to hydrodynamic pool response have been addressed.
- In any event, licensee should describe its analysis methodology for ensuring the mounting bracket and attached equipment can withstand the seismic and other (e.g., pool sloshing) dynamic forces by summarizing the structural design inputs, their bases, the method used to ensure structural integrity of affected structures/ equipment, and a summary of the comparison of the analyses results to established allowable criteria and their bases.

**[Browns Ferry and Sequoyah]**

Level transducers will be mounted to the SFP in accordance with Safety Related, Seismic Category I, requirements as defined in the BFN seismic design basis. The remaining channel components and cable routing shall be mounted in accordance with the BFN Seismic Category I design requirements.

**[Indian Point]**

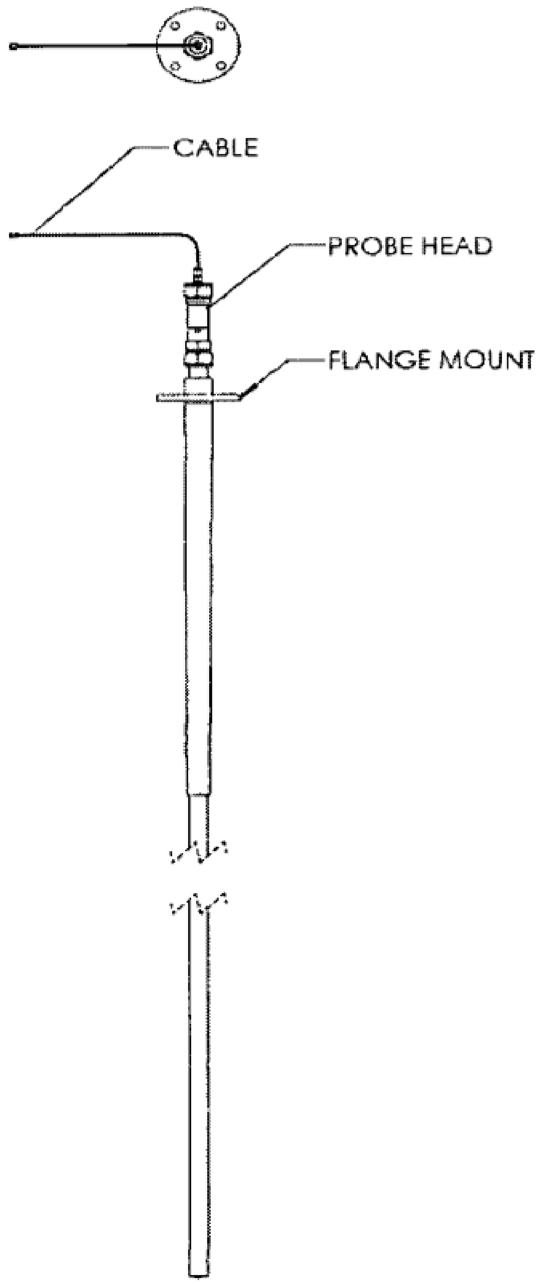
The loading on the probe mount and probe body includes both seismic and hydrodynamic loading using seismic response spectra that bound the IPEC design basis maximum seismic loads applicable to the installation location(s). The static weight load is also accounted for in the modeling described below but is insignificant in comparison to seismic and hydrodynamic loads. Analytic modeling is being performed by the instrument vendor using Institute of Electrical and Electronic Engineers IEEE 344-2004 methodology.

The simple unibody structure of the probe assembly makes it a candidate for analytic modeling and the dimensions of the probe and complex hydrodynamic loading terms in any case preclude meaningful physical testing.

A detailed computational SFP hydrodynamic model has been developed for the instrument vendor by Numerical Applications, Inc., author of the GOTHIC computational fluid dynamics code. The computational model accounts for multi-dimensional fluid motion, pool sloshing, and loss of water from the pool.

Seismic loading response of the probe and mount is separately modeled using finite element modeling software. The GOTHIC-derived fluid motion profile in the pool at the installation site and resultant distributed hydrodynamic loading terms are added to the calculated seismic loading terms in the finite element model to provide a conservative estimate of the combined seismic and hydrodynamic loading terms for the probe and probe mount, specific to the chosen installation location for the probe.

The proximal portion of the level probe is designed to be attached near its upper end to a Seismic Category I mounting bracket configured to suit the requirements of a particular SFP. The bracket may be bolted and/or welded to the SFP deck and/or SFP liner/wall according to the requirements of the particular installation per Seismic Category I requirements.




**[Mounting and stored irradiated material in the SFP]**

**[Pilgrim]**

The loading on the probe mount and probe body includes both seismic and hydrodynamic loading using seismic response spectra that bounds the licensee's design basis maximum seismic loads applicable to the installation location(s). The static weight load is also accounted for in the modeling described below but is insignificant in comparison to seismic and hydrodynamic loads. Analytic modeling is being performed by the instrument vendor using Institute of Electrical and Electronic Engineers IEEE 344- 2004 methodology.

The simple unibody structure of the probe assembly make it a candidate for analytic modeling and the dimensions of the probe and complex hydrodynamic loading terms in any case preclude meaningful physical testing.

A detailed computational SFP hydrodynamic model has been developed for the instrument vendor by Numerical Applications, Inc., author of the GOTHIC computational fluid dynamics code. The computational model accounts for multi-dimensional fluid motion, pool sloshing, and loss of water from the pool.

Seismic loading response of the probe and mount is separately modeled using finite element modeling software. The GOTHIC-derived fluid motion profile in the pool at the installation site and resultant distributed hydrodynamic loading terms are added to the calculated seismic loading terms in the finite element model to provide a conservative estimate of the combined seismic and hydrodynamic loading terms for the probe and probe mount, specific to the chosen installation location for the probe.

The proximal portion of the level probe is designed to be attached near its upper end (refer to Figure 2) to a Seismic Category I mounting bracket configured to suit the requirements of a particular SFP. The bracket may be bolted and/or welded to the SFP deck and/or SFP liner/wall according to the requirements of the particular installation per Seismic Category I requirements.

An evaluation of non-special nuclear material inventory located in the SFP will be performed during the Spent Fuel Pool Instrumentation (SFPI) modification process. Non-special nuclear material access to the SFP is governed by Procedure 1.16.1, Spent Fuel Pool Non-SNM Inventory Control. This procedure will be used to prevent any instrument interference from non-special nuclear materials. Special nuclear materials are stored in SFP racks, under administrative controls of Entergy Procedure EN-NF-200; Special Nuclear Materials Controls.

**[Ginna]**

Other material stored in the SFP (fuel handling equipment) will not adversely impact the level instrumentation as the horn antenna is cantilevered over the edge of the SFP and there is no portion that contacts the SFP water. Therefore, interaction with material stored in the SFP is not possible.

**[CONFIRMATORY RAI - Mounting]**

**Please provide the analyses verifying that the seismic testing of the sensor/probe assemblies and the electronics units, and the analysis of the combined maximum seismic and hydrodynamic forces on the cantilevered portion of the assembly exposed to the potential sloshing effects, show that the SFP instrument design configuration will be maintained during and following the maximum seismic ground motion considered in the design of the SFP structure.**

**[Mechanical and Civil Engineering Branch RAI for mounting]**

**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.**

3.6 Design Features: Qualification

It appears to the staff that vendor supplied information may be necessary to provide a response to address the reliability of the SFP level instrumentation under BDB event conditions.

**Information needed by the staff: Post Event Conditions**

- Licensee should identify the appropriate environmental conditions (temperature, humidity, radiation) where each component of the level instrument/SFP instrument channel will be installed.
- Licensee should describe the specific method or combination of methods used to demonstrate the reliability of the permanently installed equipment under BDB ambient temperature, humidity, and radiation conditions.
- Licensee should identify the maximum expected radiological conditions (dose rate and total integrated dose) to which the transmitter electronics located will be exposed.
- Licensee should provide information indicating the maximum total integrated dose the electronics for this equipment can withstand, and discusses the time period over which the analyzed total integrated dose was applied.
- Licensee should indicate the maximum expected ambient temperature and relative humidity in the room in which the channel electronics will be located under BDB conditions, with no ac power available to run heating ventilation and air conditioning (HVAC) systems.
- Licensee should indicate whether the sensor electronics are capable of continuously performing required functions under this expected temperature and relative humidity conditions.

**Information needed by the staff: Shock and Vibration**

- Licensee should describe the specific method or combination of methods to be applied to demonstrate the reliability of the permanently installed local sensor and electronics cabinet equipment under BDB shock and vibration conditions.
- Licensee should identify the specific commercial or military standards used to define the parameters of the shock and vibration testing as well as the specific acceleration (g)-forces and frequency response spectra applied during the test.
- Licensee should describe previous testing, or proposed testing that is planned for use in demonstrating that the level probe and components within the SFP area will survive high shock and vibration levels.
- Licensee should describe planned shock and vibration testing for the electronics cabinet that is mounted outside the SFP area, including the display panel, or provides summary

of previous testing on similar devices, or other justification for not planning any new testing.
- Licensee should provide results for the selected methods, tests and analyses used to demonstrate the qualification and reliability of the installed equipment in accordance with the Order requirements.

**Information needed by the staff: Seismic**

- Licensee should provide a demonstration of the reliability of the SFP Instrument channel components under design basis seismic conditions. The results of vendor tests or licensee analyses demonstrating that the instrument channel components will continue to function following application of the test response spectrum enveloping the plant-specific forces should be summarized.
- Licensee should describe how the results of any vendor analysis and seismic testing results showing that SFP level instrument performance reliability following such tests will envelope the plant-specific maximum design basis conditions.
- Licensee should include in its summary the structural design inputs, their bases, and methodology used to ensure the structural integrity of the mounting of electronic equipment onto plant structures, and a summary of the comparison of the results with established allowable criteria, as requested in "Design Features: Mounting."
- If Licensee elects to describe its methodology for demonstrating seismic reliability as being the same as the methodology used for seismically qualifying Class 1E/safety related equipment, this would be acceptable. Simply describe where in the FSAR this methodology is discussed and then show how the results compare with established allowable criteria, as requested above.
- If the licensee has a description within their current licensing basis SAR as to how any high-reliability, commercial grade equipment will be seismically mounted to Class I structures, systems, and components, this would also be acceptable. Describe where in the FSAR this methodology is described and then show how the results compare with established allowable criteria, as requested above.

**[Quality Assurance Process]**

**[STP]**

The instrumentation systems will not be safety-related, but will meet the requirements for augmented quality in accordance with NEI 12-02 [Rev.1] and the ISG as described below.

**[River Bend]**

Augmented quality requirements will be applied to all components in the instrumentation channels for:

- design control
- procurement document control
- instructions, procedures, and drawings
- control of purchased material, equipment, and services

- inspection, testing, and test control
- inspections, test, and operating status
- nonconforming items
- corrective actions
- records
- audits

3.7 Design Features: Independence

**Information needed by the staff:**

- Licensee should demonstrate that the design prevents failure of a single channel from causing the alternate channel to fail.
- Licensee should describe physical separation within the SFP area will be to the greatest extent practicable (missile protection).
- Licensee should describe planned physical separation of the two channels accomplished by separately routing cable and conduit as much as practical, or by using station design basis methods. The licensee should show that within the SFP area, the cable routing for two channels remains separated to greatest extent practicable. The licensee should show that instrument channel cables routed external to potential missile areas are separated in accordance with current plant licensing bases criteria for electrical separation to protect against plant hazards.
- Licensee should describe the plan for provision of independent normal and back-up power sources.
- Licensee should provide description of the final configuration of the power supply source.
- Licensee should provide a demonstration that failure of the power supply to either the primary or back-up instrument channel would have no effect on the operations of the other channel.

**[Vermont Yankee]**

The primary instrument (Channel A) will be along the east wall and the backup instrument (Channel B) will be along the west wall of the SFP, both at the south end. Locating the new instruments along opposite walls of the SFP takes advantage of the distance between the probes (approximately 39 feet) for missile and debris protection. Channel A and B displays will be located in the main control room on the existing panels containing the Containment Atmospheric Dilution (CAD) System components.

The conceptual design provides two independent level instruments in the SFP with cabling routed to two display/processors mounted in the Main Control Room (MCR). Power for each channel is provided from independent 120VAC, 60 Hz power sources. Backup power is provided by a battery capable of providing continuous display operation for at least three days. The battery will be provided with the display/processor. The design prevents failure of a single channel from causing the alternate channel to fail. Channel separation and independence are maintained consistent with existing design basis requirements.

The design provides two identical non-safety related wide-range level instruments which feed two independent trains of non-safety cable and indicators to provide a highly reliable remote display of SFP water level in the main control room. Physical separation of the two channels will be accomplished by separately routing cable and conduit as much as practical. The use of raceways (i.e., conduit or covered trays where appropriate for existing hazards) will provide additional protection from damage due to debris during a BDB event.

Each Control Room display/processor will have a battery installed in the display enclosure which is capable of providing power for at least three days.

**[Diablo Canyon]**

Within the SFP area, the brackets will be mounted on the South (primary sensor) and North (back-up sensor) sides of the pool for Unit 1 and the North (primary sensor) and South (back-up sensor) sides of the pool for Unit 2, as permanent plant structures allow. Placing the brackets and probes on opposite sides allows for natural protection from a single event or missile from disabling both systems. The cabling within the SFP area will be routed in separate hard pipe conduit. All conduit routing and location of system components will be designed such that there will be no adverse seismic interactions.

Each system will be installed using completely independent cabling structures, including routing of the interconnecting cable within the SFP area in separate hard-pipe conduits. Power sources will be routed to the electronics enclosures from electrically separated sources ensuring the loss of one train or bus will not disable both channels. The system displays will be installed in separate qualified National Electrical Manufacturers Association 4X or better enclosures, with the primary and back-up display in the control room. Primary and backup systems will be completely independent of each other, having no shared components.

3.8 Design Features: Power Supplies

**Information needed by the staff:**

- Licensee should describe approach to providing adequate power to the instrument. For example, normal power supply for the primary and backup instruments comes from (independent) redundant sources.
- Licensee should describe capacity and ability of the level instrument to switch in (either automatically or manually) an alternate power source.
- Licensee describes the capacity and duration of permanent installed battery capacity for continuous operation.
- Licensee should provide the results of any analyses depicting the battery backup duty cycle requirements to ensure that battery capacity is sufficient to maintain the level indication function until offsite resource availability is reasonably assured.
- For intermittent operation:
  - Licensee should demonstrate that power interruption does not significantly affecting the accuracy and reliability of the instrument reading.
  - Licensee should describe the sample rate and sample duration assumed under intermittent monitoring usage and an explanation as to whether the proposed

sampling rate and information storage capabilities/capacity is determined by the instrument features, or by plant procedures.

**[Indian Point]**

- Each instrument channel is normally powered from a 120/118 VAC 60 Hz plant distribution panel to support continuous monitoring of SFP level. The primary channel will receive power from a different 480V bus than the backup channel. Therefore, loss of any one 480V bus does not result in loss of normal 120VAC power for both instrument channels.

- On loss of normal 120/118VAC power, each channel's UPS automatically transfers to a dedicated backup battery. If normal power is restored, the channel will automatically transfer back to the normal AC power.

- The backup batteries are maintained in a charged state by commercial-grade uninterruptible power supplies. The batteries are sized to be capable of supporting monitoring for a minimum of 3 days of operation. This provides adequate time to allow the batteries to be replaced with a fresh battery or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049 Revision 0.

- An external connection permits powering the system from a portable power source.

- Instrument accuracy and performance are not affected by restoration of power or restarting the processor.

The sample rate estimates have been developed by the vendor using conservative instrument power requirements and measured battery capacity with draw-downs during and following exposure of the batteries to their maximum operating temperature for up to seven days. The instrument configuration is planned to be established for an automated sample rate when under battery power consistent with seven days continuous operation. Permanent installed battery capacity for seven days continuous operation is planned consistent with NEI 12-02 duration without reliance on or crediting of potentially more rapid FLEX Program power restoration.

Batteries are readily replaceable via spare stock without the need for recalibration to maintain accuracy of the instrument. These measures ensure adequate power capacity and margin.

Each display/processor in the Fan House will have a battery installed adjacent to the display enclosure which is capable of providing power for at least three days.

**[Sizing of the battery]**

**[STP]**

Sizing of the battery backup for the instrument is based on ability of the sensor to supply full load (20 mA) for a duration to be specified, with built-in safety margin.  Sizing of the battery will be verified by calculation and/or test prior to installation. The battery backup will be dedicated to the instrument. Currently installed station batteries will not be used for this battery backup.

**[CONFIRMATORY RAI]**

**Please provide the results 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.**

3.9 Design Features: Accuracy

**Information needed by the staff:**

- Licensee should provide evidence of the testing or analysis performed to determine the expected installed design accuracy, given the normal and environmental conditions expected to be present under BDB events.
- Licensee should demonstrate that the design accuracy is sufficiently accurate to enable personnel to discern when level exceeds Levels 1, 2, & 3 without conflicting or ambiguous indication.
- Licensee should indicate that this accuracy is applicable to the full required measured range.
- Licensee should provide a description indicating that the calibration frequency is commensurate with the expected instrument drift and/or provide description of the method that will be used to indicate that the device needs to be recalibrated.
- Licensee should provide evidence that the device retains its design calibration upon re-power-up following a loss of power.

**[South Texas Project]**

The accuracy of the instrument channel is affected under BDB conditions (i.e., radiation, temperature, humidity, post-seismic and post-shock conditions). The stainless steel horn antenna and waveguide pipe that are exposed to BDB conditions are largely unaffected by radiation, temperature and humidity other than a minor effect of condensation forming on the waveguide inner walls which will have a slight delay effect on the radar pulse velocity. Condensation is prevented from pooling in the waveguide and thus blocking the radar signal by placement of weep holes at low points in the waveguide pipe. A minor effect on the length of the overall measurement path can occur due to temperature related expansion of the waveguide pipe. The waveguide pipe permits the sensor receiver to be located in mild environment conditions (i.e. the MAB) so that the effect of elevated temperature on sensor receiver accuracy is also limited. Based on the […] Operating Instruction Manual for the […] instrument, a small correction factor is applied on the radar beam velocity to account for the impact of saturated steam at atmospheric pressure. Testing performed in saturated steam and saturated steam combined with smoke environments indicates that the overall effect on the instrument accuracy is minimal. The overall accuracy due at BDB conditions is conservatively estimated to not exceed ± 3 inches.

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 will be based upon the difference between readings from the Primary and Backup level instruments. The estimated design accuracy for each instrument is ±1 in. The maximum deviation between the two instrument channels for determining that instrument calibration is needed will be ±2 inches based on a still water level in the pool. This maximum deviation is subject to change if the design accuracy discussed in the response to RAI-7a above changes.

**[Indian Point]**

- Accuracy: The absolute system accuracy is better than + 3 inches. This accuracy is applicable for normal conditions and the temperature, humidity, chemistry, and radiation levels expected for BDBE event conditions.

- Trending: The display trends and retains data when powered from either normal or backup power.

- Restoration after Loss of Power: The system automatically swaps to available power (backup battery power or external power source) when normal power is lost. Neither the source of power nor system restoration impact accuracy. Previously collected data is retained.

- Diagnostics: The system performs and displays the results of real-time information related to the integrity of the cable, probe, and instrument channel.

The instrument channel level accuracy will be specified as ± 3.0 inches for all expected conditions. The expected instrument channel accuracy performance would be approximately ±1% of span [based on the sensitive range of the detector]. This is a conservative bounding instrument channel accuracy with the vendor estimating expected instrument channel accuracy is approximately one-third of the above bounding accuracy.

In general relative to normal operating conditions, any applicable calibration procedure tolerances [or acceptance criterion] are planned to be established based on manufacturer's stated/recommended reference accuracy [or design accuracy]. The methodology used is planned to be captured in plant procedures and/or programs.

**[CONFIRMATORY RAI]**

**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**.

3.10 Design Features: Testing

**Information needed by the staff:**

- Licensee should provide a brief description of the design provisions that have been made to enable in-situ testing and calibration.
- Licensee should describe the design provision/method for checking instrument channel calibration and how calibration adjustments may be made with the instruments installed in-situ.
- Licensee should describe any built-in automated testing or diagnostic features enabling plant operators to determine the health of the channel through automatic diagnostics, fault checks, or calibration checking/testing.

**[Ginna]**

Multi-point testing is enabled by means of a radar horn antenna capable of being rotated away from the SFP water surface and aimed at a movable metal target that is positioned at known distances from the horn. This allows checking for correct readings of all indicators along a measurement range and validates the functionality of the installed system.

The Primary and Backup instrument channels will have indicators that can be compared against each other and against any other permanently-installed SFP Level 1 instrumentation. Since the two level channels are independent, a channel check tolerance based on the final design accuracy of each channel will be applied for cross comparison between the two channels. The final accuracy of the instrumentation will be determined following installation testing to develop acceptance criteria for whether recalibration or troubleshooting is needed.

**[Indian Point]**

The display/processor performs automatic in-situ calibration and automatically monitors for cable, connector, and probe faults using time domain reflectometry [TDR] technology.

Channel degradation due to age or corrosion is not expected but can be identified by monitoring trends.

The level instrument automatically monitors the integrity of its level measurement system using in-situ capability. Deviation of measured test parameters from manufactured or as-installed configuration beyond a configurable threshold prompts operator intervention.

Periodic calibration checks of the signal processor electronics to extrinsic National Institute of Standards and Technology (NIST)-traceable standards can be achieved through the use of standard measurement and test equipment.

The probe itself is a perforated tubular coaxial waveguide with defined geometry and is not calibrated. It is planned to be periodically inspected electromagnetically using time domain reflectometry (TDR) at the probe hardline cable connector to demonstrate that the probe assembly meets manufactured specification and visually to demonstrate that there has been no mechanical deformation or fouling.

Each instrument electronically logs a record of measurement values over time in nonvolatile memory that is compared to demonstrate constancy, including any changes in pool level, such as that associated with the normal evaporative loss/refilling cycle. The channel level measurements can be directly compared to each other [i.e., regular cross channel comparisons]. The two displays are installed in close proximity to each other, thus simplifying cross channel checks. Direct measurements of SFP level may be used for diagnostic purposes if cross-channel comparisons are anomalous.

3.11 Design Features: Display

**Information needed by the staff:**

- Licensee should provide a description of the specific planned location of both the primary and the backup channel displays.
- Licensee should address the following criteria for displays that are not located in the control room:
  - The evaluation made to determine that the proposed location may be reached without unreasonable delay, inclusion of the time needed (based on walkdowns) to access the display, and that communications is established between operator and decision makers
  - The evaluation performed to determine that the radiological and environmental conditions through which personnel must pass to get to the proposed location while accessing the display are acceptable
  - The evaluation as to whether the location will remain habitable following a BDB event
  - The evaluation made to determine whether it is planned for personnel to remain at the display location or whether the display will be monitored only periodically

**[Arkansas Nuclear One]**

The primary and backup instrument displays will be located in the Main Control Room (MCR).

**[Wolf Creek]**

The primary display will be located in the Control Room A/C Unit and Filtration Units Room "A", Room 1512 Elevation 2047 ft- 6 in., on the approximate centerline of the Plant West wall. The backup display will be located in the Control Room A/C Unit and Filtration Units Room "B", Room 1501 Elevation 2047 ft - 6 in., on the approximate centerline of the Plant West wall.

Below is an excerpt of a plant drawing being used as a sketch showing the locations of the displays and the control room. The displays are on the wall separating the control room from the Auxiliary Building, to the Plant East. The displays can be promptly viewed by control room staff due an access from the control room to the Control Room A/C Unit and Filtration Units Room "A". An alternate path can be utilized through the communication corridor, into the Auxiliary Building and into either the Control Room A/C Unit and Filtration Units Room "A" or "B". During and after an event, the area of the displays will be accessible by Operations personnel from the control room. The Control Room A/C Unit and Filtration Units Rooms "A" and "B" are located in the control room envelope. The control room envelope is isolated and pressurized during an accident involving the release of radioactive gases in the surrounding zones. Due to the close proximity between the control room and the display locations, use of wireless handheld radios or other equipment for communications will not be necessary.

During drain-down scenarios and external events the control room will be manned. With the displays just outside the control room they are considered "promptly accessible."

**[Generic response by the staff for location outside MCR based, in part, on Fort Calhoun response]**

The primary display location will be located on the upper level of the auxiliary building adjacent to the proposed location of the manifold that will be used to control the distribution of water from FLEX pumps to the emergency feedwater storage tank (EFWST), the reactor coolant system (RCS) and the spent fuel pool (SFP), as shown in the XXX Plant FLEX Overall Integrated Plan (Reference 2, Enclosure, Attachment 3, Figure A-4, Section T-7). This location was selected due to its proximity to a current Appendix R access path (inside a Seismic Class 1 structure) and prompt access to other FLEX water supply monitoring equipment to address response and resources efficiencies.

Radiological habitability at this location has been evaluated against drawings XXX-XX-XXXA (Post TMI radiological condition assessment drawings, or some equivalent) for core melt scenario estimated radiological conditions as well as estimated dose rates from SFP draindown conditions to Level 3, (calculation XXX-1) and exposure to personnel monitoring SFP levels would remain less than emergency exposure limits allowable for emergency responders to perform this action, per the XXX Plant Emergency Plan. Heat and humidity from SFP boildown conditions have been evaluated for this location, and the location is at an elevation below the SFP operating floor and physically separated by closed fire doors from the SFP such that heat and humidity from a boiling SFP would not compromise habitability at this location.

The secondary display location is adjacent to the electrical switchgear room where installed electrical equipment would be manually operated in support of FLEX deployment and implementation. This location at the remote shutdown panel in the upper electrical penetration room is in an area that is physically separated from the primary monitoring location, to allow for scenarios where continuous manning of the primary control location is not warranted or desirable. The secondary monitoring location allows rapid access to and egress from the control room (CR) and the primary FLEX control station in the auxiliary building via pathways that are enclosed within seismically qualified structures. The location for the secondary display is near panel AI-185 which can be seen in Reference 2, Enclosure, Attachment 3, Figure A-3, Section E-6. Radiological habitability at this location has been evaluated with drawings XXX-XX-XXXA (Post TMI radiological condition assessment drawings, or some equivalent) for core melt scenario conditions as well as estimated dose rates from SFP draindown conditions to Level 3, (calculation XXX-1) and exposure to personnel monitoring SFP levels would remain less than emergency exposure limits allowable for emergency responders to perform this action, per the XXX Plant Emergency Plan. Heat and humidity from SFP boildown conditions have been evaluated for this location, and the location is below the SFP operating floor and physically separated by closed fire doors from the SFP such that heat and humidity from a boiling SFP would not compromise habitability at this location.

Spent fuel pool level control and level display monitoring will be the responsibility of the Auxiliary Building Operator also known as the Equipment Operator Nuclear Auxiliary (EONA) position, who will normally be stationed at the location where the primary display will be mounted, once dispatched from the Control Room. Travel time from the Control Room to the primary display is approximately 6 minutes based on walkdowns. Travel time from the Control Room to the secondary display location is approximately 1 minute based on walkdowns. Radiological habitability for the transit routes to both displays has been evaluated with drawings XXX-XX-XXXA (Post TMI radiological condition assessment drawings, or some equivalent) for core melt scenario conditions as well as estimated dose rates from SFP draindown conditions to Level 3, (calculation XXX-1) and exposure to personnel monitoring SFP levels would remain less than emergency exposure limits allowable for emergency responders to perform this action, per the XXX Plant Emergency Plan. Heat and humidity from SFP boildown conditions have been evaluated for access to this location, and the access routes are below the SFP operating floor and physically separated by closed fire doors from the SFP such that heat and humidity from a boiling SFP would not compromise habitability concerns with accessing these displays.

Diverse communications are accessible at both display locations. The operators would first employ radio communications or the Spectralink system as a means of communication. If the radio communications or Spectralink systems are non-functional, the Gai-tronics system is assumed available because it is powered from the station batteries and is located in Seismic Class 1 structures. Gai-tronics are located at both display locations.

3.12 Programmatic Controls: Training

**Information needed by the staff:**

Licensee should provide a description of the approach to training that addresses the guidance.

**[Palisades]**

The Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service.

3.13 Programmatic Controls: Procedures

**Information needed by the licensee:**

Licensee should include a list of the operating (both normal and abnormal response) procedures, and calibration/test, maintenance, and inspection procedures that will be developed, including a brief description of the technical objectives to be accomplished within each procedure.

**[Wolf Creek]**

a) Appropriate quality assurance measures will be selected for the SFPIS required by Order EA-12-051, consistent with Appendix A-1 of NEI 12-02 and similar to those imposed by Regulatory Guide 1.155. Site procedures will be developed for system inspection, calibration and test, maintenance, repair, operation and normal and abnormal responses, in accordance with WCNOC procedure controls.

b) Technical objectives to be achieved in each of the respective procedures are described below.

| | Procedure | Objectives to be achieved |
|---|---|---|
| 1) | System Inspection | To verify that system components are in place, complete, and in the correct configuration, and that the sensor probe is free of significant deposits of crystallized boric acid. |
| 2) | Calibration and Test | To verify that the system is within the specified accuracy, is functioning as designed, and is appropriately indicating SFP water level. |
| 3) | Maintenance | To establish and define scheduled and preventive maintenance requirements and activities necessary to minimize the possibility of system interruption. |
| 4) | Repair | To specify troubleshooting steps and component repair and replacement activities in the event of system malfunction. |
| 5) | Operation | To provide sufficient instructions for operation and use of the system by plant operation staff. |
| 6) | Responses | To define the actions to be taken upon observation of system level indications, including actions to be taken at the levels defined in NEI 12-02. |

3.14 Programmatic Controls: Testing and Calibration

**Information needed by the staff:**

- Licensee should provide a description of its proposed programmatic testing and calibration program—including a statement as to how it will become a part of the normal plant programmatic controls.
- Licensee should describe its plans for programmatically addressing preventive maintenance and spare parts procurement and storage
- Licensee should describe it plans for performing periodic channel checks and functional testing.
- Licensee should provide a description of the calibration test that will be conducted to ensure that the channel is being maintained at its design accuracy.
- Licensee should provide a description of the compensatory actions that will be taken in the event that one of the instrument channels cannot be restored to functional status within 90 days.

**[Pilgrim]**

Performance tests (functional checks) are automated and/or semi-automated (requiring limited operator interaction) and are performed through the instrument menu software and initiated by the operator. There are a number of other internal system tests that are performed by system software on an essentially continuous basis without user intervention but can also be performed on an on-demand basis with diagnostic output to the display for the operator to review. Other tests such as menu button tests, level alarm, and alarm relay tests are only initiated manually by the operator.  Operator performance checks are described in detail in the Vendor Operator's Manual, and the applicable information is planned to be contained in plant operating procedures.

Operator performance tests are planned to be performed periodically as recommended by the equipment vendor, for instance quarterly but no less often than the calibration interval of two years.

Channel functional tests per operations procedures with limits established in consideration of vendor equipment specifications are planned to be performed at appropriate frequencies established equivalent to or more frequently than existing SFPI.

Manual calibration and operator performance checks are planned to be performed in a periodic scheduled fashion with additional maintenance on an as-needed basis when flagged by the system's automated diagnostic testing features.

Channel calibration tests per maintenance procedures with limits established in consideration of vendor equipment specifications are planned to be performed at frequencies established in consideration of vendor recommendations.

SFPI channel/equipment maintenance/preventative maintenance and testing program requirements to ensure design and system readiness are planned to 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). Subject maintenance and testing program requirements are planned to be developed during the SFPI modification design process.

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.

| # Channel(s) Out-of-Service | Required Restoration Action | Compensatory Action if Required Restoration 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. Restore one channel to functional status within 72 hours. | Immediately initiate action in accordance with Note below. |