



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

November 4, 2013

Mr. Michael J. Pacilio  
Senior Vice President  
Exelon Generation Company, LLC  
President and Chief Nuclear Officer (CNO)  
Exelon Nuclear  
4300 Winfield Road  
Warrenville, IL 60555

**SUBJECT: BRAIDWOOD STATION, UNIT NOS. 1 AND 2 - INTERIM STAFF EVALUATION  
AND REQUEST FOR ADDITIONAL INFORMATION REGARDING THE  
OVERALL INTEGRATED PLAN FOR IMPLEMENTATION OF ORDER  
EA-12-051, RELIABLE SPENT FUEL POOL INSTRUMENTATION  
(TAC NOS. MF0821 AND MF0822)**

Dear Mr. Pacilio:

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. ML13059A265), Exelon Generation Company, LLC (the licensee) provided the Overall Integrated Plan (OIP) for Braidwood Station, Units 1 and 2, describing how it will achieve compliance with Attachment 2 of Order EA-12-051 by Fall 2014. By letter dated July 11, 2013 (ADAMS Accession No. 13191B255), the NRC staff sent a request for additional information to the licensee. The licensee provided supplemental information by letters dated July 31, 2013 (ADAMS Accession No. ML13212A364), and August 28, 2013 (ADAMS Accession No. ML13241A240).

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.

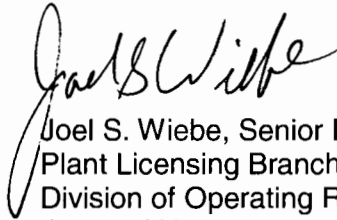
M. Pacilio

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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 March 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 301-415-6606 or via e-mail at [Joel.Wiebe@nrc.gov](mailto:Joel.Wiebe@nrc.gov).

Sincerely,



Joel S. Wiebe, Senior Project Manager  
Plant Licensing Branch LPL III-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-456 and STN 50-457

Enclosure:  
Interim Staff Evaluation and  
Request for Additional Information

cc w/encl: Distribution via Listserv



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

**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**

**EXELON GENERATION COMPANY, LLC**

**BRAIDWOOD STATION, UNITS 1 AND 2**

**DOCKET NOS. 50-456 AND 50-457**

**1.0 INTRODUCTION**

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 [SFP] 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 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. ML13059A265), Exelon Generation Company, LLC (the licensee) provided the OIP for Braidwood Station, Units 1 and 2, describing how it will achieve compliance with Attachment 2 of Order EA-12-51 by Fall 2014. By letter dated

July 11, 2013 (ADAMS Accession No. ML13191B255), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided supplemental information by letters dated July 31, 2013 (ADAMS Accession No. ML13212A364), and August 28, 2013 (ADAMS Accession No. ML13241A240).

**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 NRC regulation or license to the contrary, to comply with

ENCLOSURE

the requirements described in Attachment 2 to this 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 licensee, by February 28, 2013, to submit to the NRC 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 license 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 the 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 that 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 (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 that 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**

Braidwood Station, Units 1 and 2, share a single SFP located in the Fuel Handling Building (FHB). The SFP is approximately 33 feet (ft.) 1 inch (in.) wide by 62 ft. long and 41 ft. deep.

The licensee's OIP was submitted on February 28, 2013. The OIP states that installation of the SFP level instrumentation at Braidwood Station will be completed by Spring 2015 based on the end of the second refueling outage for Unit 1 following submittal of its integrated plan. This is the earlier outage sequence of the units discharging to the pool.

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 its OIP, the licensee stated that Level 1 is the indicated level on either primary or backup instrument channel of greater than 18 ft. (elevation 418 ft.-1 $\frac{3}{4}$  in.) above the top of the storage racks based on the design accuracy of the instrument channel (which will be determined in the detailed design phase) and a resolution of 1 foot or better of both the primary and backup instrument channels. The licensee also stated that a calculation demonstrating adequate water level will be performed as part of the detailed engineering design phase to ensure the level is adequate for normal fuel pool cooling system operation.

In its letter dated July 31, 2013, the licensee restated that the detailed design will include a calculation to determine adequate water level to maintain normal fuel pool cooling system operation. The licensee also stated that the results of this calculation will be provided in the August 2014, 6-month update report to the NRC staff.

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

The detailed design will include a calculation to determine adequate water level to maintain normal fuel pool cooling system operation. This information will be available following acceptance of the 100% design, scheduled for April, 2014. The result will be provided in the August 2014, 6- month Integrated Plan update report to the NRC.

The NRC staff notes that the licensee stated that the Braidwood SFP Level 1 is set at a plant elevation of 418 ft.-1 $\frac{3}{4}$  in. This level is located above the top of the SFP cooling pump suction inlet flange which is at elevation 417 ft. 9-3/8 in. However, as stated in NEI 12-02, Level 1 is to be established at the higher of two SFP elevations. At this time, the elevation necessary to provide the required Net Positive Suction Head (NPSH) specified by the pump manufacturer or engineering analysis is not available. The staff plans to review the results of the calculation performed by the licensee to determine that the elevation identified as Level 1 in the licensee's OIP is consistent with the guidance. The staff has identified this request as:

RAI# 1

Provide the results of the calculation used to determine the water elevation necessary for the SFP cooling pump required NPSH to confirm that Level 1 has been adequately identified.

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 its OIP, the licensee stated that Level 2 would be set at plant elevation of 410 ft. 1¾ in., which corresponds to 10 ft. above the top of the SFP fuel storage rack.

In its letter dated July 31, 2013, the licensee provided a sketch showing the elevations identified as Levels 1, 2 and 3. This sketch shows Level 2 at an elevation of 410 ft. 1¾ in., which is approximately 10 ft. above the top of the fuel rack.

The NRC notes that the licensee designated Level 2 using the first 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 the SFP elevation for Level 3 would be set at a plant elevation of 400 ft-1¾ in, which is the top of the fuel racks.

The NRC notes that this elevation is the highest point of any spent fuel storage rack seated in the SFP.

The licensee's proposed plan, with respect to identification of Levels 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 that the primary and backup instrument channel level sensing components will be located and permanently mounted in the SFP. The instrument channels will provide continuous level indication over a minimum range of approximately 24 ft. 8 in. from the high pool level elevation of 424 ft. 9½ in. to the top of the spent fuel racks at elevation 400 ft. 1¾ in.

The NRC staff notes that 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 for its SFPs, 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 winddriven 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 license stated, in part, that

The current plan is to install the SFP level sensors in the southwest and northwest corners of the SFP separated by a distance in excess of 20 feet. The sensors themselves will be mounted, to the extent practical, near the pool walls and below the pool curb to minimize their exposure to damaging debris and not interfere with SFP activities. Instrument channel electronics and power supplies will be located in seismic and missile protected areas either at an elevation below the SFP operating floor or in

buildings other than the FHB. The areas to be selected will provide suitable radiation shielding and environmental conditions for the equipment consistent with instrument manufacturer's recommendations.

Equipment and cabling for power supplies and indication for each channel will be separated equivalent to that provided for redundant safety related services.

In its letter dated July 31, 2013, the licensee provided a sketch indicating the proposed location for the SFP instruments. The sketch shows that the SFP level sensors would be located in the southeast and northwest corners of the SFP. In this letter, the licensee explained that the location of the SFP level sensors was changed since the submittal of the OIP. The licensee also stated in this letter that the design phase for Braidwood would start in November 2013 with design completion and 100% acceptance of the design in April 2014. According to the licensee information about the SFP level sensors would be provided to the staff in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that the information regarding final sensor locations and cable routings for the SFP instrumentation is not currently available for review and that in its August 28, 2013, letter, the licensee identified the status of this activity as "Not Started". The licensee indicated that the information will be provided during the August 2014, 6-month integrated plan update. The staff has identified these requests as:

#### RAI #2

Provide a clearly labeled sketch or marked-up plant drawing of the plan view of the SFP area, depicting the SFP inside dimensions, the planned locations/placement of the primary and back-up SFP level sensor, and the proposed routing of the cables that will extend from the sensors toward the location of the read-out/display device.

(This information was previously requested as RAI-2 in the NRC letter dated July 11, 2013)

#### RAI #3

Provide additional information describing how the final arrangement of the SFP instrumentation and routing of the cabling between the level instruments, the electronics and the displays, meets the Order requirement to arrange the SFP level instrument channels in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the SFP.

### 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 that the design of the mounting of the sensors in the SFP will be consistent with the seismic Class I criteria. The licensee also stated that installed equipment will be verified to be seismically adequate for the seismic motions associated with the maximum seismic ground motion considered in the design of the plant area in which it is installed.

In its letter dated July 31, 2013, the licensee stated, in part, that

Device total loading and mounting will be performed as part of the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that the information regarding the SFP instrumentation device total loading and mounting is not currently available for review and that in its August 28, 2013, letter, the licensee identified the status of this activity as "Not Started". The licensee indicated that the information will be provided during the August 2014, 6-month integrated plan update. The staff has identified these requests as:

RAI #4

Provide the following:

- a) The design criteria that will be used to estimate the total loading on the mounting device(s), including static weight loads and dynamic loads. Describe the methodology that will be used to estimate the total loading, inclusive of design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.
- b) A description of the manner in which the level sensor (and stilling well, if appropriate) will be attached to the refueling floor and/or other support structures for each planned point of attachment of the probe assembly. Indicate in a schematic the portions of the level sensor that will serve as points of attachment for mechanical/mounting or electrical connections.

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

(This information was previously requested as RAI-3 in the NRC letter dated July 11, 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 RAI:

RAI #5

For RAI 4(a) above, provide the analyses used to verify the design criteria and methodology for seismic testing of the SFP instrumentation and the electronics units, including design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.

RAI #6

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

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: (3.6.1) Augmented Quality Process, and (3.6.2) Qualification and Reliability.

### 3.6.1 Augmented Quality Process

Appendix A-1 of the guidance in NEI 12-02 describes a quality assurance process for nonsafety 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 the reliability of the instrumentation will be established through the use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

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

### 3.6.2 Qualification and Reliability

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 offsite 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, and
- a concentrated borated water environment.

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

Temperature, humidity and radiation levels consistent with the conditions in the vicinity of the SFP and the area of use considering normal operation, 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 (Ref.4) will be addressed in the detailed design engineering phase of the project. 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 Order EA-12-051,
- temperatures of 212 degrees F and 100% relative humidity environment,
- boiling water and/or steam environment, and
- a concentrated borated water environment.

In its letter dated July 31, 2013, the licensee states, in part, that

Device qualification and reliability will be performed as part of the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding device qualification and reliability is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified these requests as:

RAI #7

Provide the following:

- a) A description of the specific method or combination of methods that will be applied to demonstrate the reliability of the permanently installed equipment under beyond-design-basis ambient temperature, humidity, shock, vibration, and radiation conditions.
- b) A description of the testing and/or analyses that will be conducted to provide assurance that the equipment will perform reliably under the worstcase credible design basis loading at the location where the equipment will be mounted. Include a discussion of this seismic reliability demonstration as it applies to a) the level sensor mounted in the SFP area, and b) any control boxes, electronics, or read-out and re-transmitting devices that will be employed to convey the level information from the level sensor to the plant operators or emergency responders.
- c) A description of the specific method or combination of methods that will be used to confirm the reliability of the permanently installed equipment such that following a seismic event the instrument will maintain its required accuracy.

(This information was previously requested as RAI-4 in the NRC letter dated July 11, 2013)

In addition, the NRC staff plans to verify the results of the licensee's testing and analysis used to demonstrate the qualification and reliability of the installed equipment when it is completed based on the licensee's response to the following RAI.

RAI #8

For RAI #7 above, provide the results from the selected methods, tests and analyses used to demonstrate the qualification and reliability of the installed equipment in accordance with the Order requirements.

### 3.6.3 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 that the primary instrument channel will be independent of the backup instrument channel and that this independence will be achieved through physical and electrical separation of each channels' components commensurate with hazard and electrical isolation needs.

In its July 31, 2013, letter, the licensee stated, in part, that

Device channel independence evaluation will be performed as part of the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding the device channel independence evaluation is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified this request as:

RAI #9

Provide the following:

- a) A description of how the two channels of the proposed level measurement system meet this requirement so that the potential for a common cause event to adversely affect both channels is minimized to the extent practicable.

- b) Further information on how each level measurement system, consisting of level sensor electronics, cabling, and readout devices will be designed and installed to address independence through the application and selection of independent power sources, the use of physical and spatial separation, independence of signals sent to the location(s) of the readout devices, and the independence of the displays.

(This information was previously requested as RAI-5 in the NRC letter dated July 11, 2013)

### 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

Each channel will be normally powered from a different 120Vac bus. Upon loss of normal ac power, individual channel installed batteries will automatically maintain



continuous channel operation. The batteries will be replaceable and be sized to maintain channel operation until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049(Ref.4). Additionally, each channel will have provisions for connection to another suitable power source.

In its letter dated July 31, 2013, the licensee stated, in part, that

Device total power supply configuration will be performed as part of the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding the SFP instrumentation device total power supply configuration is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified this request as:

RAI #10

Provide the following:

- a) A description of the electrical ac power sources and capabilities for the primary and backup channels.
- b) 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.

(This information was previously requested as RAI-6 in the NRC letter dated July 11, 2013)

### 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

The instrument channels will be designed to maintain their design accuracy following a power interruption or change in power source without recalibration. Instrument channel accuracy, to be determined during detailed design, will consider Spent Fuel Pool conditions (e.g., saturated water, steam environment, concentrated borated water), as well as, other applicable radiological and environmental conditions and include display accuracy. Instrument channel 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 or 3) without conflicting or ambiguous indications.

In its letter dated July 31, 2013, the licensee stated, in part, that

Device channel accuracy analysis will be performed as part of the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding SFP instrumentation device channel accuracy is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified this request as:

RAI #11

Provide the following:

- a) An estimate of the expected instrument channel accuracy performance under both (a) normal SFP level conditions (approximately Level1 or higher) and (b) at the beyond design-basis conditions (i.e., radiation, temperature, humidity, post-seismic and post-shock conditions) that would be present if the SFP level were at the Level2 and Level3 datum points.
- b) A description of the methodology that will be used for determining the maximum allowed deviation from the instrument channel design accuracy that will be employed under normal operating conditions as an acceptance criterion for a calibration procedure to flag to operators and to technicians that the channel requires adjustment to within the normal condition design accuracy.

(This information was previously requested as RAI-7 in the NRC letter dated July 11, 2013)

### 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 that instrument channel design will provide for routine testing and calibration consistent with the guidelines of NRC JLD-ISG-2012-03 (Ref. 2) and NEI12-02 (Reference 3).

In its July 31, 2013, letter the licensee stated, in part, that

Device testing requirement analysis will be performed as part of the detailed design process just prior to turnover to Operations. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. Following the issue of the design, procedures will start being developed with a projected July 2014, completion date. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding SFP instrumentation device testing requirements is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified this request as:

RAI #12

Provide the following:

- a) A description of the capability and provisions the proposed level sensing equipment will have to enable periodic testing and calibration, including how this capability enables the equipment to be tested in-situ.
- b) A description of how such testing and calibration will enable the conduct of regular channel checks of each independent channel against the other, and against any other permanently-installed SFP level instrumentation.
- c) A description of how functional checks will be performed, and the frequency at which they will be conducted. Describe how calibration tests will be performed, and the frequency at which they will be conducted.
- d) A discussion as to how these surveillances will be incorporated into the plant surveillance program.

- e) A description of the preventive maintenance tasks required to be performed during normal operation, and the planned maximum surveillance interval that is necessary to assure that the channels are fully conditioned to accurately and reliably perform their functions when needed.

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

### 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

The primary and backup instrument displays will be located at the control room, alternate shutdown panel, or other appropriate and accessible location. The specific location will be determined during detailed design.

In its letter dated July 31, 2013, the licensee stated, in part, that

Device channel display location will be finalized during the detailed design process. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

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

Both the primary and backup channel Spent Fuel Pool Instrumentation displays will be located in the main control room. The primary channel display will be located on a Unit 1 main control room panel with the backup channel display located on a Unit 2 main control room panel.

The NRC staff notes that the NEI guidance for "Display" specifically mentions the control room as an acceptable location for SFP instrumentation displays as it is occupied or promptly accessible, outside the area surrounding 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. The licensee's proposed location for the primary and backup SFP instrumentation displays appears to be consistent with NEI 12-02, as endorsed by the ISG.

### 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

Personnel performing functions associated with these Spent Fuel Pool level instrumentation channels will be trained to perform the job specific functions necessary for their assigned tasks (maintenance, calibration, surveillance, etc.). This training will be consistent with equipment vendor guidelines, instructions and recommendations. The Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service.

The licensee's proposed plan, with respect to the training personnel in the use and the provision of alternate power to the primary and backup instrument channels, including the approach to identifying 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 primary and backup channels of Spent Fuel Pool instrumentation.

In its letter dated July 31, 2013, the licensee stated, in part, that

Device program features analysis will be performed as part of the detailed design process just prior to turnover to Operations. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. Following the issue of the design, procedures will start being developed with a projected July 2014 completion date. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013, the licensee stated that the information regarding SFP instrumentation device program features is not available at this time and identified the status of this activity as "Not Started". The licensee indicated that the information will be provided to the staff during the August 2014, 6-month integrated plan update.

The staff has identified this request as:

RAI #13

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

(This information was previously requested as RAI-10 in NRC letter dated July 11, 2013, which has been revised in this ISE.)

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

The testing and calibration of the instrumentation will be consistent with vendor recommendations or other documented basis. Calibration will be specific to the mounted instruments and the displays. Calibration will be performed to an Instrument Maintenance Procedure (BIP/BISR series). A Passport PMID will be used to direct frequency for performance of the instrument calibration. Both primary and backup instrumentation channels will be functional at all times when there is fuel in the SFP with allowance for testing, maintenance or repair per NEI 12-02 (Ref.3).

In its letter dated July 31, 2013, the licensee stated, in part, that

Device testing and calibration requirements analysis will be performed as part of the detailed design process just prior to turnover to Operations. The current plan for the design of the SFPI system based on the current Exelon Nuclear program schedule for Braidwood will start the design phase in November 2013 with design completion and 100% acceptance of the design in April 2014. Following the issue of the design, procedures will start being developed with a projected July 2014 completion date. The requested information will be provided in the August 2014, 6-month Integrated Plan update.

The NRC staff notes that in its letter dated August 28, 2013 the licensee stated that the information regarding SFP instrumentation device testing and calibration requirements is not available at this time and identified the status of this activity as "Not Started" and that the information will be provided to the staff during the August 2014, 6-month integrated plan update. The staff has identified this request as:  
RAI #14

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. Include a description of your 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) A description of how the guidance in NEI 12-02 section 4.3 regarding compensatory actions for one or both non-functioning channels will be addressed.
- c) A description of what compensatory actions are planned in the event that one of the instrument channels cannot be restored to functional status within 90 days.

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

### 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 the 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 as discussed below under Design Features and Program Features.

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.



M. Pacilio

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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 March 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 301-415-6606 or via e-mail at [Joel.Wiebe@nrc.gov](mailto:Joel.Wiebe@nrc.gov)

Sincerely,

**/ RA /**

Joel S. Wiebe, Senior Project Manager  
Plant Licensing Branch LPL III-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-456 and STN 50-457

Enclosure:  
Interim Staff Evaluation and  
Request for Additional Information

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