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

December 5, 2013

Mr. Thomas D. Gatlin
Vice President, Nuclear Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
Post Office Box 88, Mail Code 800
Jenkinsville, SC 29065

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1 - 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 NO. MF1173)

Dear Mr. Gatlin:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A679), to all power reactor licensees and holders of construction permits in active or deferred status. This order requires the licensee to 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.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A099), South Carolina Electric & Gas Company (SCE&G) (the licensee) provided the Overall Integrated Plan (OIP) for Virgil C. Summer Nuclear Station Unit 1 (VCSNS) describing how it will achieve compliance with Attachment 2 of Order EA-12-051 by April 1, 2015. By letter dated July 29, 2013 (ADAMS Accession No. ML13203A180), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided supplemental information by letters dated August 28, 2013 (ADAMS Accession No. ML13247A338), and August 30, 2013 (ADAMS Accession No. ML13247A339).

The NRC staff has reviewed these submittals with the understanding that the licensee will update its OIP as implementation of the Order progresses. With this in mind, the staff has included an interim staff evaluation with this letter to provide feedback on the OIP. The staff's findings in the interim staff evaluation are considered preliminary and will be revised as the OIP is updated. As such, none of the staff's conclusions are to be considered final. A final NRC staff evaluation will be issued after the licensee has provided the information requested.

The interim staff evaluation also includes RAIs, response to which the NRC staff needs to complete its review. The licensee should provide the information requested in the 6-month status updates, as the information becomes available. However, the staff requests that all

information be provided by October 31, 2014, to ensure that any issues are resolved prior to the date by which the licensee must complete full implementation of Order EA-12-051. The licensee should adjust its schedule for providing information to ensure that all this information is provided by the requested date.

If you have any questions regarding this letter, please contact me at 301-415-1009 or via e-mail at Shawn.Williams@nrc.gov.

Sincerely,

Shawn Williams

Shawn Williams, Senior Project Manager
Plant Licensing Branch LPL2-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:
Interim Staff Evaluation and
Request for Additional Information

cc w/encl: Distribution via Listserv

INTERIM STAFF EVALUATION AND REQUEST FOR ADDITIONAL INFORMATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO THE OVERALL INTEGRATED PLAN IN RESPONSE TO ORDER EA-12-051, RELIABLE SPENT FUEL POOL INSTRUMENTATION SOUTH CAROLINA ELECTRIC & GAS COMPANY VIRGIL C. SUMMER NUCLEAR STATION UNIT 1 DOCKET NO. 50-395

1.0 INTRODUCTION

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

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A099), South Carolina Electric & Gas Company (SCE&G) (the licensee) provided the OIP for Virgil C. Summer Nuclear Station (VCSNS) Unit 1, describing how it will achieve compliance with Attachment 2 of Order EA-12-051 by fall, 2015. By letter dated July 29, 2013 (ADAMS Accession No. ML13203A180), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided supplemental information by letters dated August 28, 2013 (ADAMS Accession No. ML13247A338), August 28, 2013 (ADAMS Accession No. ML13242A272), and August 30, 2013 (ADAMS Accession No. ML13247A339).

2.0 REGULATORY EVALUATION

Order EA-12-051 requires all holders of operating licenses issued under 10 CFR Part 50, notwithstanding the provisions of any Commission regulation or license to the contrary, to comply with the requirements described in Attachment 2 to the Order except to the extent that a more stringent requirement is set forth in the license. Licensees shall promptly start implementation of the requirements in Attachment 2 to the Order and shall complete full implementation no later than two refueling cycles after submittal of the OIP or December 31, 2016, whichever comes first.

Order EA-12-051 required the licensees, by February 28, 2013, to submit to the Commission an OIP, including a description of how compliance with the requirements described in Attachment 2 of the Order will be achieved.

Attachment 2 of Order EA-12-051 requires the licensees to have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system, (2) level that is adequate to provide substantial radiation shielding for a person standing on the SFP operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

Attachment 2 of Order EA-12-051 states that SFP 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.

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.

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.

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).

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

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 [alternating current (ac)] and [direct current (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.

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

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

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.

Attachment 2 of Order EA-12-051 states the SFP 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.

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.

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.

On August 29, 2012, the NRC issued an Interim Staff Guidance document (the ISG), JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation" (ADAMS Accession No. ML12221A339), to describe methods acceptable to the NRC staff for complying with Order EA-12-051. The ISG endorses, with exceptions and clarifications, the methods described in the Nuclear Energy Institute (NEI) guidance document NEI 12-02, Revision 1, "Industry Guidance for Compliance with NRC Order EA-12-051, 'To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,'" dated August 2012 (ADAMS Accession No. ML12240A307). Specifically, the ISG states:

> The NRC staff considers the methodologies and guidance in conformance with the guidelines provided in NEI 12-02, Revision 1, subject to the clarifications and

exceptions in Attachment 1 to this ISG, are an acceptable means of meeting the requirements of Order EA-12-051.

3.0 TECHNICAL EVALUATION

3.1 Background and Schedule

VC Summer Nuclear Power Station has a single SFP located in the fuel handling building.

The licensee submitted its OIP on February 28, 2013. The OIP states that installation of the SFP level instrumentation is scheduled for completion prior to startup from the fall 2015 refueling outage.

The NRC staff has reviewed the licensee's schedule for implementation of SFP level instrumentation provided in its OIP. If the licensee completes implementation in accordance with this schedule, it would appear to achieve compliance with Order EA-12-051 within two refueling cycles after submittal of the OIP and before December 31, 2016.

3.2 Spent Fuel Pool Water Levels

Attachment 2 of Order EA-12-051 states, in part, that

> 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 [Level 1], (2) level that is adequate to provide substantial radiation shielding for a person standing on the SFP operating deck [Level 2], and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred [Level 3].

NEI 12-02 states, in part, that

> Level 1 represents the HIGHER of the following two points:
>
> - The level at which reliable suction loss occurs due to uncovering of the coolant inlet pipe, weir or vacuum breaker (depending on the design), or
>
> - The level at which the water height, assuming saturated conditions, above the centerline of the cooling pump suction provides the required net positive suction head specified by the pump manufacturer or engineering analysis.

In the OIP, the licensee stated that Level 1 is the indicated level on either the primary or backup instrument channel of greater than elevation 460 feet (ft.) and 3 inches (3 in.), based on the design level of the anti-siphoning holes that prevent pool drainage below this water level. The licensee also stated that the low water level alarm is at the 461 foot elevation for the present SFP level monitoring system.

In its letter dated August 28, 2013, the licensee stated, in part, that

> The normal SFP water level to support SFP cooling pump operation is the 461.5 feet Elevation. Abnormal Operating Procedures for a decreasing SFP water level requires restoration to the 460.5 feet elevation before returning to normal operation. The NEI 12-02 "Level 1" datum is considered to be 461.5 feet Elevation. Per existing design basis calculations, Net Positive Suction Head (NPSH) margin exists with the SFP level at a Technical Specification minimum level, with the pool at saturated conditions, and a bounding high pump-flow-rate. Therefore, the chosen Level 1 datum of 461.5 feet is greater than a SFP level that would cause loss of NPSH at saturated conditions and also greater than the elevation where the anti-siphoning holes are located.

The NRC staff notes that Level 1 at 461.5 ft. is adequate for normal SFP cooling system operation; it is also sufficient for NPSH and represents the higher of the two points described in NEI 12-02 for this level.

NEI 12-02 states, in part, that

> Level 2 represents the range of water level where any necessary operations in the vicinity of the spent fuel pool can be completed without significant dose consequences from direct gamma radiation from the stored spent fuel. Level 2 is based on either of the following:
>
> - 10 feet (+/- 1 foot) above the highest point of any fuel rack seated in the spent fuel pools, or
>
> - a designated level that provides adequate radiation shielding to maintain personnel radiological dose levels within acceptable limits while performing local operations in the vicinity of the pool. This level shall be based on either plant-specific or appropriate generic shielding calculations, considering the emergency conditions that may apply at the time and the scope of necessary local operations, including installation of portable SFP instrument channel components.

In the OIP, the licensee stated, in part, that

> Indicated level on either the primary or backup instrument channel of greater than elevation 447.5 feet. This elevation is approximately 11 feet above the top of the fuel assemblies stored in the racks (Reference 13). This level would allow radiation shielding protection for personnel on the spent fuel operating deck by limiting the dose rates to approximately 210 mrem/hr. However, it is desirable to limit the dose rates to less than 100 mrem/hr which would require the level to be maintained at greater than elevation 455.5 feet or approximately 19 feet above the top of the fuel assemblies stored in the racks (Reference 5). This monitoring level ensures there is adequate margin in the water level to provide substantial radiation shielding for personnel to respond to Beyond-Design-Basis External Events and to initiate SFP makeup strategies.

In its letter dated August 30, 2013, the licensee provided a sketch depicting the elevations identified for Levels 1, 2, and 3, and the top of the fuel rack. The NRC staff reviewed this sketch and notes Level 2 is identified at an elevation of 455.5 ft., which is the elevation required to limit the dose rate to less than 100 mrem/hr. The staff also notes this level is more than 10 ft. above the top of the fuel racks. The licensee designated Level 2 using the second of the two options described in NEI 12-02 for Level 2.

NEI 12-02 states, in part, that

> Level 3 corresponds nominally (i.e., +/- 1 foot) to the highest point of any fuel rack seated in the spent fuel pool. Level 3 is defined in this manner to provide the maximum range of information to operators, decision makers and emergency response personnel.

In its OIP, the licensee stated that Level 3 is the monitoring level on either the primary or backup instrument channel of greater than an elevation of 436 ft. and 8 in.

In its letter dated August 30, 2013, the licensee provided a sketch depicting the elevations identified as Levels 1, 2, and 3, and the top of the fuel rack. The NRC staff reviewed this sketch and notes Level 3 is identified at an elevation of 437.0 ft., which is above the highest point of any spent fuel storage rack seated in the SFP.

The licensee's proposed plan, with respect to identification of Levels 1, 2, and 3, appears to be consistent with NEI 12-02, as endorsed by the ISG.

3.3 Design Features: Instruments

Attachment 2 of Order EA-12-051 states, in part, that

> 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.

NEI 12-02 states, in part, that

> A spent fuel pool level instrument channel is considered reliable when the instrument channel satisfies the design elements listed in Section 3 [Instrumentation Design Features] of this guidance and the plant operator has fully implemented the programmatic features listed in Section 4 [Program Features].

In its OIP, the licensee stated the primary instrument channels will consist of fixed components and the backup instrument channel will consist of fixed and portable components. The licensee also stated that measured range will be continuous from the normal pool level elevation 461 ft. and 5 in. to the top of the spent fuel seated in the racks at elevation 437 ft. and 5 in.

Furthermore, the licensee stated that the normal value for SFP level of 461 ft. 6 in. is verified twice daily per Operations Administrative Procedure.

In its letter August 28, 2013, the licensee stated the plan has been changed for the backup channel, which was previously to be portable with respect to the waveguide and horn assembly. The licensee also stated the entire backup channel will now be permanently installed meeting all of the requirements of the primary channel and installed to the same standards of the primary channel.

The NRC staff notes the range specified for the licensee's instrumentation will cover Levels 1, 2, and 3 as described in Section 3.2 above. The licensee's proposed plan, with respect to the number of channels and the range of the SFP level instrumentation appears to be consistent with NEI 12-02, as endorsed by the ISG.

3.4 Design Features: Arrangement

Attachment 2 of Order EA-12-051 states, in part, that

> 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 the 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.

NEI 12-02 states, in part, that

> The intent of the arrangement requirement is to specify reasonable separation and missile protection requirements for permanently installed instrumentation used to meet this order. Although additional missile barriers are not required to be installed, separation and shielding can help minimize the probability that damage due to an explosion or extreme natural phenomena (e.g., falling or wind-driven missiles) will render fixed channels of SFP instrumentation unavailable. Installation of the SFP instrument channels shall be consistent with the plant-specific SFP design requirements and should not impair normal SFP function.
>
> Channel separation should be maintained by locating the installed sensors in different places in the SFP area.

In its OIP, the licensee stated the primary instrument channel level sensing components will be located in the southwest corner of the SFP and the backup instrument channel level sensing components will be located in the northwest corner of the SFP. The licensee also stated the back-up channel horn antenna and wave guide would be stored in the east stairwell of the auxiliary building at approximately the 463 foot elevation and the backup channel sensor and display will be permanently installed at a location that is readily accessible to the operator, in the vicinity of the 463 foot elevation of the east stairwell of the auxiliary building.

Since the licensee revised the design to have a permanently fixed backup instrument channel, in its letter dated August 28, 2013, the licensee stated, in part, that

> The back-up channel will be permanently installed to the same standards of the primary channel. The power supply and sensing device will be located outside of the Fuel Handling Building on the exterior west side wall (441 foot elevation) near the north bay entrance to the Auxiliary Building. The read-out device location will be exterior to the building and protected from the elements.
>
> No additional analysis will be performed for deployment since the back-up channel will now be permanently installed.

In its OIP, the licensee provided a figure showing the location of the SFP level instruments. In addition, in its letter dated August 30, 2013, the licensee provided an additional drawing depicting the planned location of the two permanently mounted level probes within the SFP area. The NRC staff reviewed these drawings and notes the primary level sensor would be permanently located in the southwest corner of the SFP and the backup level sensor would be permanently located in the northwest corner of the SFP. These drawings also show the cables are routed separately from the sensors to the instrument display locations.

The staff notes the licensee's proposed location and routing of the cables of the primary and backup level instruments for SFP appears to be consistent with NEI 12-02, as endorsed by the ISG. However, in its letter dated August 28, 2013, the licensee stated the shielding design for the sensor channels has not been completed and the design information will be provided in a six-month update report as it becomes available. The staff has identified this request as:

RAI #1

Please provide additional information describing how the design of shielding for the SFP level instrumentation meets the requirement of the Order to arrange the instruments 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. Also, describe plans for protecting any equipment mounted outside the buildings from the effects of tornado-driven missiles, freezing, elevated temperature, humidity, flooding, and other BDB conditions.

3.5 Design Features: Mounting

Attachment 2 of Order EA-12-051 states, in part, that

> 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.

NEI 12-02 states, in part, that

> The mounting shall be designed to be consistent with the highest seismic or safety classification of the SFP. An evaluation of other hardware stored in the SFP shall be conducted to ensure it will not create adverse interaction with the fixed instrument location(s).
>
> The basis for the seismic design for mountings in the SFP shall be the plant seismic design basis at the time of submittal of the Integrated Plan for implementing NRC Order EA-12-051.

In its OIP, the licensee stated, in part, that

> All permanently installed equipment associated with the level monitoring system will be mounted in accordance with Seismic Class I requirements. Installed equipment will be seismically qualified to withstand the maximum seismic ground motion considered in the design of the plant area in which it is installed and will be consistent with the highest seismic and safety classification applied to the Spent Fuel Pool original design. Should the plant seismic design basis change, changes to the seismic design mountings for the installed level monitoring system will be processed in accordance with station procedures.

In its letter dated August 28, 2013, the licensee stated the seismic design mounting for the SFP level instrumentation has not been completed and the information will be provided in a six-month update report as it becomes available. The NRC staff has identified this request as:

RAI #2

Please provide the following:

a) **The design criteria to be used to estimate the total loading on the mounting device(s), including static weight loads and dynamic loads. Describe the methodology to 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 sensing/waveguide assembly.**

Indicate in a schematic the portions of the level sensor/waveguide 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 wall or floor structures so as to support the waveguide/level sensor assembly.**

(This information was previously requested as RAI-3 in the NRC letter dated July 29, 2013)

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 RAIs.

RAI #3

Please provide an evaluation verifying the seismic testing of the horn and waveguide assembly 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, demonstrate 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.

RAI #4

For each of the mounting attachments required to fasten SFP level equipment to plant structures, please describe the design inputs, and the methodology that will be used to qualify the structural integrity of the affected structures/equipment.

3.6 Design Features: Qualification

Attachment 2 of Order EA-12-051 states, in part, that

> 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).

NEI 12-02 states, in part, that

> The instrument channel reliability shall be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the following sets of parameters, as described in the paragraphs below:
>
> - conditions in the area of instrument channel component use for all instrument components,

- effects of shock and vibration on instrument channel components used during any applicable event for only installed components, and

- seismic effects on instrument channel components used during and following a potential seismic event for only installed components...

The NRC staff assessment of the instrument qualification is discussed in the following subsections below: (3.6.1) Augmented Quality Process, (3.6.2) Post Event Conditions, (3.6.3) Shock and Vibration, and (3.6.4) Seismic Reliability.

3.6.1 Augmented Quality Process

Appendix A-1 of the guidance in NEI 12-02 describes a quality assurance process for non-safety systems and equipment that is not already covered by existing quality assurance requirements. Within the ISG, the NRC staff found the use of this quality assurance process to be an acceptable means of meeting the augmented quality requirements of Order EA-12-051.

In its OIP, the licensee stated that augmented quality requirements, similar to those applied to fire protection, would be applied to this project.

The licensee's proposed quality assurance process appears to be consistent with NEI 12-02, as endorsed by the ISG.

3.6.2 Post Event Conditions

NEI 12-02 states, in part, that

> The temperature, humidity and radiation levels consistent with conditions in the vicinity of the [SFP] and the area of use considering normal operational, event and post-event conditions for no fewer than seven days post-event or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049 should be considered. Examples of post-event (beyond-design-basis) conditions to be considered are:
>
> - radiological conditions for a normal refueling quantity of freshly discharged (100 hours) fuel with the SFP water level 3 as described in this order,
>
> - temperatures of 212 degrees F and 100% relative humidity environment,
>
> - boiling water and/or steam environment,
>
> - a concentrated borated water environment, and...

In its OIP, the licensee stated, consistent with NEI 12-02, in part, that

> Post-event (beyond-design-basis) conditions that will be considered in the design of the components that are subject to conditions in the vicinity of the Spent Fuel Pool are:

- radiological conditions for a normal refueling quantity of freshly discharged (100 hours) fuel with the SFP water level3 as described in this EA-12-049 (Reference 7),
- temperatures of 212 degrees F and 100% relative humidity environment,
- boiling water and/or steam environment,
- a concentrated borated water environment, and...

Related to radiological conditions, in its OIP, the licensee stated, in part, that

> Equipment located in the vicinity of the SFP will be qualified to withstand peak and total integrated dose radiation levels for its installed location assuming that post event SFP water level remains above the fuel for an extended period of time.

In its letter dated August 28, 2013, the licensee stated, in part, that

> Radiation:
>
> The area above and around the pool will be subject to large amounts of radiation in the event water level decreases near the top of the fuel racks. The only parts of the measurement channel in the pool radiation environment are the metallic waveguide and horn, which are not susceptible to the expected levels of radiation. The sensor electronics will be located in an area that does not exceed their $1x10^3$ Rad design limit for the required operating time, or the design will provide shielding as required.

The NRC staff has concerns with the licensee's lack of information regarding its analysis of the maximum expected radiological conditions for the FH building exterior wall and the auxiliary building stairwell that might be considered credible under BDB conditions. The staff is also concerned with the lack of documentation indicating how it was determined the electronics can withstand a total integrated dose of $1X10^3$ Rads. The staff has identified this request as:

RAI #5

Please provide analysis of the maximum expected radiological conditions (dose rate and total integrated dose) to which the equipment located within the FH building exterior wall and the auxiliary building stairwell will be exposed. Also, provide documentation indicating how it was determined the electronics for this equipment is capable of withstanding a total integrated dose of $1X10^3$ Rads. Discuss the time period over which the analyzed total integrated dose was applied.

While addressing post-event temperature and humidity conditions, in its OIP, the licensee stated, in part, that

> Both channels will be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. Sensors and displays are located outside of the area of the pool and are not subject to the radiation, temperature and humidity conditions that are postulated for the areas in the vicinity of the pool during post event conditions. Post event humidity in the Auxiliary Building near and above the SFP is assumed to be 100% with condensing steam. Equipment will be qualified for expected conditions at the installed location assuming that normal power is unavailable and that the SFP has been at saturation for an extended period. ...
>
> The horn antenna and wave guide piping are insensitive to temperature. The "Through Air Radar" system performance is unaffected by vapor, gas composition, pressure and temperature changes at the surface of the pool. The sensor is able to penetrate foam, saturated steam and smoke without any adverse effect on the accuracy of the pool level measurement. Antenna location will not be subject to pool overflow and the mounting of the antenna to the sensor at the wall penetration will be qualified to the SFP area post event environment.

In its letter dated August 28, 2013, the licensee stated, in part, that

> The primary and back-up SFP level channel instrumentation reliability will be established based on a combination of similarity analyses, testing, and operating experience, as described below.
>
> Temperature:
>
> The postulated temperature in the spent fuel pool area that results from a boiling pool is 100 degrees Celsius (212 degree Fahrenheit). The radar sensor electronics will be located outside of the spent fuel pool room in an area where the temperature will not exceed the radar sensor electronics rated design temperature.
>
> Humidity:
>
> The maximum humidity postulated for the spent fuel pool area is 100 percent relative humidity, saturated steam. The radar sensor electronics will be located outside of the spent fuel pool room in an area away from the steam atmosphere. The waveguide pipe can tolerate condensation formation on the inner wall surface, provided condensate pooling does not occur within the waveguide pipe. Condensate pooling is prevented by installing a weep hole(s) at the low point(s) in the wave guide pipe.

Steam:

The ability of the radar wave to propagate through steam has been demonstrated by vendor testing. In addition, "Through Air Radar" has been used in numerous applications that involve measuring the level of boiling liquids. The vendor manual contains a table that provides accuracy correction factors for superimposed gas or vapor including saturated steam at various pressures. Therefore successful operating experience has demonstrated that the through air radar functions at high levels of steam saturation.

The NRC staff notes that information related to the qualification and test program to confirm the reliability of the permanently installed equipment during and following BDB events are not available for review. The staff has identified these requests as:

RAI #6

Please provide information indicating (a) the temperature ratings and whether the temperature ratings for the system electronics are continuous duty ratings; and, (b) the maximum expected ambient temperature in the rooms in which the system electronics will be located under BDB conditions, with no AC power available to run Heating Ventilation and Air Conditioning (HVAC) systems?

RAI #7

Please provide information indicating the maximum expected relative humidity in the rooms in which the system electronics will be located under BDB conditions, with no AC power available to run HVAC systems, and whether the sensor electronics are capable of continuously performing required functions under this expected humidity condition.

3.6.3 Shock and Vibration

NEI 12-02 states, in part, that

Applicable components of the instrument channels are rated by the manufacturer (or otherwise tested) for shock and vibration at levels commensurate with those of postulated design basis event conditions in the area of instrument channel component use using one or more of the following methods:

- instrument channel components use known operating principles, are supplied by manufacturers with commercial quality programs (such as ISO9001) with shock and vibration requirements included in the purchase specification and/or instrument design, and commercial design and testing for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications;

- substantial history of operational reliability in environments with significant shock and vibration loading, such as transportation applications, or

- use of components inherently resistant to shock and vibration loadings or are seismically reliable such as cables.

In its OIP, the licensee stated, in part, that

> Components of the instrument channels will be qualified for shock to Mil-S-901D "Requirements for Shock Tests, High Impact, Shipboard Machinery, Equipment and Systems" (Reference 8) and for vibration to Mil-Std-167 "Mechanical Vibrations of Shipboard Equipment" (Reference 9). For seismic effects on instrument channel components used after a potential seismic event for only installed components (with the exception of battery chargers and replaceable batteries), the following measures will be used to verify that the design and installation is adequate. Applicable components of the instrument channels are rated by the manufacturer (or otherwise tested) for seismic effects at levels commensurate with those of postulated design basis event conditions in the area of instrument channel component use. Adequacy of seismic design and installation is demonstrated based on the guidance in Sections 7, 8, 9, and 10 of IEEE Standard 344-2004, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, (Reference 10) or a substantially similar industrial standard.

In its letter dated August 28, 2013, the licensee stated, in part, that

> Shock and Vibration:
>
> The "Through Air Radar" sensor was shock and vibration tested in accordance with MIL-S-901D and MIL-STD-167-1. This shock and vibration testing only applies to the sensor. The waveguide piping is 3 inch diameter Schedule 40 piping and is seismically anchored to the floor. Thus the waveguide piping is not considered to be sensitive to shock or vibration. The power supply panel contains components that are part of the standard VEGA Mobile Remote Display. In addition, the readout portion of the display panel (PLICSCOM), was installed in the sensor during the shock and vibration testing. The Mobile Remote Display is designed for truck-mounted mobile applications subject to shock and vibration from normal handling, after transportation and setup on the job. Per NEI 12-02, designing instruments for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications, is an acceptable measure for verifying that the design is adequate to withstand shock and vibration. This panel is therefore considered to have an acceptable resistance to shock and vibration.

The NRC staff notes the use of MIL-STD-901D is an acceptable method for shock testing. However, the staff has concerns regarding the lack of information describing the tests, applied forces, and the operability condition of the sensor after the tests were completed. The staff has identified this request as:

RAI #8

Please provide information describing the evaluation of the comparative sensor design, the shock test method, test results, and forces applied to the sensor applicable to its successful tests demonstrating the referenced previous testing provides an appropriate means to demonstrate reliability of the sensor under the effects of severe shock.

In addition, the NRC staff notes the use of MIL-STD-167-1 is an acceptable method for vibration testing. However, the staff has concerns with the lack of information describing the tests, applied forces and their directions and frequency ranges, or the operability condition of the sensor after the tests were completed. The staff has identified this request as:

RAI #9

Please provide information describing the evaluation of the comparative sensor design, the vibration test method, test results, and the forces and their frequency ranges and directions applied to the sensor applicable to its successful tests, demonstrating the referenced previous testing provides an appropriate means to demonstrate reliability of the sensor under the effects of high vibration.

The NRC staff also notes the readout portion of the display panel was installed in the sensor during the shock and vibration testing. The NRC staff has concerns with the lack of information describing the manufacturer's shock and vibration ratings for this equipment and the results of any testing performed by the manufacturer against postulated plant conditions under design basis events. The staff has identified this request as:

RAI #10

Please provide results of the manufacturer's shock and vibration test methods, test results, and the forces and their frequency ranges and directions applied to the display panel associated with its successful tests.

3.6.4 Seismic Reliability

The ISG recommends the use of Sections 7, 8, 9, and 10 of IEEE 344-2004 for seismic qualification of the SFP level instrumentation.

In its OIP, the licensee stated, in part, that

> For seismic effects on instrument channel components used after a potential seismic event for only installed components (with the exception of battery chargers and replaceable batteries), the following measures will be used to verify that the design and installation is adequate. Applicable components of the instrument channels are rated by the manufacturer (or otherwise tested) for seismic effects at levels commensurate with those of postulated design basis event conditions in the area of instrument channel component use. Adequacy of seismic design and installation is demonstrated based on the guidance in Sections 7, 8, 9, and 10 of IEEE Standard 344-2004, *IEEE Recommended*

> *Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,* (Reference 10) or a substantially similar industrial standard.

In its letter dated August 28, 2013, the licensee stated, in part, that

> A seismic shake test will be performed to the requirements of IEEE 344-2004 for elements of the "Through Air Radar" to levels anticipated that will envelope most if not all plants in the United States. The equipment to be tested includes the sensor, readout and power control panel, horn end of the waveguide, pool end and sensor end mounting brackets, and waveguide piping. The items will be tested to the Required Response Spectra (RRS) contained in EPRI TR-107330 to account for the potentially high seismic motion that could occur to the cabinet-mounted readout and the power control panel. This RRS will also envelop the seismic ground motion for items mounted to the building structure, pool edge, etc.
>
> The seismic testing described in RAI#4 b) [above] includes testing the system for functionality prior to and post seismic testing, which include verification of the instrument accuracy.

The NRC staff notes the licensee will demonstrate the requirements of the seismic design and installation in accordance with NEI 12-02, as endorsed by the ISG. The licensee's planned approach with respect to the seismic reliability of the instrumentation appears to be consistent NEI 12-02, as endorsed by the ISG. 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 #11

Please provide an evaluation of the seismic testing results to show that the instrument performance reliability, following exposure to simulated seismic conditions representative of the environment anticipated for the SFP structures at Virgil C. Summer Nuclear Station has been adequately demonstrated. Include information describing the design inputs and methodology used in any analyses of the mounting of electronic equipment onto plant structures, as requested in RAI #4 above.

3.6.5 Qualification Evaluation Summary

Upon acceptable resolution of the RAIs in Section 3.6, the NRC staff will be able to make a conclusion regarding the instrument qualification.

3.7 Design Features: Independence

Attachment 2 of Order EA-12-051 states, in part, that

> The primary instrument channel shall be independent of the backup instrument channel.

NEI 12-02 states, in part, that

> Independence of permanently installed instrumentation, and primary and backup channels, is obtained by physical and power separation commensurate with the hazard and electrical isolation needs. If plant AC or DC power sources are used then the power sources shall be from different buses and preferably different divisions/channels depending on available sources of power.

In its OIP, the licensee stated, in part, that

> The primary instrument channel will be redundant to and independent of the backup instrument channel. The power sources for the primary and backup channels will be independent through the utilization of standalone battery power. The channels will be separated by a distance commensurate with the shortest length of a side of the spent fuel pool as defined by NEI 12-02 Section 3.2.

In its letter dated August 28, 2013, the licensee stated, in part, that

> NEI 12-02 Section 3.2 provides the guidance for separation of the primary and back -up channels. The guidance is to be "separated by a distance commensurate with the shortest length of a side of the spent fuel pool." The primary horn will be located at the southwest corner of the pool and the back-up horn will be located at the northwest corner of the pool. The horn, waveguide, sensor, readout devices and power supply panels are all separated by this distance.
>
> The primary and back-up channels have completely independent power supplies and as described in the response to RAI #5 a) above, all of the components for each channel are "separated by a distance commensurate with the shortest length of a side of the spent fuel pool." In addition, the primary and back-up channel electronics will also be located at different plant elevations. The approximate locations will be at the 468 foot elevation for the primary channel and at the 441 foot elevation for the back-up channel.

The NRC staff notes that with this arrangement, the loss of one backup power supply will not affect the operation of the independent channel under BDB event conditions. The implementation of such design provisions appears to be consistent with NEI 12-02, as endorsed by the ISG, and the electrical functional performance of each level measurement channel would be considered independent of the other channel. The NRC staff plans to verify the final electrical power supply design information when it is provided. The NRC staff has identified this request as:

RAI #12

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

3.8 Design Features: Power Supplies

Attachment 2 of Order EA-12-051 states in part, that

> 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.

NEI 12-02 states, in part, that

> The normal electrical power supply for each channel shall be provided by different sources such that the loss of one of the channels primary power supply will not result in a loss of power supply function to both channels of SFP level instrumentation.
>
> All channels of SFP level instrumentation shall provide the capability of connecting the channel to a source of power (e.g., portable generators or replaceable batteries) independent of the normal plant AC and DC power systems. For fixed channels this alternate capability shall include the ability to isolate the installed channel from its normal power supply or supplies. The portable power sources for the portable and installed channels shall be stored at separate locations, consistent with the reasonable protection requirements associated with NEI 12-06 (Order EA-12-049). The portable generator or replaceable batteries should be accessible and have sufficient capacity to support reliable instrument channel operation until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049.
>
> If adequate power supply for either an installed or portable level instrument credits intermittent operation, then the provisions shall be made for quickly and reliably taking the channel out of service and restoring it to service. For example, a switch on the power supply to the channel is adequate provided the power can be periodically interrupted without significantly affecting the accuracy and reliability of the instrument reading. Continuous indication of SFP level is acceptable only if the power for such indication is demonstrably adequate for the time duration specified in section 3.1[.]

In its OIP, the licensee stated, in part, that

> Both the primary and back-up channels will be powered from dual selectable power supplies utilizing dedicated lithium ion batteries with backup batteries available for easy replacement. Minimum expected battery life each battery supply provides for 7 days of continuous service. The battery systems will include provision for battery replacement should the installed battery be non-

> functional following the event. Spare batteries will be readily available to maintain power to the system for the entire period of the FLEX response.

In its letter dated August 28, 2013, the licensee stated, in part, that

> No electrical AC power source is required for either the primary or back-up channel.
>
> Both the primary and back-up channels will be powered from dual selectable power supplies utilizing dedicated lithium ion batteries. The battery systems will include provision for battery replacement should the installed battery be non-functional following the event. The primary and back-up SFP level channel dedicated battery capacity is based on ability of the sensor to supply full load (20 mA) for the duration specified in the plant FLEX mitigation strategy with built-in safety margin. The battery capacity will be verified by analyses and/or test prior to installation. The preliminary estimate of battery capacity is expected to be approximately 6-7 days. It is estimated that a minimum battery capacity of 72 hours is required to align with the FLEX mitigation plan. Battery replacement provisions will be included in the FLEX Phase III strategy to provide continued SFP level monitoring capability.
>
> Spare batteries will be readily available to maintain power to the system for the entire period of the FLEX response. Batteries can be replaced within 15 minutes. Tools, spare batteries and instructions that are required will be maintained at the location of the power supply panel. SFP Level Channel can be returned to service within 30 minutes.

The NRC staff notes the proposed criteria for sizing of the battery backup appears to be consistent with NEI 12-02, as endorsed by the ISG. However, the staff notes the licensee has not completed the sizing calculations. The licensee has not provided information either on how the spare battery will be maintained to ensure that it will be readily available. The staff plans to verify the results of the licensee's calculation for required duty cycle given the final design load of the instrument channel for its installed configuration. The staff has identified this request as:

RAI #13

Please provide the following:

a) **A description of how the spare battery will be maintained to ensure that it will be readily available.**

b) **The results of the calculation depicting the battery backup duty cycle requirements demonstrating that battery capacity is sufficient to maintain the level indication function.**

3.9 Design Features: Accuracy

Attachment 2 of Order EA-12-051 states, in part, that

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

NEI 12-02 states, in part, that

> Accuracy should consider operations while under SFP conditions, e.g., saturated water, steam environment, or concentrated borated water. Additionally, instrument accuracy should be sufficient to allow trained personnel to determine when the actual level exceeds the specified lower level of each indicating range (levels 1, 2 and 3) without conflicting or ambiguous indication.

In its OIP, the licensee stated in part, that

> Instrument channels will be designed such that they will maintain their design accuracy following a power interruption or change in power source without recalibration.
>
> Accuracy will consider SFP conditions, e.g., saturated water, steam environment, or concentrated borated water. Additionally, instrument accuracy will be sufficient to allow trained personnel to determine when the actual level exceeds the specified lower level of each indicating range (levels 1, 2 and 3) without conflicting or ambiguous indication. The Through Air Radar system has accuracy equal to or better than +/- 3 inches.

In its letter dated August 28, 2013, the licensee stated, in part, that

> The manufacturer reference accuracy for the primary SFP level channel is no greater than ±1 inch based on tests performed by vendor. This is the design accuracy value that will be specified for the primary SFP level instrument channel. This value is subject to change dependent on the actual performance with the installed waveguide. The accuracy of the primary SFP level channel is minimally affected by postulated BDB conditions (i.e., radiation, temperature, humidity, post-seismic and post- shock conditions). The stainless steel horn antenna and waveguide pipe that is exposed to Beyond Design Basis (BDB) conditions is unaffected by radiation, temperature and humidity other than a minor effect of condensation forming on the waveguide inner walls. This minor effect will have a slight slowing 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 accuracy is the length of the overall measurement path can change due to temperature related expansion of the waveguide pipe. The waveguide pipe permits the sensor electronics to be located in mild environment conditions so that the effect of elevated temperature on accuracy is also limited. Based on vendor operating instructions for the system, a small correction factor is

applied to account for the impact of saturated steam at atmospheric pressure on the radar beam velocity. Testing performed by vendor using saturated steam and saturated steam combined with smoke indicate that the overall effect on the instrument accuracy is minimal. The overall accuracy due to BDB conditions described above is estimated to not exceed ±3 inches. As part of the engineering change process, the overall level channel uncertainties will be formally documented by an instrument uncertainty calculation.

Operational surveillance procedures will perform periodic channel checks (monthly) for the primary and back-up SFP level instrumentation to verify proper operation. The channel checks will be accomplished by comparison between the presently installed wide-range channel indications, or by comparison to the known SFP physical level elevation reference markings. The acceptance criteria will consider the respective overall channel uncertainty contributions for accuracy, calibration setting tolerance, resolution, and drift as applicable. The back-up channel will be verified during the 12-month functional testing and will also be checked against a known physical level elevation reference marking as part of the deployment Flex Support Guideline for the installation of the back-up channel waveguide and horn during a BDB event.

The NRC staff notes the estimated instrument channel design accuracies and methodology appear to be sufficient to maintain the instrument channels to within their designed accuracies before significant drift can occur. The NRC staff plans to verify that the licensee's proposed instrument performance is consistent with these estimated accuracy values. 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 the proposed instrument performance is consistent with these estimated accuracy normal and BDB values. Demonstrate the channels will retain these accuracy performance values following a loss of power and subsequent restoration of power.

3.10 Design Features: Testing

Attachment 2 of Order EA-12-051 states, in part, that

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

NEI 12-02 states, in part, that

Static or non-active installed (fixed) sensors can be used and should be designed such that testing and/or calibration can be performed in-situ. For microprocessor based channels the instrument channel design shall be capable of testing while mounted in the pool.

In its OIP, the licensee stated, in part, that

> The backup portable channel will not require additional calibration or testing at the time of deployment. Details will be determined during the engineering and design phase for PM Program requirements, testing and calibration frequencies. It is expected that the batteries will be changed annually at the recommended frequency suggested by the OEM. Calibration of the instrument itself is not required. The recommended surveillance testing will be performed within 60 days of a refueling outage and not more than once in a 12 month period to verify channel operability for both the primary channel and the back-up.

However, the NRC staff notes the licensee has changed its approach for implementing the back-up instrument channel, and will be using a permanently-installed set of equipment similar to that of the primary instrument channel.

In its letter dated August 28, 2013, the licensee stated, in part, that

> Both the primary and back-up channels will be functionally tested with a calibration check performed on a 12-month periodicity. There will be no difference in the testing requirements for the back-up channel since the plan has changed to make the entire channel permanently installed.
>
> The back-up channel waveguide tube and horn will now be permanently installed and the channel will receive the same 12-month functional testing with calibration check as the primary channel.
>
> Operational surveillance procedures will perform periodic channel checks (monthly) for the primary and back-up SFP level instrumentation to verify proper operation. The channel checks will be accomplished by comparison between the presently installed wide-range channel indications, or by comparison to the known SFP physical level elevation reference markings. The acceptance criteria will consider the respective overall channel uncertainty contributions for accuracy, calibration setting tolerance, resolution, and drift as applicable.
>
> Periodic channel checks will be established for the primary and back-up SFP level channels to verify proper instrument operation, as described in the response to RAI #7 b). The frequency of the channel checks is expected to be at least monthly (± 25% grace period). This frequency will readily satisfy NEI 12-02 (section 4.3) requirements.
>
> Periodic calibration checks will be performed as described in the response to RAI #8 a). Instrument channel calibration check frequency will be 12 months and performed in accordance with the manufacture recommendations, and/or as established based on operating experience within the preventive maintenance program. As part of the periodic calibration check surveillance for the primary and back-up SFP level channel, further functional verifications will be performed to verify proper operation of the battery back-up feature.

> The channel checks will be performed by Operations surveillance procedures, and the instrument calibrations checks will be performed by Maintenance instrumentation calibration surveillance procedures. Recurring work orders will be established within the periodic maintenance program to govern the scheduling and performance of the periodic calibration checks.
>
> Routine preventive maintenance required during normal operation is limited to periodic channel calibration check, and/or battery replacement. The preventive maintenance frequency will be established as outlined in the response to RAI #8 d).

The NRC staff notes the SFP level instrument channels can be compared with the acceptance criteria described in Section 3.9 above to deterrmine if recalibration or troubleshooting is needed. However, the NRC staff has concerns with the lack of information regarding the feasibility of the licensee's process for in-situ calibration to ensure the design accuracy will be maintained. The staff has identified this request as:

RAI# 15

Please provide a description of the in-situ calibration process at the SFP location that will result in the channel calibration being maintained at its design accuracy.

3.11 Design Features: Display

Attachment 2 of Order EA-12-051 states, in part, that

> 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.

NEI 12-02 states, in part, that

> The intent of this guidance is to ensure that information on SFP level is reasonably available to the plant staff and decision makers. Ideally there will be an indication from at least one channel of instrumentation in the control room. While it is generally recognized (as demonstrated by the events at Fukushima Daiichi) that SFP level will not change rapidly during a loss of spent fuel pool cooling scenario more rapid SFP drain down cannot be entirely discounted. Therefore, the fact that plant personnel are able to determine the SFP level will satisfy this requirement, provided the personnel are available and trained in the use of the SFP level instrumentation (see Section 4.1) and that they can accomplish the task when required without unreasonable delay.

SFP level indication from the installed channel shall be displayed in the control room, at the alternate shutdown panel, or another appropriate and accessible location (reference NEI 12-06). An appropriate and accessible location shall have the following characteristics:

- occupied or promptly accessible to the appropriate plant staff giving appropriate consideration to various drain down scenarios,
- outside of the area surrounding the SFP floor, e.g., an appropriate distance from the radiological sources resulting from an event impacting the SFP,
- inside a structure providing protection against adverse weather, and
- outside of any very high radiation areas or LOCKED HIGH RAD AREA during normal operation.

If multiple display locations beyond the required "appropriate and accessible location" are desired, then the instrument channel shall be designed with the capability to drive the multiple display locations without impacting the primary "appropriate and accessible" display.

In its OIP, the licensee stated, in part, that

> Remote indication will be provided in two "appropriate and accessible locations" in the Auxiliary Building. The primary channel display will provide a read-out in the vicinity of the north wall 463 foot elevation adjacent to and outside of the southwest corner of the Spent Fuel Pool and Fuel Handling Building. The backup channel will provide a readout in the northeast stairwell of the Auxiliary Building in the vicinity of the 463 foot elevation and adjacent to the northwest corner of the Spent Fuel Pool and west wall of the Fuel Handling Building.

In its August 28, 2013 letter, the licensee stated, in part, that

> The primary and back-up SFP channel displays are located outside of the main control room and remote from the SFP area and in two separate areas; the primary in the Auxiliary Building north stairwell 468 feet elevation and the back-up on the west exterior wall of the Fuel Handing Building at the 441 feet elevation (FIGURE 2). The display locations are outside of any locked high radiation areas, and are accessible by operations personnel during a postulated BDB event through at least two paths through the Auxiliary Building. One path is on the west side of the building and the second is on the north end of the building. The primary level channel read- out display is located in a Seismic Category I structure, which is protected from potential threats posed by external natural phenomena events, such as flooding, seismic and tornado missiles. Personnel access to the display locations relies upon the stairwells within the Auxiliary Building north side and west side for alternate access. The back-up channel readout display is located at the 441 foot elevation on the exterior west wall of the Fuel Handling Building. Access to the back-up channel can be through the

Auxiliary Building or from paths outside of the station's power block. The back-up channel read-out display will be protected from seismic, flooding and high wind external events. During a postulated Extended Loss of AC Power (ELAP) event, ambient temperatures at both locations would not be expected to prohibit periodic personnel access to monitor SFP levels. The estimated time for personnel to access the primary or back-up channel display is 10-15 minutes, after personnel dispatch. Personnel accessing this area would rely on portable hand- held lighting, and hand-held radio communication with the main control room, and/or SFP inventory control personnel. The location of both read-out displays will allow easy access to the spent fuel pool makeup valve should it be necessary to utilize the same personnel for monitoring spent fuel pool/eve/ as well as controlling SFP inventory. This location is considered to be promptly accessible for the purposes of monitoring SFP level during a postulated BDB event.

The primary and back-up SFP level read-out displays are remotely located outside the SFP area and are readily accessible by operational personnel. The primary SFP level channel read-out display is located in Seismic Category I structures, which are protected from potential threats posed by external natural phenomena events, such as flooding, seismic and tornado missiles. The back-up channel readout display is located at the 441 foot elevation on the exterior west wall of the Fuel Handling Building. Access to the back-up channel can be through the Auxiliary Building or from paths outside of the station's power block. The back-up channel read-out display will be protected from seismic, flooding and high wind external events. The estimated time for personnel to access the primary or back-up SFP level display is 10-15 minutes, after personnel dispatch. The location of the primary and back-up SFP level display is in close proximity to the areas that Operations personnel would potentially be dispatched to as part of the FLEX strategy for providing makeup to the spent fuel pool. If a drain-down event is determined to be in progress, operators for monitoring level will be assigned for continuous level monitoring as a priority response until such time as the drain-down event is terminated and periodic monitoring for evaporative losses is resumed.

The NRC staff notes the licensee will locate the primary SFP level instrumentation display in the Seismic Category I Auxiliary Building north stairwell at the 468 ft. elevation, and the backup display at the 441 ft. elevation on the exterior west wall of the Fuel Handling Building. The staff is concerned with the licensee's lack of information regarding the characteristics that would make these locations appropriate and accessible in accordance with NEI 12-02. The staff is also concerned with the licensee's lack of information on the methods/processes to be used to protect the backup display against seismic, flooding, freezing, and high wind external events. The staff has identified this request as:

RAI #16

Please describe the evaluation used to validate the display locations 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, 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.

3.12 Programmatic Controls: Training

Attachment 2 of Order EA-12-051 states, in part, that

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

NEI 12-02 states, in part, that

> The personnel performing functions associated with these SFP level instrumentation channels shall be trained to perform the job specific functions necessary for their assigned tasks (maintenance, calibration, surveillance, etc.). SFP instrumentation should be installed via the normal modification processes. In some cases, utilities may choose to utilize portable instrumentation as a portion of their SFP instrumentation response. In either case utilities should use the Systematic Approach to Training (SAT) to identify the population to be trained. The SAT process should also determine both the initial and continuing elements of the required training.

In its OIP, the licensee stated, in part, that

> The Systematic Approach to Training 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 consist of the use of the level instrumentation system as well as the deployment of the portable components of the backup channel. Training will be completed prior to placing the instrumentation in service.

In its letter dated August 28, 2013, the licensee stated, in part, that

> The back-up channel is no longer planned to have portable components requiring installation prior to being placed in service. The back-up channel will be permanently installed to the same requirements of the primary channel.

The licensee's proposed plan to train personnel in the use and the provision of alternate power to the primary and backup instrument channels, including the approach to identify the population to be trained appears to be consistent with NEI 12-02, as endorsed by the ISG.

3.13 Programmatic Controls: Procedures

Attachment 2 of Order EA-12-051 states, in part, that

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

NEI 12-02 states, in part, that

> Procedures will be developed using guidelines and vendor instructions to address the maintenance, operation and abnormal response issues associated with the new SFP instrumentation.

In its OIP, the licensee stated that procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the new SFP instrumentation.

In its letter dated August 28, 2013, the licensee stated, in part, that

> The operation procedure for the alignment and functional check of the system will be addressed in a FLEX Support Guideline (FSG). The calibration/test procedures for the 12-month functional testing and calibration check will be performed by I&C technicians in accordance with I&C Procedure. The monthly channel check for the primary and back-up channels will be performed in accordance with plant operation logs under an Operation Administrative Procedure and will include as appropriate the acceptance criteria for channel check verification. The FSG will be referenced from the appropriate Emergency Operating Procedure for placing the channels in service following an ELAP event.
>
> The FSG for Spent Fuel Pool Level Monitoring will require specific technical objectives to place the primary channel in service by turning on the power and performing a functional check of the system. If it is determined that the primary channel has been damaged or has failed to function as a result of the functional check, the FSG will direct the station personnel to place the back-up portable channel in service. The back-up channel is no longer planned to be a portable channel.

The NRC staff has concerns with the lack of information on the procedures for the testing, calibration, and use of the primary and backup SFP instrument channels. The staff previously requested this information as RAI-11 in the NRC letter dated July 29, 2013. However, based on feedback from licensees, the staff revised this RAI as follows:

RAI #17

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

3.14 Programmatic Controls: Testing and Calibration

Attachment 2 of Order EA-12-051 states, in part, that

> 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.

NEI 12-02 states, in part, that

> Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup SFP level instrument channels to maintain the instrument channels at the design accuracy. The testing and calibration of the instrumentation shall be consistent with vendor recommendations or other documented basis.

In its OIP, the licensee stated, in part, that

> Processes will be established for scheduling the necessary testing and calibration of all spent fuel pool level instrument channels. This schedule will also be used to maintain the instrument channels at the design accuracy. Testing and calibration of the instrumentation will be consistent with vendor recommendations and other documented basis during the design process. Calibration will be specific to the mounted sensor and the display and will include an in-situ check of the entire channel including the wave guide piping and horn antenna. Surveillance and testing will be performed at frequencies consistent with those specified in NEI-12-02 Section 4.3.

In its letter dated August 28, 2013, the licensee stated, in part, that

> Both the primary and back-up channels will be functionally tested with a calibration check performed on a 12-month periodicity.
>
> The channel checks will be accomplished by comparison between the presently installed wide-range channel indications, or by comparison to the known SFP physical level elevation reference markings. The acceptance criteria will consider the respective overall channel uncertainty contributions for accuracy, calibration setting tolerance, resolution, and drift as applicable.

Periodic channel checks will be established for the primary and back-up SFP level channels to verify proper instrument operation, as described in the response to RAI #7 b). The frequency of the channel checks is expected to be at least monthly (± 25 percent grace period). This frequency will readily satisfy NEI 12-02 (section 4.3) requirements.

Instrument channel calibration check frequency will be 12 months and performed in accordance with the manufacture recommendations, and/or as established based on operating experience within the preventive maintenance program. As part of the periodic calibration check surveillance for the primary SFP level channel, further functional verifications will be performed to verify proper operation of the battery back-up feature.

The channel checks will be performed by Operations surveillance procedures, and the instrument calibrations checks will be performed by Maintenance instrumentation calibration surveillance procedures. Recurring work orders will be established within the periodic maintenance program to govern the scheduling and performance of the periodic calibration checks.

Routine preventive maintenance required during normal operation is limited to the periodic channel calibration check, and/or battery replacement.

The spent fuel pool level monitoring system maintenance and testing program will be inspected and audited in a manner consistent with the Appendix B requirements for safety and quality related instrumentation.

If both channels are non-functional and at least one channel cannot be restored within 24 hours, a complete spare channel will be maintained at the site such that replacement of the primary channel can be initiated within 24 hours and completed within 72 hours.

If only one channel is non-functional and cannot be restored to functional status within 90 days the channel will be replaced with the complete spare channel available on site.

The licensee's proposed plan, with respect to defining processes for scheduling and implementing necessary testing and calibration and compensatory actions when a channel is out-of-service or when one of the instrument channels cannot be restored to functional status within 90 days appears to be consistent with NEI 12-02, as endorsed by the ISG. However, the NRC staff notes the information regarding the SFP level instrumentation testing, calibration, and compensatory actions is not currently available for review. In its letter dated September 23, 2013, the licensee indicated the information will be provided to the staff in the August 28, 2015, OIP status update. The staff has identified this request as:

RAI #18

Please provide the following:

a) **Further information describing the maintenance and testing program the licensee will establish and implement to ensure that regular testing and calibration is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. Please include a description of the plans for ensuring that necessary channel checks, functional tests, periodic calibration, and maintenance will be conducted for the level measurement system and its supporting equipment.**

b) **Information describing compensatory actions when both channels are out-of-order, and the implementation procedures.**

c) **Additional information describing expedited and compensatory actions in the maintenance procedure to address when one of the instrument channels cannot be restored to functional status within 90 days.**

3.15 Instrument Reliability

NEI 12-02 states, in part, that

> A spent fuel pool level instrument channel is considered reliable when the instrument channel satisfies the design elements listed in Section 3 [Instrument Design Features] of this guidance and the plant operator has fully implemented the programmatic features listed in Section 4 [Program Features].

In its OIP, the licensee stated that reliability of the primary and backup instrument channels will be assured by conformance with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02.

Upon acceptable resolution of the RAIs noted above, the NRC staff will be able to make a conclusion regarding the reliability of the SFP instrumentation.

4.0 CONCLUSION

The NRC staff is unable to complete its evaluation regarding the acceptability of the licensee's plans for implementing the requirements of Order EA-12-051 due to the need for additional information as described above. The staff will issue an evaluation with its conclusion after the licensee has provided the requested information.

information be provided by October 31, 2014, to ensure that any issues are resolved prior to the date by which the licensee must complete full implementation of Order EA-12-051. The licensee should adjust its schedule for providing information to ensure that all this information is provided by the requested date.

If you have any questions regarding this letter, please contact me at 301-415-1009 or via e-mail at Shawn.Williams@nrc.gov.

Sincerely,
/RA/

Shawn Williams, Senior Project Manager
Plant Licensing Branch LPL2-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:
Interim Staff Evaluation and
Request for Additional Information

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