



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

October 23, 2013

Mr. Michael J. Pacilio  
President and Chief Nuclear Officer  
Exelon Nuclear  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 - INTERIM STAFF  
EVALUATION AND REQUEST FOR ADDITIONAL INFORMATION  
REGARDING THE OVERALL INTEGRATED PLAN FOR IMPLEMENTATION  
OF ORDER EA-12-051, RELIABLE SPENT FUEL POOL INSTRUMENTATION  
(TAC NOS. MF0854 AND MF0855)

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. ML13059A391), Exelon Generation Company, LLC (the licensee) provided the Overall Integrated Plan (OIP) for Limerick Generating Station, Units 1 and 2 describing how it will achieve compliance with Attachment 2 of Order EA-12-051 by spring 2015. By letter dated June 24, 2013 (ADAMS Accession No. ML13171A315), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided supplemental information by letters dated July 18, 2013 (ADAMS Accession No. ML13199A485), and August 28, 2013 (ADAMS Accession No. ML13241A037).

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

M. Pacilio

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information be provided by September 30, 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 301-415-1420 or via e-mail at [Rick.Ennis@nrc.gov](mailto:Rick.Ennis@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "R B Ennis". The signature is written in a cursive, somewhat stylized font.

Richard B. Ennis, Senior Project Manager  
Plant Licensing Branch I-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-352 and 50-353

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

EXELON GENERATION COMPANY, LLC

LIMERICK GENERATING STATION, UNITS 1 AND 2

DOCKET NOS. 50-352 AND 50-353

**1.0 INTRODUCTION**

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC or the Commission) issued Order EA-12-51, "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. ML13059A391), Exelon Generation Company, LLC (the licensee) provided the OIP for Limerick Generating Station, Units 1 and 2, describing how it will achieve compliance with Attachment 2 of Order EA-12-51 by Spring 2015 for Units 1 and 2. By letter dated June 24, 2013 (ADAMS Accession No. ML13171A315), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided supplemental information by letters dated July 18, 2013 (ADAMS Accession No. ML13199A485) and August 28, 2013 (ADAMS Accession No. ML13241A037).

**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 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.

Enclosure

Order EA-12-051 required the licensee, 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 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 (ISG) document, 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

Limerick Generating Station, Units 1 and 2, share a common Reactor Enclosure (RE) refueling floor and two interconnected SFPs. The pools are normally interconnected and at the same water level when the water level in either SFP is greater than nominally 1 foot above the top of the spent fuel storage racks. The gates between the pools are closed for limited time periods for maintenance or non-refueling operations.

The licensee submitted its OIP on February 28, 2013. The OIP states that installation of the SFP level instrumentation at Limerick Generating Station, Units 1 and 2, will be completed by the end of Spring 2015, based on the end of the second refueling outage for Unit 2 following submittal of its OIP.

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 for both units is the indicated level on either primary or backup instrument channel of greater than 23 feet (ft.) 6 inches (in.) (approximately 351 ft. elevation) plus instrument channel accuracy. The licensee based this elevation on the height of the SFP weirs, demonstrating a water level of 23 ft. 6 in. (approx. 351 ft. elevation) is adequate for normal fuel pool cooling system operation.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The Spent Fuel Pool at Limerick Generating Station has wave suppression scuppers located at the 351'-0" elevation that water must flow into. From there the water is routed to the surge tanks from which the Fuel Pool Cooling (FC) Pumps draw suction. The suction trip is at an approximate 344' elevation. Thus, the 351'-0" elevation reflects the higher of the two points noted in NEI 12-02, Section 2.3.1.

The NRC staff notes that Level 1 is adequate for normal SFP cooling system operation; it is also sufficient for net positive suction head and represents the higher of the two points described above.

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 for both units, Level 2 is the indicated level on either the primary or backup instrument channel of greater than 10 ft. (elevation 337.5 ft.) plus instrument channel accuracy above the top of the storage.

In its letter dated July 18, 2013, the licensee provided a sketch showing the approximate location of the level sensor and the elevations identified as Levels 1, 2 and 3. This sketch shows Level 2 at an elevation of 337.5 ft., 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 for both units, Level 3 is the indicated level on either the primary or backup instrument channel of greater than 0 ft. (elevation 327.5 ft.) plus instrument channel accuracy above the top of the storage racks.

The NRC staff notes that the elevation for Level 3 is the highest point of any spent fuel storage rack seated in the SFP. However, the staff has concerns with the licensee's lack of information regarding the SFP's permanent configuration and the SFP level instrumentation reliability. Specifically, for Level 3 when the bottom opening of the gates or the bottom of the transfer canal connecting the pools is above the top of the fuel racks, in the event that one level sensor were to fail, the remaining sensor would not be able to monitor the level in the connected pool below the level of gate or transfer canal. The staff has identified this request as:

#### **RAI #1**

**Please provide the following:**

- a) A description of the operational circumstances under which the gates are expected to be installed, and describe how continuous back-up monitoring (e.g., direct visual observation) is available when the gates are installed.**
- b) The elevation for the bottom of the gate opening to demonstrate that both the primary and backup SFP instrument channels can simultaneously measure the same Level 3 elevation.**

The licensee's proposed plan, with respect to identification of Levels 1, and 2, 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 both the primary and backup instrument channels will utilize permanently-installed instruments. The primary instrument channel level sensing components will be located in the Unit 1 SFP and the backup instrument channel level sensing components will be located in the Unit 2 SFP. According to the license, each instrument channel will be capable of continuous level indication over a minimum range of approximately 23 ft. 6 in. from the high pool elevation to the top of the spent fuel racks at elevation 327.5 ft. The licensee also mentioned that the same level sensing technology will be used for both instrument channels.

In its letter dated July 18, 2013, the licensee provided a sketch depicting the approximate location of the level sensor. This sketch shows that the approximated level measurement range is 23 ft. 6 in. from the high pool level elevation to the top of the spent fuel racks. 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 and the range of the instrumentation for both of its SFPs, appears to be consistent with NEI 12-02, as endorsed by the ISG. However, the staff has concerns regarding the effects the installation of the gate could have on the reliability of the SFP level instrumentation to meet the requirements of Order EA-12-051 when the gate between the pools is closed. The staff has identified this request as:

## **RAI #2**

**Please describe the impact of the installation of the gate on the reliability of the SFP level instrumentation for each SFP, and what compensatory measures would be taken to ensure reliable level indication in each SFP when the gate is installed.**

### 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, in part that:

The current plan is to install SFP level sensors in the northwest corner of the Unit 1 SFP and in the northeast corner of the Unit 2 SFP separated by a distance in excess of 50 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 below the SFP operating floor or in buildings other than the RE. 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 18, 2013, the licensee stated, in part, that:

The current plan for the Spent Fuel Pool Instrumentation (SFPI) design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail will be provided 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 letter dated August 28, 2013, 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 #3**

**Please 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 backup 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 June 24, 2013.)*

**RAI #4**

**Please 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 license stated that the design of the mounting of the sensors in the SFP would be consistent with the seismic Class I criteria. The licensee stated that installed equipment would 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 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail 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 mounting device total loading and attachments 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 #5**

**Please provide the following:**

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

*(This information was previously requested as RAI-3 in NRC letter dated June 24, 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 #6**

**For RAI 5(a) above, please provide the analyses used to verify the design criteria and methodology for seismic testing of the SFP instrumentation and the electronics units, including, design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.**

**RAI #7**

**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 subsections 3.6.1 and 3.6.2 below.

### *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 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 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:

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 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...

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail 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 equipment reliability qualification 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 #8**

**Please 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 BDB 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 worst-case 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 NRC letter dated June 24, 2013.)*

In addition, the 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 #9**

**For RAI #8 above, please provide the results for the selected methods, tests and analyses utilized 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 would be independent of the backup instrument channel and that this independence would be achieved through physical and

electrical separation of each channels' components commensurate with hazard and electrical isolation needs.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail 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 channel independence 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**

**Please 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 NRC letter dated June 24, 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 [120 volts-alternating current] 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. Additionally, each channel will have provisions for connection to another suitable power source.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail 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 equipment total power supply configuration and characteristics 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**

**Please provide the following:**

- a) A description of the electrical ac power sources and capacities for the primary and backup channels.**
- b) Please provide the results of the calculation depicting the battery backup duty cycle requirements demonstrating that its capacity is sufficient to maintain the level indication function until offsite resource availability is reasonably assured.**

*(This information was previously requested as RAI-6 in NRC letter dated June 24, 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 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of

the design in May of 2014. The requested detail 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 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 #12**

**Please provide the following:**

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

*(This information was previously requested as RAI-7 in NRC letter dated June 24, 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 would provide for routine testing and calibration consistent with the guidelines of the ISG and NEI 12-02 and those details would be determined during detailed design engineering.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. Following the issue of the design and prior to operation acceptance, procedures will start being developed with a projected March 2015 completion date. The requested information will be developed early in the process and 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 equipment testing, calibration, functional checks and maintenance requirement 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**

**Please provide the following:**

- a) A description of the capability and provisions the proposed level sensing equipment will have to enable periodic testing and calibration, including how this capability enables the equipment to be tested in-situ.**
- b) A description of how such testing and calibration will enable the conduct of regular channel checks of each independent channel against the other, and against any other permanently-installed 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. Provide a discussion as to how these surveillances will be incorporated into the plant surveillance program.**
- d) A description of what preventive maintenance tasks are required to be performed during normal operation, and the planned maximum surveillance interval that is necessary to ensure that the channels are fully conditioned to accurately and reliably perform their functions when needed.**

*(This information was previously requested as RAI-8 in NRC letter dated June 24, 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 that the primary and backup instrument displays will be located at the control room, alternate shutdown panel, or other appropriate and accessible location.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. The requested detail 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 channel display location 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 #14**

**Please provide the following:**

- a) **The specific location for the primary and backup instrument channel display.**
- b) **For any display located outside the main control room, please describe the evaluation used to validate that the display location can be accessed without unreasonable delay following a BDB event. Include the time available for personnel to access the display as credited in the evaluation, as well as the actual time (e.g., based on walk-throughs) that it will take for personnel to access the display. Additionally, please include a description of the radiological and environmental conditions on the paths personnel might take. Describe whether the display location remains habitable for radiological, heat and humidity, and other environmental conditions following a BDB event. Describe whether personnel are continuously stationed at the display or monitor the display periodically.**

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 SFP 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 both 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 would be developed using guidelines and vendor instructions to address the maintenance, operation and abnormal response issues associated with the primary and backup channels of SFP instrumentation.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. Following the issue of the design and prior to operation acceptance, procedures will start being developed with a projected March 2015 completion date. The requested information will be developed early in the process and 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 procedural details 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 #15**

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

*(This information was previously requested as RAI-10 in NRC letter dated June 24, 2013, which has been revised in this Interim Staff Evaluation.)*

**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. A procedure will be written to direct calibration and repair of the instruments. Preventive Maintenance (PM) program will be used to direct the calibration frequency of the instruments.

In its letter dated July 18, 2013, the licensee stated, in part, that:

The current plan for the SFPI design of the system based on the current Exelon Nuclear program schedule for Limerick Generating Station is to begin the design phase in September of 2013 with the design completion and 100% acceptance of the design in May of 2014. Following the issue of the design and prior to operation acceptance, procedures will start being developed with a projected March 2015 completion date. The requested information will be developed early in the process and 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 testing and calibration program requirement and compensatory actions 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 #16**

**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 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 NRC letter dated June 24, 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, in part, that:

Reliability of 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

- 2 -

information be provided by September 30, 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 301-415-1420 or via e-mail at [Rick.Ennis@nrc.gov](mailto:Rick.Ennis@nrc.gov).

Sincerely,

*/ra/*

Richard B. Ennis, Senior Project Manager  
Plant Licensing Branch I-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-352 and 50-353

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Interim Staff Evaluation and  
Request for Additional Information

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\*Concurrence via memo dated 9/27/13

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