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Chief
Rules, Announcements, and Directives Branch (RADB)
Office of Administration
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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Submittal of NEI 12-02, Revision 0, Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" and Comments on NRC Interim Staff Guidance Compliance with Order EA-2012-051, Reliable Spent Fuel Pool Instrumentation (JLD-ISG-2012-03) (77 *Fed. Reg.* 33780; Docket ID NRC-2012-0067)

Project Number: 689

Dear Ms. Bladey:

The Nuclear Energy Institute,[1] on behalf of the nuclear industry, is pleased to submit to the U.S. Nuclear Regulatory Commission (NRC) for review and endorsement, NEI 12-02, Revision 0, *Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,"* dated July 2012 (Attachment 1). To aid in identifying the changes, Attachment 2 is a line-in/line-out formatted version of NEI 12-02, Revision 0.

NRC draft Interim Staff Guidance JLD-ISG-2012-03 endorsed Revision B of NEI 12-02 with a number of comments and exceptions. Revision 0 to NEI 12-02 addresses the comments in the draft ISG, additional comments provided by the NRC staff in public meetings, and a template for the Integrated Plan. The attachments to this letter represent the industry comments on the draft ISG.

[1] NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

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In some cases, exceptions in the draft ISG have been addressed in different sections of the guidance. Attachment 3 is a table that links such exceptions to where the issues are resolved in NEI 12-02, Revision 0.

Finally, Attachment 4 contains a revision of the Integrated Plan Template in line-in/line-out format that highlights changes proposed by the industry from the version contained in the draft ISG.

We request that the NRC review and endorse NEI 12-02, Revision 0. If you have any questions or require additional information, please contact Steve Kraft (202-739-8116; spk@nei.org) or me.

Sincerely,

Adrian P. Heymer

Attachments

c: Mr. David L. Skeen, NRR/JLD, NRC
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NRC Document Control Desk

NEI 12-02 [Revision 0]

Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation"

July 2012

ACKNOWLEDGEMENTS

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A team of highly qualified individuals drawn from the Task Force devoted countless hours to writing and re-writing NEI 12-02. We are grateful for the efforts of the following individuals:

Randy Bunt, SNC
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While no document such as NEI 12-02 is the product of one or two individuals, we would be remiss in not recognizing the selfless efforts of Randy Bunt and Bryan Ford for their taking on the responsibility of the final document writing, editing and comment resolution.

With the deepest appreciation,
Steven P. Kraft
Nuclear Energy Institute
Washington, D.C.

EXECUTIVE SUMMARY

In studying the sequence of events that took place at Fukushima Daiichi during the accident that occurred due to the March 11, 2011, earthquake and resulting tsunami, the U.S. Nuclear Regulatory Commission (NRC) determined that several near-term actions were needed at U.S. commercial nuclear power plants. Among them was to provide Spent Fuel Pools (SFP) with reliable level instrumentation to significantly enhance the knowledge of key decision makers such that resources are allocated effectively in the event of a very low probability beyond design basis event. Consequently, the NRC issued Order EA-12-051 "*Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*" (ML12054A679) on March 12, 2012, for all U.S. nuclear plants with an operating license, construction permit or combined construction and operating license.

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

All licensees subject to the technical scope of the NRC Order EA-12-051 shall:

- provide a primary and back-up level instrument that will monitor water level from the normal level to the top of the used fuel rack in the pool;
- provide a display in an area accessible following a severe event; and
- provide independent electrical power to each instrument channel and provide an alternate remote power connection capability.

This guidance document provides additional details on an acceptable approach for complying with NRC Order EA-12-051. In addition, as suggested in section two of NRC EA-12-051:

> "*Additional details on an acceptable approach for complying with this Order will be contained in final interim staff guidance (ISG) scheduled to be issued by the NRC in August 2012.*"

The guide provides the industry suggested method for compliance with NRC Order EA-12-051.

AP1000 licensees shall refer to Appendix A-4 of this document for guidance to address the technical scope of the NRC Order for Reliable Spent Fuel Pool Level Instrumentation; the guidance in Appendix A-4 applies *only* to the AP1000 plants.

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A-4. AP1000 SPENT FUEL POOL INSTRUMENTATION GUIDANCE **ERROR! BOOKMARK NOT DEFINED.**

1. Introduction

On March 11, 2011, an earthquake occurred off the coast of Japan that resulted in a tsunami causing considerable damage to several commercial nuclear power plant facilities. The U.S. Nuclear Regulatory Commission (NRC) assembled a response task force to investigate and review the event. The task force recommended a series of actions to be taken by each licensee, and provided a series of orders and rulemaking. These actions were grouped into three tiers to address those items requiring an immediate response as well as items that will require significant time for implementation due to resource limitations or required additional, detailed study. The items to be performed without undue delay were the Tier 1 actions. These Tier 1 actions were approved by the Commission on the one-year anniversary of the accident, and issued to each licensee. One of these Tier 1 actions was to provide reliable spent fuel pool level instrumentation.

The NRC found that providing spent fuel pools with reliable level instrumentation would significantly enhance the knowledge of key decision makers such that resources are allocated effectively in the event of a very low probability beyond design basis accident. The NRC issued Order EA-12-051 " *Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,*" ML12054A679, on March 12, 2012 (Reference 1) for all US nuclear plants with an operating license, COL (Combined Operating License) or CP (Construction Permit). Each licensee shall, unless granted relief by the NRC, comply with Order EA-12-051 within two fuel cycles following the submittal of the overall integrated plan required by Order EA-12-051 or not later than December 31, 2016, whichever comes first.

This guidance is complementary to the guidance for implementing Order EA-12-049, "*Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,*" and associated implementation guidance (NEI 12-06) (Reference 2) and presents an acceptable method for implementing Order EA-12-051. For considerations of the SFP level instruments related to Order EA-12-049 (Reference 3) each channel is considered a set of response equipment, thus the primary and back-up channels meet the N+1 requirements of NEI 12-06.

All holders of COLs issued under Part 52, notwithstanding the provisions of any Commission regulation or license to the contrary, comply with the requirements described in Attachment 3 of the Order except to the extent that a more stringent requirement is set forth in the license. These licensees shall promptly start implementation of the requirements in Attachment 3 to the Order and shall complete full implementation prior to fuel load.

The AP1000 standard plant responses for Attachment 3 are discussed in Appendix A-4.

2. Levels of Required Monitoring

2.1. Introduction

The NRC issued Order EA-12-051 for Modification of Licenses with Regard to Reliable Spent Fuel Pool Instrumentation on March 12, 2012 (Reference 1). The requirements for the new instrumentation state, in part:

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

2.2. Rationale

During the events at Fukushima Daiichi, responders were without reliable instrumentation to determine water level in the spent fuel pool. This led to NRC concerns that the Fukushima Daiichi Unit 4 (1F4) pool might have boiled dry, resulting in significant fuel damage. The events at Fukushima Daiichi demonstrated the confusion and misapplication of resources that may result from beyond-design-basis external events when reliable spent fuel pool level instrumentation is not available.

2.3. Wide Range Pool Level Instrumentation

The requirement from this order is for instrumentation that covers a wide level range within the spent fuel pool. For implementation of this order and guideline a spent fuel pool has the following distinct characteristics:

- is a water-filled structure housing storage racks that contain irradiated fuel discharged from the reactor vessel that has been used for power generation within the last five years, and
- is considered a single spent fuel pool when two or more spent fuel pools are connected by normally open gates designed for under-water transfer of irradiated fuel (refer to Appendix A-3 for further details and examples).

Conversely, for purposes of implementation of this order and guideline, pools that have the following distinct characteristics are not spent fuel pools:

- Spent fuel pools that contain no fuel used in a reactor vessel for power generation within the past five years, or
- Water-filled structures within primary containments that contain temporary fuel storage locations at some Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR).

The three critical levels that must be monitored in a spent fuel pool are discussed below. It should be noted that continuous indication from a single instrument over the entire span from Level 1 to Level 3 is not required, but the set of instruments used to monitor the entire span is necessary to satisfy the requirements for the primary or backup instrument channel (refer to Figure 1 below).

A visual representation of monitoring levels 1, 2 and 3 and the associated resolution requirements for monitoring between the points are presented in Figure 1. The minimum resolution requirements apply to the separation distance between level indications and support development of appropriate response procedures. These requirements are separate from the instrument channel design accuracy discussed in section 3.

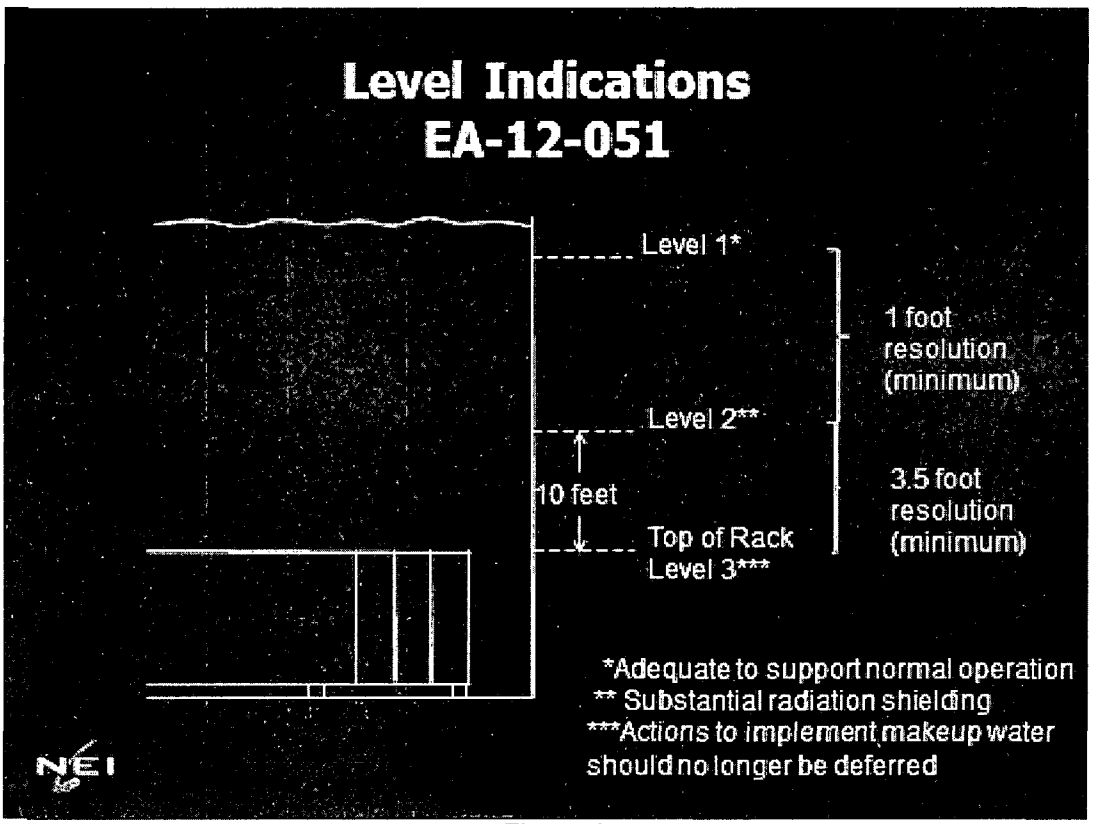

Figure 1

2.3.1. Level 1 – level that is adequate to support operation of the normal fuel pool cooling system

A typical fuel pool cooling system design includes a combination of weirs and/or vacuum breakers that prevent siphoning of the pool water level, below a minimum level, in the event of a piping rupture that can affect the SFP level. 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.

This level will vary from plant to plant and the instrument designer will need to consult plant-specific design information to determine the actual point that supports adequate cooling system performance.

2.3.2. Level 2 – level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck

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
- that level, which provides adequate radiation shielding to protect personnel performing local operations in the vicinity of the pool to restore makeup or cooling, based on either plant-specific or appropriate generic shielding calculations, considering the emergency conditions that may apply at the time. Additional guidance can be found in EPA-400 (Reference 4), USNRC Regulatory Guide 1.13 (Reference 5) and ANSI/ANS-57.2-1983 (Reference 6).

Designation of this level should not be interpreted to imply that actions to initiate water make-up must be delayed until SFP water levels have reached or are lower than this point.

2.3.3. Level 3 – level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

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. Designation of this level should not be interpreted to imply that actions to initiate water make-up must or should be delayed until this level is reached.

3. Instrumentation Design Features

3.1. Instruments

Order Requirement:

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.

Guidance:

Reliable level indication shall be provided for each spent fuel pool that can be used in responding to beyond design basis external events as described in Order EA-12-051. This instrumentation shall consist of at least one primary and one backup instrument channel. The backup instrument channel may be fixed, portable, or a combination of fixed and portable components. A spent fuel pool level instrument channel is considered reliable when the instrument channel satisfies the design elements listed in Section 3 of this guide and implementation of the programmatic features listed in Section 4. Appropriate quality assurance measures are listed in Appendix A-1 (these are similar to those imposed by Regulatory Guide 1.155, "Station Blackout").

Primary and backup instruments that are permanently mounted should meet the criteria below. If a portable backup instrument channel is used, then to limit exposure to the personnel it shall be designed such that it can easily be deployed by a maximum of two trained personnel within a task duration of 60 minutes or fewer at the spent fuel pool or based on plant specific ALARA evaluations. Wireless and other advanced technologies may be used provided that an evaluation is performed to address the interaction and failure modes such as EMI/RFI, Cyber security, etc. The portable instrument must be able to be monitored from an accessible location.

The time duration for which SFP level instrumentation shall be required to be functional is until additional off-site resources can be obtained, deployed and SFP conditions stabilized as described in NEI 12-06. In determining if the alternate sources of power for the two channels of level instrumentation meet that requirement, reasonable assumptions about intermittent (as opposed to continuous) level monitoring may be made, provided the channels have the capability for intermittent monitoring. If intermittent monitoring is credited, the assumptions shall be consistent with the emergency operating instructions for the equipment and the capability of plant staff to put the level instrumentation into and out of service.

3.2. Arrangement

Order Requirement:

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.

Guidance:

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. However, the intent of this requirement is not to constrain the design of the SFP instrumentation channels to the extent that it unduly impairs reliability, operability, or maintainability of the instrumentation. To the extent practical, the SFP instrumentation channels should not impair the ability to accomplish normal SFP operations and associated support activities, nor other activities that take place on the SFP deck. Installation of the SFP instrument channels shall be consistent with the plant specific SFP design requirements.

Channel separation should be maintained by locating the installed sensors in different places in the SFP area. If practical, examples of sensor location arrangements are

- on opposite sides or corners of the pool area,
- separated by a distance comparable to the shortest length of a side of the pool,
- in recesses of the pool to maximize the inherent missile protection provided by the pool walls,
- cask decontamination pits and fuel transfer tube areas, or
- next to or connected to structures that are securely connected to the side of the pool (e.g., a new fuel elevator), which may provide some protection from falling debris or missiles.

Provisions for portable instruments should also reflect the desire for physical separation. Plans for portable instrument use should allow inserting and operating the sensors and associated equipment in a different part of the SFP from the permanent channel. Ideally the portable channel will be able to use multiple (or all) SFP locations.

Similarly, cabling for power supplies and indications for each channel should be routed separately from cabling for the other channel .

The reasonable protection guidance outlined in NEI 12-06 to meet Order EA-12-049 should be used to provide protection from external hazards.

3.3. Mounting

Order Requirement:

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.

Guidance:

These order requirements apply to portions of any of this order's SFP level instrument channels' equipment that is permanently installed in the SFP. Consideration of maximum seismic ground motion to the current design of the SFP structure does not include changes to design bases initiated after March 12, 2012.

The mounting shall be designed 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).

3.4. Qualification

Order Requirement:

The level 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 the use of an augmented quality assurance process (e.g. a process similar to that applied to the site fire protection program).

Guidance

The instrument channel reliability shall be demonstrated, via an appropriate combination of design, analyses, operating experience, and/or testing of channel components. The temperature, humidity, radiation levels, shock, vibration, and seismic motion consistent with conditions in the area of use considering normal operational, event and post event conditions for no less than 7 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
- the impact of FLEX mitigating strategies.

The following operating experience measures are acceptable to verify that the design and installation is sufficient for shock, vibration, and seismic motion in providing this reliability, except for the mounting of components which is discussed in Section 3.3:

All components of the instrument channels are protected against shock, vibration, and seismic motion by one of the following methods:

- commercial design and testing for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications;
- substantial history of operational reliability in environments with significant shock and vibration loading, such as transportation applications; or
- components inherently resistant to shock and vibration loadings, such as cables.

The instrument channel components do not have to be qualified for missile impact. Meeting the arrangement requirements in Section 3.2 will satisfy the missile protection requirements of Order EA-12-051.

The quality assurance process to be applied is provided in Appendix A-1.

3.5. Independence

Order Requirement:

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

Guidance:

Independence of permanently installed instrumentation is obtained by physical 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. Use of stand-alone battery powered channels is acceptable. For two (2) permanently mounted (fixed) instruments in the pool, they should be separated to the extent practicable considering existing spent fuel pool construction (reference Section 3.2). Instrument technologies of the two (2) channels may be the same.

3.6. Power Supplies

Order Requirement:

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.

Guidance:

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 have sufficient capacity to support at least three days of instrument channel operation or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-0049

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.

3.7. Accuracy

Order Requirement:

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

Guidance:

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

3.8. Testing

Order Requirement:

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

Guidance:

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.

Back-up portable channels shall be designed such that calibration does not require the use of any additional test or reference equipment at the time of deployment, i.e., plug-and-play type technology.

Other testing and calibration requirements are located in Section 4.3. Existing work control processes may be used to control maintenance and testing. (*e.g.*, PM Program, Surveillance Program, Vendor Contracts, or work orders).

3.9. Display

Order Requirement:

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.

Guidance:

The intent of this guidance is to ensure that information on SFP level is promptly available to the plant staff and decisionmakers. 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 include 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.

SFP level indication from a portable channel shall be displayed in a accessible location.

4. Program Features

4.1. Training

Order Requirement:

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

Guidance:

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.

4.2. Procedures

Order Requirement:

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

Guidance:

Procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the new SFP instrumentation. For portable instruments, the procedures will also specify storage location and installation activities.

All licensees shall have a strategy to ensure SFP water level addition is initiated at an appropriate time consistent with the implementation of NEI 12-06.

4.3. Testing and Calibration

Order Requirement:

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.

Guidance:

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. Calibration shall be specific to the mounted instrument and the monitor.

Surveillances or testing to validate functionality of an installed instrument channel shall be performed within 60 days of a planned refueling outage considering normal testing scheduling allowances (e.g., 25%). This is not required to be performed more than once per 12 months.

The primary or back-up instrument channel can be out of service for testing, maintenance and/or calibration for up to 90 days provided the other channel is functional. Additionally, compensatory actions must be taken if the instrumentation channel is not expected to be restored or is not restored within 90 days. If both channels become non-functioning then initiate actions within 24 hours to restore one of the channels of

instrumentation and implement compensatory actions (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours.

If a single SFP for the purposes of this order is divided by the closure of a normally open gate(s) such that a portion of the SFP containing fuel used for power production within the last five years is no longer able to be monitored by a required SFP instrumentation channel, then the actions described above must be taken for the impacted instrumentation channel.

5. References

1. USNRC, Letter EA-12-051, "*Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,*" March 12, 2012.

2. NEI 12-06, "*Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,*" July 2012.

3. USNRC, Letter EA-12-049, "*Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis external Events,*" March 12, 2012.

4. US Environmental Protection Agency, "*Manual of Protection Action Guides and Protective Actions for Nuclear Incidents,*" EPA-400-R-92-001, May 1992.

5. USNRC, Regulatory Guide 1.13, Revision 2, "Spent Fuel Storage Facility Design Basis," March 2007.

6. ANSI/ANS 57.2 – 1983, "Requirements for Light Water Reactor Spent Fuel Storage Facilities," W1993.

Appendices

A-1. Quality Assurance

The QA guidance provided here is applicable to non-safety systems and equipment used to meet the requirements of this document that is not already explicitly covered by existing QA requirements. Additionally, non-safety equipment installed to meet this document must be implemented so that it does not degrade the existing safety-related systems. Activities should be implemented from this section as appropriate, depending on whether the equipment is being added (new) or is existing.

A-1-1. Design Control and Procurement Document Control

Measures should be established to ensure that all design related guidelines used in complying with this document are included in design and procurement documents, and that deviations there from are controlled.

A-1-2. Instructions, Procedures and Drawings

Inspections, tests, administrative controls, and training necessary for compliance with this document should be prescribed by documented instructions, procedures, and drawings and should be accomplished in accordance with these documents.

A-1-3. Control of Purchased Material, Equipment, and Services

Measures should be established to ensure that purchased material, equipment, and services conform to the procurement documents.

A-1-4. Inspection

A program for independent inspection of activities required to comply with this document should be established and executed by or for the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

A-1-5. Testing and Test Control

A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.

A-1-6. Inspection, Test, and Operating Status

Measures should be established to identify items that have satisfactorily passed required tests and inspections.

A-1-7. Nonconforming Items

Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use or installation.

A-1-8. Corrective Action

Measures should be established to ensure that failures, malfunctions, deficiencies, deviations, defective components, and non-conformances are promptly identified, reported, and corrected.

A-1-9. Records

Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities required to comply with this document.

A-1-10. Audits

Audits should be conducted and documented to verify compliance with design and procurement documents, instructions, procedures, drawings, and inspection and test activities developed to comply with this document.

A-2. Order Response Template

Order Requirement:

All holders of operating licenses issued under Part 50 shall by February 28, 2013, submit to the Commission for review an overall integrated plan, including a description of how compliance with the requirements described in Attachment 2 will be achieved.

All Licensees and CP holders shall provide an initial status report sixty (60) days after the issuance of the final ISG, and at six (6) month intervals following submittal of the overall integrated plan, as required in Condition C.1, which, delineates progress made in implementing the requirements of this Order.

Guidance:

The following content is suggested for the reports required by the order

A-2-1. 60 Day Progress Report:

- Acknowledgement of availability of guidance
- Plan to submit Integration Plan

A-2-2. Overall Integrated Plan

- See next page

A-2-3. 6 Month Progress Reports:

- Any changes in compliance method
- Schedule
- Need for Relief and basis, if any

Overall Integrated Plan Guidance

Applicability:

This integrated plan applies to [Unit] [and Unit].

Schedule:

[Single Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] is scheduled for completion prior to [November 30, 2015] [based on the end of the second refueling outage following the submittal of this integrated plan.]]

[Multiple Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] [and Unit] is scheduled for completion prior to [November 30, 2015] [based on the end of the second refueling outage for [Unit] following the submittal of this integrated plan.] [This is the [earlier/later] outage sequence of the units discharging to the pool.] [The schedule is based on the later outage sequence because...]]

[Associated Spent Fuel Pool Configuration:

[Unit] [and Unit] discharge irradiated fuel to a [single][shared][set of {2} interconnected] spent fuel storage pool[s]. [With the exception of limited time periods for maintenance or non-refueling operations, administrative controls maintain gates between the following pools open: [spent fuel pool {A}], [spent fuel pool {B}], [fuel transfer canal to [Unit]], and [cask loading pit]. Thus, these pools are normally inter-connected and at the same water level when the water level in the spent fuel pool is greater than [1 foot] above the top of stored fuel seated in the storage racks.]]

Identification of Spent Fuel Pool Water Levels:

Key spent fuel pool water levels will be identified as follows:

- Level adequate to support operation of the normal fuel pool cooling system – Indicated level on either the primary or backup instrument channel of greater than [x feet] above the top of stored fuel seated in the storage racks and will consider the design instrument channel accuracy. This water level is adequate for normal fuel pool cooling system operation.

- Level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck - Indicated level on either the primary or backup instrument channel of greater than [10/x feet] above the top of stored fuel seated in the storage racks considering the design instrument channel accuracy. [[The monitoring level of x feet was selected considering the guidelines in EPA-400 for

recommended personnel exposure limits considering the emergency conditions would at the time. This monitoring level verifies there is an adequate water level to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck.]

- Level where fuel remains covered - Indicated level on either the primary or backup instrument channel of greater than [x foot] above the top of stored fuel seated in the storage racks considering design instrument channel accuracy. This monitoring level assures that there is adequate water level above the stored fuel seated in the rack.

Instruments:

The design of the instruments will be consistent with the guidelines of NRC JLD-ISG-2012 and NEI 12-02[, with the exceptions and clarifications noted below.] Specifically, the channels will be designed as discussed below.

Primary (fixed) instrument channel: The primary instrument channel level sensing component[s] will be located in [the cask loading pit]. [For locations outside of the spent fuel pool a description of the how the location provides the appropriate water level coupling to the spent fuel pool should be provided.] The primary instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. [The continuous level indication will be provided by a [pressure transmitter]./The discrete level indication will be provided by [level switches]].

Backup instrument channel: The backup instrument channel level sensing component[s] consist of [both portable and fixed] components. [The [portable components will be deployed in [spent fuel pool A], and the fixed components are located in the [transfer canal adjacent to spent fuel pool A]. The backup instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. The continuous level indication will be provided by a [portable ultrasonic level detector]] and the discrete level indication will be provided by [level switches].] Instrumentation channel independence is achieved in the following manner: [Plant specific response]

Reliability:

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[, with the exceptions and clarifications noted below:]

[plant specific response]

Instrument Channel Design Criteria:

Consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:

Arrangement: [Plant specific response]

Mounting: [Plant specific response]

Qualification: [Plant specific response]

Power Supplies: [Plant specific response]

The power supplies for the instrument channels are arranged as follows. [The primary instrument channel normally receives power from plant [alternating current] AC power, and this power supply can be separated from the channel with a disconnect switch and replaced by battery power for intermittent monitoring. The backup instrument channel components are all powered by batteries maintained in a charged state by commercial-grade uninterruptible power supplies.]

Accuracy:

The accuracy will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Testing:

Testing will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Display:

[The primary instrument display will be located in (at) the [control room, auxiliary shutdown panel, or described accessible location]. The backup instrument channel display will use wireless data transmission to a portable, battery-powered display.] The display will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Instrument Channel Program Criteria:

The program criteria will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Need for Relief and basis, if any.

A-3. Implementation Considerations

For plant sites (units) with shared SFPs (two or more SFPs connected by normally open gates designed for under-water transfer of irradiated fuel) the shared pool(s) may be treated as a single SFP and the latest of the unit's 2nd refueling outage post Feb. 28, 2013, or Dec. 31, 2016, whichever is earlier, will determine the implementation deadline for the actions from this order for that plant site. However, this clarification needs to be stated in the Integrated Plan Submittal and an appropriate justification on the need for invoking this clarification should be included with the plan.

An example of justifications for use of this clarification is a plant with physical constraints that dictate the instrument channel components need to be routed during a refueling outage associated with the later unit (as defined above). This constraint could be breach of containment boundaries for penetrations or mountings, location of connected buses during one refueling outage versus another.

A-4. AP1000 Spent Fuel Pool Instrumentation Guidance

[*N.B.*, This Appendix applies only to the AP1000 plants.]

A-1-11. Introduction

AP1000 is required to provide 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.

A-1-12. Background

The design bases of AP1000 address many of these attributes of spent fuel pool level instrumentation. The NRC staff reviewed these design features prior to issuance of the combined licenses for these facilities and certification of the AP1000 design referenced therein. The AP1000 certified design largely addresses the above requirements by providing two safety-related spent fuel pool level instrument channels. The instruments measure level from the top of the spent fuel pool to the top of the fuel racks to address the range requirements listed above. The safety-related classification provides for the following additional design features:

- Seismic and environmental qualification of the instruments
- Independent power supplies
- Electrical isolation and physical separation between instrument channels
- Display in the control room as part of the post-accident monitoring instrumentation
- Routine calibration and testing

A-1-13. Requirements

AP1000 is required to address the following requirements that were not specified in the certified design.

A-4-3.1 Arrangement

Order Requirement

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 safety-related instruments 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.

Guidance

Protection against missiles should be described, noting the protection that may be provided by location of the safety-related instruments and their associated connections below the operating deck. Describe the arrangement and basis for why the operating deck provides protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. Alternatively, provide description of the features for additional protection that may be provided by the location the safety-related instruments 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.

A-4-3.2 Qualification

Order Requirement

The level 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.

Guidance

Provide a description of the instrumentation sensors and their capability to operate in the environmental conditions that they will experience during design basis events, noting that for the AP1000 design basis conditions include a SBO with steaming in the SFP. The environmental conditions to be addressed should include appropriate consideration for temperature, humidity, steaming, radiation, and seismic activity (SSE) levels where the sensors are located. Provide information to demonstrate the reliability of the instrument under these conditions.

Appropriate evaluations should also be provided to demonstrate the operability of these sensors for indefinite SBO durations.

A-4-3.3 Power Supplies

Order Requirement

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. Power supply designs should provide for quick and accessible connection of sources independent of the plant AC and DC power distribution systems. 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.

Guidance

Provide a description of the design features provided to ensure continuous power supply to the instrumentation for extended loss of power conditions. The AP1000 design provides extended SFP monitoring capability with two trains of dedicated class 1E DC power supply for at least 72 hours of post accident monitoring. Beyond the initial 72 hours, the response shall detail how the instrument power supply can be met by the use of offsite portable generators with quick and accessible connection points to the existing AC or DC power distribution system and sufficient capacity to maintain level indication indefinitely. The capability to use both onsite and offsite equipment should be discussed as well as the availability of clear guidance for the operator as part of the AP1000 post-72 hours procedures per AP1000 DCD Section 1.9.5.4.

A-4-3.4 Accuracy

Order Requirement

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

Guidance

As discussed under Section A-4-3.3the AP1000 design provides means for continued power supply to the spent fuel pool level instrumentation, relying for the first 72 hours only on class 1E batteries. The power supply can then be extended indefinitely by various means as described in Section A-4-3.3

Additionally, the potential impact on temporary loss of power to the level instrument shall be discussed and evaluated in this section including confirmation that the DP cells would not need to be re-calibrated following a loss of power.

The instrument should be discussed to address sufficient accuracy during SBO conditions which includes boiling of the SFP water.

A-4-3.5 Display

Order Requirement

The display shall provide on-demand or continuous indication of spent fuel pool water level.

Guidance

For the first 72 hours, provide details regarding the continuous display provided in the Main Control Room with power provided by the class 1E batteries. For Post 72 hours, describe the features of the Main Control Room display and use of power supplies

described in Section A-4-3.3. Describe the SFP water level display features. Provide a description of appropriate alarms for low water level. The display requirement may be described by reference to appropriate instrumentation datasheets, specifications, and other relevant documentation.

A-1-14. Programmatic Controls

Order Requirement

The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of a training program. Personnel shall be trained in the use and the provision of alternate power to the safety-related level instrument channels.

Guidance

As noted in the background, the safety-related classification of the AP1000 spent fuel level instrumentation ensures routine calibration and testing of the instrumentation, which maintains the equipment as available and reliable. The training program shall be described to provide training to personnel in the use and the provision of alternate power supplies to the existing AC or DC power distribution system to power the instrument channels consistent with the post-72 hours procedures detailed in DCD Section 1.9.5.4. Implemented procedures consistent with the training program shall be summarized and clarified as part of the response.

NEI 12-02 [Revision ~~B~~0]

Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation"

~~May~~July 2012

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With the deepest appreciation,
Steven P. Kraft
Nuclear Energy Institute
Washington, D.C.

NOTICE

EXECUTIVE SUMMARY

In studying the sequence of events that took place at Fukushima Daiichi during the accident that occurred due to the ~~May~~March 11, 2011, earthquake and resulting tsunami, the U.S. Nuclear Regulatory Commission (NRC) determined that several near-term actions were needed at U.S. commercial nuclear power plants. Among them was to provide Spent Fuel Pools (SFP) with reliable level instrumentation to significantly enhance the knowledge of key decision makers such that resources are allocated effectively in the event of a very low probability beyond design basis event. Consequently, the NRC issued Order EA-12-051 "*-Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*" (ML12054A679) on March 12, 2012, for all ~~US~~U.S. nuclear plants with an operating license, construction permit or combined construction and operating license.

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

All licensees subject to the technical scope of the NRC Order EA-12-051 shall:

- provide a primary and back-up level instrument that will monitor water level from the normal level to the top of the used fuel rack in the pool;
- provide a display in an area accessible following a severe event; and
- provide independent electrical power to each ~~train~~instrument channel and provide an alternate remote power connection capability.

~~AP1000 licensees shall refer to Appendix A-4 of this document for response guidance to address the technical scope of the NRC Order for Reliable Spent Fuel Pool Level Instrumentation.~~

This guidance document provides additional details on an acceptable approach for complying with NRC Order EA-12-051. -In addition, as suggested in section two of NRC EA-12-051:

> *"Additional details on an acceptable approach for complying with this Order will be contained in final interim staff guidance (ISG) scheduled to be issued by the NRC in August 2012."*

The guide provides the industry suggested method for compliance with NRC Order EA-12-051.

AP1000 licensees shall refer to Appendix A-4 of this document for guidance to address the technical scope of the NRC Order for Reliable Spent Fuel Pool Level Instrumentation; the guidance in Appendix A-4 applies *only* to the AP1000 plants.

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1. Introduction

On March 11, 2011, an earthquake occurred off the coast of Japan~~, which~~ that resulted in a tsunami ~~that caused~~causing considerable damage to several commercial nuclear power plant facilities. The U.S. Nuclear Regulatory Commission (NRC) assembled a response task force to investigate and review the event. The task force recommended a series of actions to be taken by each licensee, and provided a series of orders and rulemaking. These actions were grouped into three tiers to address those items requiring an immediate response as well as items that will require significant time for implementation due to resource limitations or required additional, detailed study. The items to be performed without undue delay were the Tier 1 actions. These Tier 1 actions were approved by the ~~full NRC commission~~Commission on the one-year anniversary of the accident, and issued to each licensee. One of these Tier 1 actions was to provide reliable spent fuel pool level instrumentation.

The NRC found that providing spent fuel pools with reliable level instrumentation would significantly enhance the knowledge of key decision makers such that resources are allocated effectively in the event of a very low probability beyond design basis accident. The NRC issued Order EA-12-051 " *Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*~~",~~," ML12054A679, on March 12, 2012 (Reference 1) for all US nuclear plants with an operating license, COL (Combined Operating License) or CP (Construction Permit). Each licensee shall, unless granted relief by the NRC, comply with Order EA-12-051 within two fuel cycles following the ~~final issuance of NRC's Interim Staff Guidance (ISG)~~submittal of the overall integrated plan required by Order EA-12-051 or not later than December 31, 2016, whichever comes first.

This guidance is complementary to the guidance for implementing ~~order~~Order EA-12-049, "*Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,*" and associated implementation guidance (NEI 12-06) (Reference 2) and presents an acceptable method for implementing ~~order~~Order EA-12-051. For considerations of the SFP level instruments related to ~~order~~Order EA-12-049 (Reference 3) each channel is considered a set of response equipment, thus the primary and back-up channels meet the N+1 requirements of NEI 12-06.

All holders of COLs issued under Part 52, notwithstanding the provisions of any Commission regulation or license to the contrary, comply with the requirements described in Attachment 3 of the Order except to the extent that a more stringent requirement is set forth in the license. These licensees shall promptly start implementation of the requirements in Attachment 3 to the Order and shall complete full implementation prior to fuel load.

The AP1000 standard plant responses for Attachment 3 are discussed in Appendix A-4.

2. Levels of Required Monitoring

2.1. Introduction

The NRC issued Order EA-12-051 for Modification of Licenses with Regard to Reliable Spent Fuel Pool Instrumentation on March 12, 2012 (Reference 1). The requirements for the new instrumentation state, in part:

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

2.2. Rationale

During the events at Fukushima Daiichi, responders were without reliable instrumentation to determine water level in the spent fuel pool. This led to NRC concerns that the Fukushima Daiichi Unit 4 (1F4) pool might have boiled dry, resulting in significant fuel damage. The events at Fukushima Daiichi demonstrated the confusion and misapplication of resources that may result from beyond-design-basis external events when reliable spent fuel pool level instrumentation is not available.

2.3. Wide Range Pool Level Instrumentation

The requirement from this order is for instrumentation that covers a wide level range within the spent fuel pool. For implementation of this order and guideline a spent fuel pool has the following distinct ~~characteristic~~characteristics:

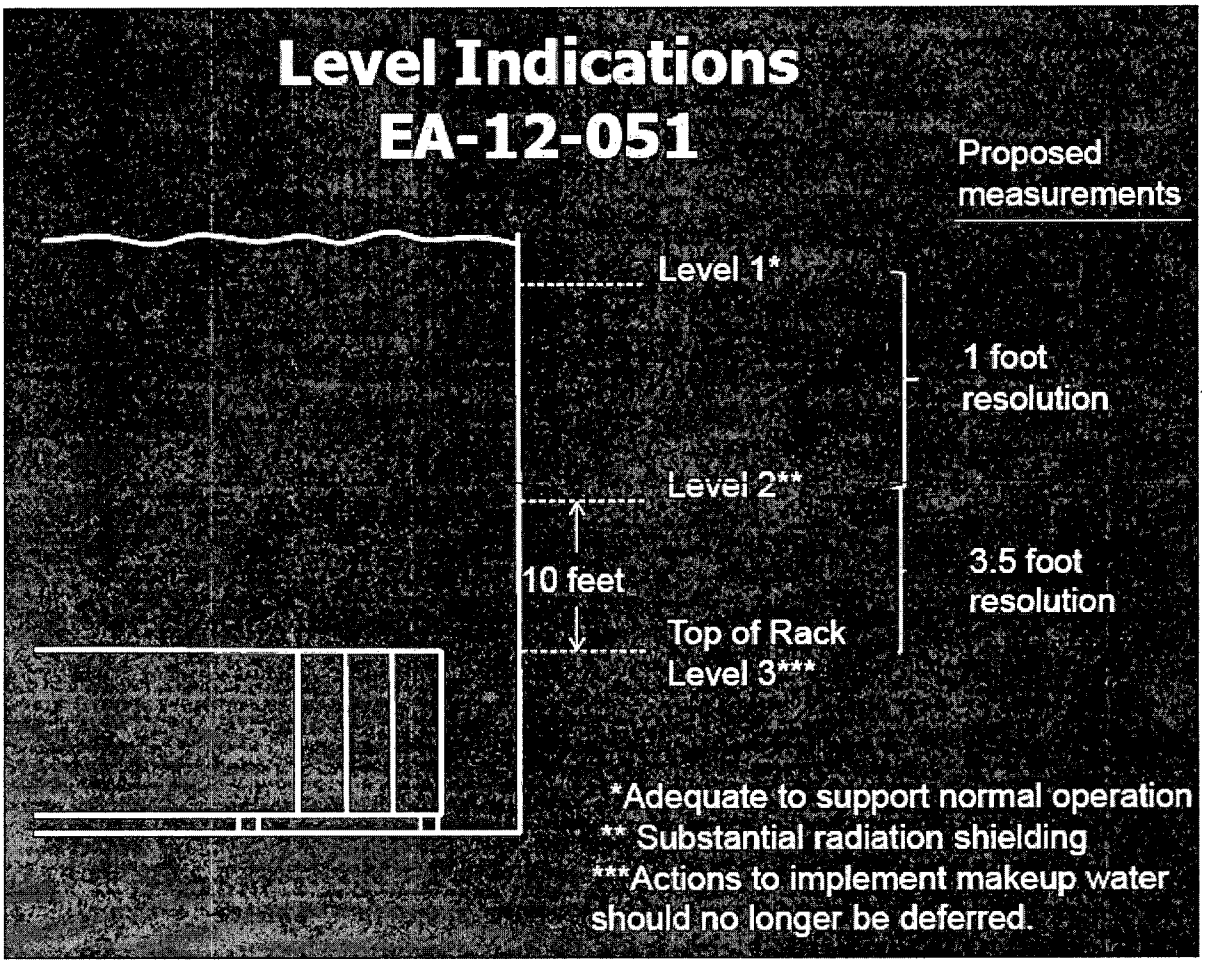
- is a water-filled structure housing storage racks that contain irradiated fuel discharged from the reactor vessel ~~which~~that has been used for power generation within the last five years, and
- is considered a single spent fuel pool when two or more spent fuel pools are connected by normally open gates designed for under-water transfer of irradiated fuel (refer to Appendix A-3 for further details and examples).

Conversely, for purposes of implementation of this order and guideline, pools that have the following distinct characteristics are not spent fuel pools:

- Spent fuel pools that contain no fuel used in a reactor vessel for power generation within the past five years, or
- Water-filled structures within primary containments that contain temporary fuel storage locations~~,~~ at some Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR).

The three critical ~~points~~levels that must be monitored in a spent fuel pool are discussed below. It should be noted that continuous indication from a single instrument over the entire span from ~~Point~~Level 1 to ~~Point~~Level 3 is not required~~.~~, but the set of instruments used to monitor the entire span is necessary to satisfy the requirements for the primary or backup instrument channel (refer to Figure 1 below~~)~~).

A visual representation of ~~the~~ monitoring ~~level points~~levels 1, 2~~,~~ and 3 ~~is~~and the associated resolution requirements for monitoring between the points are presented in Figure 1. The minimum resolution requirements apply to the separation distance between level indications and support development of appropriate response procedures. These requirements are separate from the instrument channel design accuracy discussed in section 3.


Level Indications
EA-12-051
Proposed measurements
Level 1*
1 foot resolution
Level 2**
10 feet
3.5 foot resolution
Top of Rack
Level 3***
*Adequate to support normal operation
** Substantial radiation shielding
***Actions to implement makeup water should no longer be deferred.

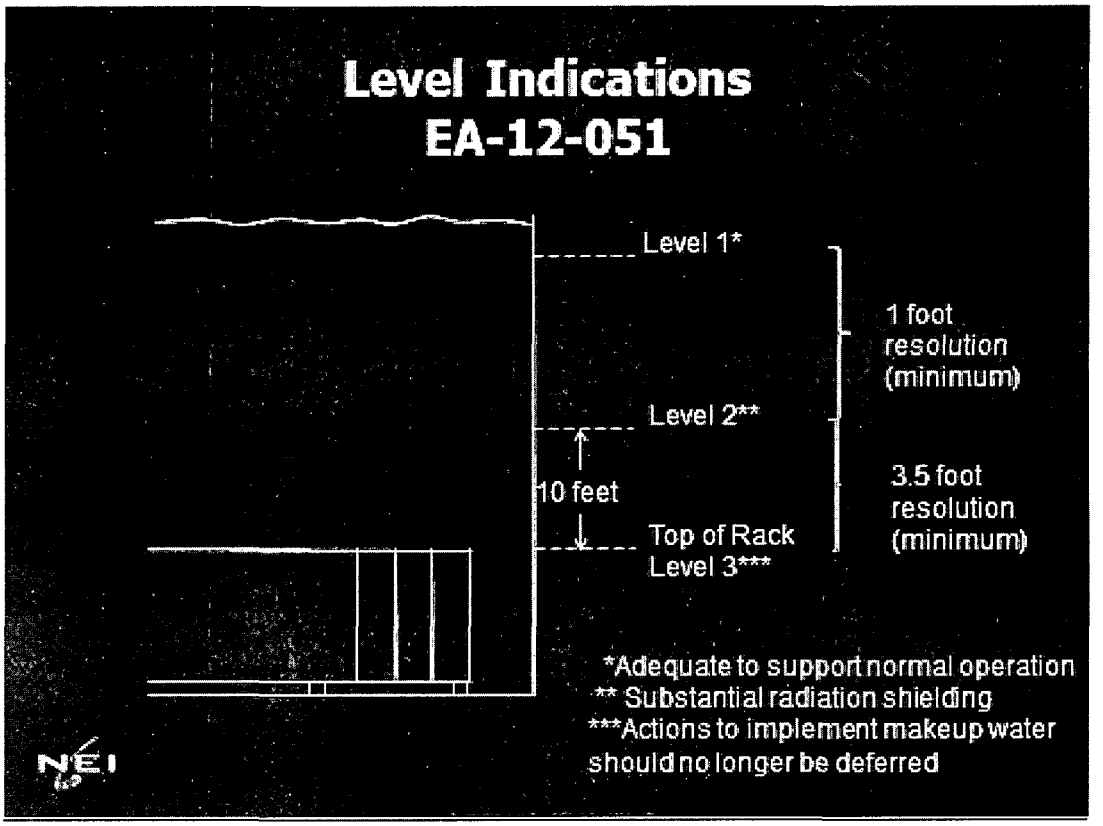

Level Indications
EA-12-051
Level 1*
1 foot
resolution
(minimum)
Level 2**
10 feet
3.5 foot
resolution
(minimum)
Top of Rack
Level 3***
*Adequate to support normal operation
** Substantial radiation shielding
***Actions to implement makeup water
should no longer be deferred
NEI

Figure 1

2.3.1. Level 1 – level that is adequate to support operation of the normal fuel pool cooling system

A typical fuel pool cooling system design includes a combination of weirs and/or vacuum breakers that prevent siphoning of the pool water level, below a minimum level, in the event of a piping rupture that can affect the SFP level. Level 1 represents the HIGHER of the following two points:

- The ~~point~~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 ~~point~~level at which the water height, assuming saturated conditions, above the centerline of the cooling pump suction ~~necessary to provide~~provides the required net positive suction head specified by the pump manufacturer or engineering analysis. (minimum)

This level will vary from plant to plant and the instrument designer will need to consult plant-specific design information to determine the actual point ~~which~~that supports adequate cooling system performance. (minimum)

2.3.2. Level 2 – level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck

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
- that level, which provides adequate radiation shielding to protect personnel performing local operations in the vicinity of the pool to restore makeup or cooling, based on either plant-specific or appropriate generic shielding calculations~~. The guidelines of EPA-400 (Reference 3) should be consulted for recommended personnel exposure limits.~~, considering the emergency conditions that may apply at the time. Additional guidance can be found in EPA-400 (Reference 4), USNRC Regulatory Guide 1.13 (Reference ~~2~~5) and ANSI/ANS-57.2-1983 (Reference 4~~6~~).

Designation of this level should not be interpreted to imply that actions to initiate water make-up must be delayed until SFP water levels have reached or are lower than this point.

2.3.3. Level 3 – level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

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. Designation of this level should not be interpreted to imply that actions to initiate water make-up must or should be delayed until this level is reached.

3. Instrumentation Design Features

3.1. Instruments

Order Requirement:

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.

Guidance:

Reliable level indication shall be provided for each spent fuel pool~~.~~ that can be used in responding to beyond design basis external events as described in Order EA-12-051. This instrumentation shall consist of at least one primary and one backup instrument channel. The backup instrument channel may be fixed, portable, or a combination of fixed and portable components. A spent fuel pool level instrument channel is considered reliable when the instrument channel satisfies the design elements listed in Section 3 of this guide and implementation of the programmatic features listed in Section 4. Appropriate quality assurance measures are listed in Appendix A-1 (these are similar to those imposed by Regulatory Guide 1.155, -"Station Blackout").

Primary and backup instruments that are permanently mounted should meet the criteria below. If a portable backup instrument channel is used, then to limit exposure to the personnel it shall be designed such that it can easily be deployed by a maximum of two trained personnel within a task duration of 60 minutes or fewer at the spent fuel pool or based on plant specific ALARA evaluations. Wireless and other advanced technologies may be used provided that an evaluation is performed to address the interaction and failure modes such as EMI/RFI, Cyber security, etc. The portable instrument must be able to be monitored from an accessible location.

The time duration for which SFP level instrumentation shall be required to be functional is until additional off-site resources can be obtained, deployed and SFP conditions stabilized as described in NEI 12-06. In determining if the alternate sources of power for the two channels of level instrumentation meet that requirement, reasonable assumptions about intermittent (as opposed to continuous) level monitoring may be made, provided the channels have the capability for intermittent monitoring. If intermittent monitoring is credited, the assumptions shall be consistent with the emergency operating instructions for the equipment and the capability of plant staff to put the level instrumentation into and out of service.

3.2. Arrangement

Order Requirement:

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.

Guidance:

The intent of the arrangement requirement is to specify reasonable separation and missile protection requirements for permanently installed instrumentation used to meet this order. ~~Separation~~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. However, the intent of this requirement is not to constrain the design of the SFP instrumentation channels to the extent that it unduly impairs reliability, operability, or maintainability of the instrumentation. To the extent practical, the SFP instrumentation channels should not impair the ability to accomplish normal SFP operations and associated support activities, nor other activities that take place on the SFP deck. Installation of the SFP instrument channels shall be consistent with the plant specific SFP design requirements.

Channel separation should be maintained by locating the installed sensors in different places in the SFP area. If practical, examples of sensor location arrangements are

- on opposite sides or corners of the pool area,
- separated by a distance comparable to the shortest length of a side of the pool,
- in recesses of the pool to maximize the inherent missile protection provided by the pool walls,
- cask decontamination pits and fuel transfer tube areas, or
- next to or connected to structures that are securely connected to the side of the pool (e.g., a new fuel elevator~~)~~), which may provide some protection from falling debris or missiles.

Provisions for portable instruments should also reflect the desire for physical separation. Plans for portable instrument use should allow inserting and operating the sensors and associated equipment in a different part of the SFP from the permanent channel. Ideally the portable channel will be able to use multiple (or all) SFP locations.

Similarly, cabling for power supplies and indications for ~~the two channels~~each channel should be routed separately from cabling for the other channel .

The reasonable protection guidance outlined in NEI 12-06 to meet Order EA-12-049 should be used to provide protection from external hazards.

3.3. Mounting

Order Requirement:

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.

Guidance:

These ~~Order~~order requirements apply to portions of any of this ~~Order's~~order's SFP level instrument channels' equipment that is permanently installed in the SFP.- Consideration of maximum seismic ground motion to the current design of the SFP structure does not include changes to design bases initiated after ~~3/~~March 12~~/12~~, 2012.

The mounting shall be designed 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).

3.4. Qualification

Order Requirement:

The level 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 the use of an augmented quality assurance process (e.g. a process similar to that applied to the site fire protection program).

Guidance

The instrument channel reliability shall be demonstrated, via an appropriate combination of design, analyses, operating experience, and/or testing of channel components ~~at the~~. The temperature, humidity ~~and~~, radiation levels, shock, vibration, and seismic motion consistent with conditions in the area of use considering normal operational ~~conditions~~, event and post event conditions~~,~~ for no less than 7 days post-event or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-~~0049~~ 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
- the impact of FLEX mitigating strategies.

The following operating experience measures are acceptable to verify that the design and installation is sufficient for shock, vibration, and seismic motion in providing this reliability, except for the mounting of components which is discussed in Section 3.3:

All components of the instrument channels are protected against shock, vibration, and seismic motion by one of the following methods:

- commercial design and testing for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications;
- substantial history of operational reliability in environments with significant shock and vibration loading, such as transportation applications; or
- components inherently resistant to shock and vibration loadings, such as cables.

The instrument channel components do not have to be qualified for missile impact. Meeting the arrangement requirements in Section 3.2 will satisfy the missile protection requirements of Order EA-12-051.

The quality assurance process to be applied is provided in Appendix A-1.

3.5. Independence

Order Requirement:

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

Guidance:

Independence of permanently installed instrumentation is obtained by physical separation commensurate with the hazard and electrical isolation needs. If plant ~~ac~~AC or ~~dc~~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. Use of stand-alone battery powered channels is acceptable. For two (2) permanently mounted (fixed) instruments in the pool, they should be separated to the extent practicable considering existing spent fuel pool construction (reference Section 3.2). Instrument technologies of the two (2) channels may be the same.

3.6. Power Supplies

Order Requirement:

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.

Guidance:

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~~AC and ~~dc~~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 have sufficient capacity to support at least ~~3~~three days of instrument channel operation or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-0049

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.

3.7. Accuracy

Order Requirement:

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

Guidance:

The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration. Accuracy should ~~be maintained within the resolution identified in Figure 1 and~~ consider 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.

3.8. Testing

Order Requirement:

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

Guidance:

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~~.~~.

Back-up portable channels shall be designed such that calibration does not require the use of any additional test or reference equipment at the time of deployment, i.e., plug-and-play type technology.

Other testing and calibration requirements are located in Section 4.3. Existing work control processes may be used to control maintenance and testing. (*e.g.*, PM Program, Surveillance Program, Vendor Contracts, or work orders).

3.9. Display

Order Requirement:

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.

Guidance:

The intent of this guidance is to ensure that information on SFP level is ~~reasonably~~promptly available to the plant staff and ~~decision makers~~decisionmakers. Ideally there will be an indication from at least one channel of instrumentation in the control room. ~~However,~~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~~include 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.

SFP level indication from a portable channel shall be displayed in a accessible location.

4. Program Features

4.1. Training

Order Requirement:

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

Guidance:

The personnel performing functions associated with ~~this~~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.

4.2. Procedures

Order Requirement:

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

Guidance:

Procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the new SFP instrumentation. For portable instruments, the procedures will also specify storage location and installation activities.

All licensees shall have a strategy to ensure SFP water level addition is initiated at an appropriate time consistent with the implementation of NEI 12-06.

4.3. Testing and Calibration

Order Requirement:

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.

Guidance:

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. Calibration shall be specific to the mounted instrument and the monitor.

Surveillances or testing to validate functionality of an installed instrument channel shall be performed within 60 days of a planned refueling outage considering normal testing scheduling allowances (e.g., 25%). ~~-~~This is not required to be performed more than once per 12 months.

The primary or back-up instrument channel can be out of service for testing, maintenance and/or calibration for up to 90 days provided the other channel is functional~~ and actions are initiated to protect the functionality of the other channel's components.~~. Additionally, compensatory actions must be taken if the instrumentation channel is not expected to be restored or is not restored within 90 days. If both channels become non-functioning then initiate actions within 24 hours to restore one of the channels of instrumentation and implement compensatory actions (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours.

If a single SFP for the purposes of this order is divided by the closure of a normally open gate(s) such that a portion of the SFP containing fuel used for power production within the last five years is no longer able to be monitored by a required SFP instrumentation channel, then the actions described above must be taken for the impacted instrumentation channel.

5. References

1. USNRC, Letter EA-12-051, "*Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*~~",~~," March 12, 2012.

~~2. USNRC, Regulatory Guide 1.13, Revision 2, "*Spent Fuel Storage Facility Design Basis*", March 2007.~~

~~3. US Environmental Protection Agency, "*Manual of Protection Action Guides and Protective Actions for Nuclear Incidents*", EPA-400-R-92-001, May 1992.~~

~~4. ANSI/ANS 57.2 – 1983, "*Requirements for Light Water Reactor Spent Fuel Storage Facilities*", W1993.~~

~~5.~~2. NEI 12-06, "*Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*~~", May,~~" July 2012.

~~6.~~3. USNRC, Letter EA-12-049, "*Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis external Events*~~",~~," March 12, 2012.

4. US Environmental Protection Agency, "*Manual of Protection Action Guides and Protective Actions for Nuclear Incidents,*" EPA-400-R-92-001, May 1992.

5. USNRC, Regulatory Guide 1.13, Revision 2, "Spent Fuel Storage Facility Design Basis," March 2007.

6. ANSI/ANS 57.2 – 1983, "Requirements for Light Water Reactor Spent Fuel Storage Facilities," W1993.

Appendices

A-1. Quality Assurance

The QA guidance provided here is applicable to non-safety systems and equipment used to meet the requirements of this document that is not already explicitly covered by existing QA requirements. Additionally, non-safety equipment installed to meet this document must be implemented so that it does not degrade the existing safety-related systems. Activities should be implemented from this section as appropriate, depending on whether the equipment is being added (new) or is existing.

A-1-1. Design Control and Procurement Document Control

Measures should be established to ensure that all design related guidelines used in complying with this document are included in design and procurement documents, and that deviations there from are controlled.

A-1-2. Instructions, Procedures and Drawings

Inspections, tests, administrative controls, and training necessary for compliance with this document should be prescribed by documented instructions, procedures, and drawings and should be accomplished in accordance with these documents.

A-1-3. Control of Purchased Material, Equipment, and Services

Measures should be established to ensure that purchased material, equipment, and services conform to the procurement documents.

A-1-4. Inspection

A program for independent inspection of activities required to comply with this document should be established and executed by or for the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

A-1-5. Testing and Test Control

A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.

A-1-6. Inspection, Test, and Operating Status

Measures should be established to identify items that have satisfactorily passed required tests and inspections.

A-1-7. Nonconforming Items

Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use or installation.

A-1-8. Corrective Action

Measures should be established to ensure that failures, malfunctions, deficiencies, deviations, defective components, and non-conformances are promptly identified, reported, and corrected.

A-1-9. Records

Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities required to comply with this document.

A-1-10. Audits

Audits should be conducted and documented to verify compliance with design and procurement documents, instructions, procedures, drawings, and inspection and test activities developed to comply with this document.

A-2. Order Response Template

Order Requirement:

All holders of operating licenses issued under Part 50 shall by February 28, 2013, submit to the Commission for review an overall integrated plan, including a description of how compliance with the requirements described in Attachment 2 will be achieved.

All Licensees and CP holders shall provide an initial status report sixty (60) days after the issuance of the final ISG, and at six (6) month intervals following submittal of the overall integrated plan, as required in Condition C.1, which, delineates progress made in implementing the requirements of this Order.

Guidance:

The following content is suggested for the reports required by the order

A-2-1. 60 Day Progress Report:

- Acknowledgement of availability of guidance
- Plan to submit Integration Plan

A-2-2. Overall Integrated Plan~~:~~

~~- Planned compliance method~~

- ~~ISG/NEI~~ See next page
  - ~~*Guidance*~~
    - ~~Utilization of NRC ISG and NEI 12-02~~
    - ~~Exceptions to guidance with justification~~

~~- Compliance Date~~

- ~~Major Milestone (quarter expected to complete)~~

~~Conceptual Design complete (30%)~~

- ~~**Instrument Channel** Procurement~~
- ~~Detailed design complete (90%)~~
- ~~Equipment delivery~~
- ~~Training complete~~
- ~~Implementation complete~~

~~Procedure validation complete~~

~~- **Need for Relief and basis, if any**~~

A-2-3. 6 Month Progress Reports:

- Any changes in compliance method
- Schedule
- Need for Relief and basis, if any

Overall Integrated Plan Guidance

Applicability:

This integrated plan applies to [Unit] [and Unit].

Schedule:

[Single Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] is scheduled for completion prior to [November 30, 2015] [based on the end of the second refueling outage following the submittal of this integrated plan.]]

[Multiple Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] [and Unit] is scheduled for completion prior to [November 30, 2015] [based on the end of the second refueling outage for [Unit] following the submittal of this integrated plan.] [This is the [earlier/later] outage sequence of the units discharging to the pool.] [The schedule is based on the later outage sequence because…]]

[Associated Spent Fuel Pool Configuration:

[Unit] [and Unit] discharge irradiated fuel to a [single][shared][set of {2} interconnected] spent fuel storage pool[s]. [With the exception of limited time periods for maintenance or non-refueling operations, administrative controls maintain gates between the following pools open: [spent fuel pool {A}], [spent fuel pool {B}], [fuel transfer canal to [Unit]], and [cask loading pit]. Thus, these pools are normally inter-connected and at the same water level when the water level in the spent fuel pool is greater than [1 foot] above the top of stored fuel seated in the storage racks.]]

Identification of Spent Fuel Pool Water Levels:

Key spent fuel pool water levels will be identified as follows:

- Level adequate to support operation of the normal fuel pool cooling system – Indicated level on either the primary or backup instrument channel of greater than [x feet] above the top of stored fuel seated in the storage racks and will consider the design instrument channel accuracy. This water level is adequate for normal fuel pool cooling system operation.

- Level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck - Indicated level on either the primary or backup instrument channel of greater than [10/x feet] above the top of stored fuel seated in the storage racks considering the design instrument channel accuracy. [[The monitoring level of x feet was selected considering the guidelines in EPA-400 for

recommended personnel exposure limits considering the emergency conditions would at the time. This monitoring level verifies there is an adequate water level to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck.]

- Level where fuel remains covered - Indicated level on either the primary or backup instrument channel of greater than [x foot] above the top of stored fuel seated in the storage racks considering design instrument channel accuracy. This monitoring level assures that there is adequate water level above the stored fuel seated in the rack.

Instruments:

The design of the instruments will be consistent with the guidelines of NRC JLD-ISG-2012 and NEI 12-02[, with the exceptions and clarifications noted below.] Specifically, the channels will be designed as discussed below.

Primary (fixed) instrument channel: The primary instrument channel level sensing component[s] will be located in [the cask loading pit]. [For locations outside of the spent fuel pool a description of the how the location provides the appropriate water level coupling to the spent fuel pool should be provided.] The primary instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. [The continuous level indication will be provided by a [pressure transmitter]./The discrete level indication will be provided by [level switches]].

Backup instrument channel: The backup instrument channel level sensing component[s] consist of [both portable and fixed] components. [The [portable components will be deployed in [spent fuel pool A], and the fixed components are located in the [transfer canal adjacent to spent fuel pool A]. The backup instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. The continuous level indication will be provided by a [portable ultrasonic level detector]] and the discrete level indication will be provided by [level switches].] Instrumentation channel independence is achieved in the following manner: [Plant specific response]

Reliability:

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[, with the exceptions and clarifications noted below:]

[plant specific response]

Instrument Channel Design Criteria:

Consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:

Arrangement: [Plant specific response]

Mounting: [Plant specific response]

Qualification: [Plant specific response]

Power Supplies: [Plant specific response]

The power supplies for the instrument channels are arranged as follows. [The primary instrument channel normally receives power from plant [alternating current] AC power, and this power supply can be separated from the channel with a disconnect switch and replaced by battery power for intermittent monitoring. The backup instrument channel components are all powered by batteries maintained in a charged state by commercial-grade uninterruptible power supplies.]

Accuracy:

The accuracy will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Testing:

Testing will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Display:

[The primary instrument display will be located in (at) the [control room, auxiliary shutdown panel, or described accessible location]. The backup instrument channel display will use wireless data transmission to a portable, battery-powered display.] The display will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Instrument Channel Program Criteria:

The program criteria will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Need for Relief and basis, if any.

A-3. Implementation Considerations

For plant sites (units) with shared SFPs (two or more SFPs connected by normally open gates designed for under-water transfer of irradiated fuel) the shared pool(s) may be treated as a single SFP and the latest of the unit's 2nd refueling outage post ~~2/~~Feb. 28~~/~~, 2013, or ~~12/~~Dec. 31~~/~~, 2016, whichever is earlier, will determine the implementation deadline for the actions from this order for that plant site. However, this clarification needs to be stated in the Integrated Plan Submittal and an appropriate justification on the need for invoking this clarification should be included with the plan.

An example of justifications for use of this clarification is a plant with physical constraints that dictate the instrument channel components need to be routed during a refueling outage associated with the later unit (as defined above). This constraint could be breach of containment boundaries for penetrations or mountings, location of connected buses~~, RG 612 load paths~~ during one ~~RFO~~refueling outage versus another.

A-4. AP1000 Spent Fuel Pool Instrumentation Guidance

[*N.B.*, This Appendix applies only to the AP1000 plants.]

A-1-11. Introduction

AP1000 is required to provide 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.

A-1-12. Background

The design bases of AP1000 address many of these attributes of spent fuel pool level instrumentation. The NRC staff reviewed these design features prior to issuance of the combined licenses for these facilities and certification of the AP1000 design referenced therein. The AP1000 certified design largely addresses the above requirements by providing two safety-related spent fuel pool level instrument channels. The instruments measure level from the top of the spent fuel pool to the top of the fuel racks to address the range requirements listed above. The safety-related classification provides for the following additional design features:

- Seismic and environmental qualification of the instruments
- Independent power supplies
- Electrical isolation and physical separation between instrument channels
- Display in the control room as part of the post-accident monitoring instrumentation
- Routine calibration and testing

A-1-13. Requirements

AP1000 is required to address the following requirements that were not specified in the certified design.

A-4-3.1 Arrangement

Order Requirement

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 safety-related instruments 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.

Guidance

Protection against missiles should be described, noting the protection that may be provided by location of the safety-related instruments and their associated connections below the operating deck. Describe the arrangement and basis for why the operating deck provides protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. Alternatively, provide description of the features for additional protection that may be provided by the location the safety-related instruments 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.

~~*Guidance*~~

~~Section 3.2 provides the applicable guidance.~~

A-4-3.2 Qualification

Order Requirement

The level 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.

~~*Guidance*~~

~~Section 3.4 provides the applicable guidance.~~

Guidance

Provide a description of the instrumentation sensors and their capability to operate in the environmental conditions that they will experience during design basis events, noting that for the AP1000 design basis conditions include a SBO with steaming in the SFP. The environmental conditions to be addressed should include appropriate consideration for temperature, humidity, steaming, radiation, and seismic activity (SSE) levels where the sensors are located. Provide information to demonstrate the reliability of the instrument under these conditions.

Appropriate evaluations should also be provided to demonstrate the operability of these sensors for indefinite SBO durations.

A-4-3.3 Power Supplies

Order Requirement

Instrumentation channels shall provide for power connections from sources independent of the plant alternating current (~~ac~~AC) and direct current (~~dc~~DC) power distribution systems, such as portable generators or replaceable batteries. Power supply designs should provide for quick and accessible connection of sources independent of the plant ~~ac~~AC and ~~dc~~DC power distribution systems. 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.

Guidance

~~Section 3.6 provides the applicable guidance.~~

Provide a description of the design features provided to ensure continuous power supply to the instrumentation for extended loss of power conditions. The AP1000 design provides extended SFP monitoring capability with two trains of dedicated class 1E DC power supply for at least 72 hours of post accident monitoring. Beyond the initial 72 hours, the response shall detail how the instrument power supply can be met by the use of offsite portable generators with quick and accessible connection points to the existing AC or DC power distribution system and sufficient capacity to maintain level indication indefinitely. The capability to use both onsite and offsite equipment should be discussed as well as the availability of clear guidance for the operator as part of the AP1000 post-72 hours procedures per AP1000 DCD Section 1.9.5.4.

A-4-3.4 Accuracy

Order Requirement

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

Guidance

As discussed under Section A-4-3.3the AP1000 design provides means for continued power supply to the spent fuel pool level instrumentation, relying for the first 72 hours only on class 1E batteries. The power supply can then be extended indefinitely by various means as described in Section A-4-3.3

Additionally, the potential impact on temporary loss of power to the level instrument shall be discussed and evaluated in this section including confirmation that the DP cells would not need to be re-calibrated following a loss of power.

The instrument should be discussed to address sufficient accuracy during SBO conditions which includes boiling of the SFP water.
~~*Guidance*~~
~~Section 3.7 provides the applicable guidance.~~

A-4-3.5 Display

Order Requirement

The display shall provide on-demand or continuous indication of spent fuel pool water level.

Guidance
~~*Guidance*~~
~~Describe~~

For the first 72 hours, provide details regarding the continuous display provided in the Main Control Room with power provided by the class 1E batteries. For Post 72 hours, describe the features of the Main Control Room display and use of power supplies described in ~~the body of this guide~~ Section A-4-3.3. Describe the SFP water level display features. Provide a description of appropriate alarms for low water level. The display requirement may be described by reference to appropriate instrumentation datasheets, specifications, and other relevant documentation.

A-1-14. Programmatic Controls

Order Requirement

The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of a training program. Personnel shall be trained in the use and the provision of alternate power to the safety-related level instrument channels.

~~Guidance~~
Guidance

As noted in the background, the safety-related classification of the AP1000 spent fuel level instrumentation ensures routine calibration and testing of the instrumentation, which maintains the equipment as available and reliable. The training program shall be described to provide training to personnel in the use and the provision of alternate power supplies to the existing ~~ac~~AC or ~~dc~~DC power distribution system to power the instrument channels consistent with the post-72 hours procedures detailed in DCD Section 1.9.5.4. Implemented procedures consistent with the training program shall be summarized and clarified as part of the response.

JLD-ISG-2012-03	Response
Section 2.3: In addition to the listed characteristics of what are not spent fuel pools, "water-filled structures within primary containments that contain temporary fuel storage locations" apply to BWR-6 and some PWR designs. Section 2.3: If continuous indication from a single instrument is not able to measure the entire span from level indications 1, 2 and 3, then additional instruments need to be provided. The set of instruments used to measure the full range of indications should be considered to satisfy the requirements for one channel, either primary or back-up. Section 2.3: Indications may be continuous or discrete (i.e. incremental) over the ranges identified in each subsection of Section 2.3, sufficient to provide at least the minimum resolution specified. The minimum resolution specification applies to the separation distance between discrete point indications. The monitoring requirements pertaining to minimum resolution are distinct from the specified instrument channel system design accuracy discussed in Section 3.7.	Changes have been proposed to NEI 12-02 sections 2.3 and 3.7 to address these issues.
Section 2.3.2: EPA-400-R-92-001 Table 2-2, "Guidance on Dose Limits for Workers Performing Emergency Services" apply to the full duration of the emergency. Since workers may be involved in other recovery actions during the emergency, a fraction of the limit (~20%) should be used in establishing a water level where dose considerations may become important to spent fuel pool recovery actions (i.e., Level 2). References found in Regulatory Guide 1.13 and ANSI/ANS-57.2-1983 apply to normal dose rates and not emergency worker exposure considerations, and should not be used solely to establish level criteria for Level 2.	Changes have been proposed to NEI 12-02 section 2.3.2 to address this issue
3.1 Instruments Section 3.1: In addition to the specified design and programmatic elements in NEI 12-02, the instrument channels must be designed, procured, and qualified to resist shock, vibration, seismic	Changes have been proposed to NEI 12-02 section 3.1, 3.2, and 3.4 to address these issues

JLD-ISG-2012-03	Response

motion, submergence, and a reasonable spectrum of missiles for reliability following beyond design basis external events. Appropriate quality assurance measures should be applied to the procurement, design and installation of the instrument channels to provide reasonable assurance of functionality following beyond design basis external events. The staff considers application of the following measures to the design and installation acceptable in providing this reliability:
 	
• all components of the instrument channels are protected against shock, vibration, and seismic motion by one of the following methods:
  ○ commercial design and testing for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications
  ○ substantial history of operational reliability in environments with significant shock and vibration loading, such as transportation applications
  ○ components inherently resistant to shock and vibration loadings, such as cables
• all components located less than [5 feet] above the design basis flood elevation for the site are commercially designed for submerged operation or located within sealed conduit commercially designed for submergence assuming a water level [5 feet] above the site design basis flood elevation
• all components located outside safety-related structures and away from the spent fuel pool area are protected against missiles and high winds by locating components within trenches or are otherwise protected by location within structures consistent with the site design basis.	

JLD-ISG-2012-03	Response
Section 3.2: Installation of additional missile barriers is not required; however, consideration should be given to instrument placement so that an instrument is protected from missiles and the possibility that such missiles could be wind driven, or objects falling over or down onto the instruments (as in Category two-over-one criteria).	Changes have been proposed to NEI 12-02 section 3.2 to address this issue.
3.4 Qualification Appropriate quality assurance measures should be applied to all instrument channel components to ensure reliability following beyond design basis external events, including seismic events. The qualification methods, which may include justification based on significant operating history, testing results, or other appropriate means, should apply to the beyond-design-basis initiating event, as well as the potential result of the spent fuel pool remaining at saturation conditions for an extended period.	Changes have been proposed to NEI 12-02 section 3.4 to address this issue.
3.9 Display Section 3.9: Spent fuel instrumentation readings for SFP level are to be available to appropriate plant staff and decision makers when required. Once required, the location where the display(s) are located should remain occupied or promptly accessible upon demand for reading.	Changes have been proposed to NEI 12-02 section 3.9 to address this issue
Section A-2-2: The overall integrated plan is to provide a level of detail sufficient for the staff to provide a safety evaluation and license specific order to the licensee. Each licensee should provide information at a similar level of detail as that provided in Attachment 2 to satisfy the level of detail necessary for the Integrated Plan. Information in brackets is provided as an example only, and is not intended to describe means of complying the requirements of the order.	Changes have been proposed to NEI 12-02 Appendix A.2 to address this issue

~~TEMPLATE FOR INTEGRATED PLAN~~

Overall Integrated Plan Guidance

Applicability:

This integrated plan applies to [Unit] [and Unit].

Schedule:

[Single Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] is scheduled for completion prior to [November 30, 2015] [based on the end of the second refueling outage following the submittal of this integrated plan.]]

[Multiple Unit Spent Fuel Pool - The installation of reliable spent fuel pool level instrumentation for the spent fuel pool associated with [Unit] [and Unit] is scheduled for completion prior to [November 30, 2015~~],~~] [based on ~~submittal of this integrated plan on [*February 25, 2013*], and~~ the end of the ~~following two~~second refueling ~~outages~~outage for [Unit] ~~scheduled to be complete by [*May 31, 2014*], and [*November 30, 2015*], [*which*~~following the submittal of this integrated plan.] [This is the [earlier/later] outage sequence of the ~~*two*~~ units discharging to the pool~~].~~.] [The schedule is based on the later outage sequence because…]]

[Associated Spent Fuel Pool Configuration:

[Unit] [and Unit] discharge irradiated fuel to a [single][shared][set of {2} interconnected] spent fuel storage pool[s]. [With the exception of limited time periods for maintenance or non-refueling operations, administrative controls maintain gates between the following pools open: [spent fuel pool {A}], [spent fuel pool {B}], [fuel transfer canal to [Unit]], and [cask loading pit]. Thus, these pools are normally inter-connected and at the same water level when the water level in the spent fuel pool is greater than [1 foot] above the top of stored fuel seated in the storage racks~~.~~.]]

Identification of Spent Fuel Pool Water Levels:

Key spent fuel pool water levels will be identified as follows:

- Level adequate to support operation of the normal fuel pool cooling system – Indicated level on either the primary or backup instrument channel of greater than [x

feet] above the top of stored fuel seated in the storage racks ~~based on~~ and will consider the design instrument channel accuracy ~~of [+/- x feet for both the primary and backup instrument channels] and [a calculation demonstrating a~~. This water level ~~of x feet] above the top of stored fuel seated in the storage racks~~ is adequate ~~water level~~ for normal fuel pool cooling system operation.

- Level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck - Indicated level on either the primary or backup instrument channel of greater than [10/x feet] above the top of stored fuel seated in the storage racks ~~based on~~ considering the design instrument channel accuracy. [[The monitoring level of [~~≤+/-~~ x feet ~~for both the primary and backup instrument channels for discrete indications and~~was selected considering the ~~specified accuracy for~~guidelines in EPA-400 for recommended personnel exposure limits considering the ~~continuous indications] and [the relatively low sensitivity of dose rate to changes in water depth~~emergency conditions would at the ~~Regulatory Guide 1.13 specified depth for shielding of x feet] above the top of stored fuel seated in the storage racks~~time. This monitoring level verifies there is an adequate water level to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck~~.~~.]

- Level where fuel remains covered - Indicated level on either the primary or backup instrument channel of greater than [x foot] above the top of stored fuel seated in the storage racks ~~based on~~considering design instrument channel accuracy ~~of [+/- x feet] for both the primary and backup instrument channels and [location of the primary and backup instrument channel sensing components in areas separated from the fuel storage area by weirs no more than x feet]~~. This monitoring level assures that there is adequate water level above the ~~top of~~ stored fuel seated in the ~~storage racks is adequate water level to assure the stored fuel is covered.~~rack.

Instruments:

The design of the instruments will be consistent with the guidelines of NRC JLD-ISG-2012 and NEI 12-02[, with the exceptions and clarifications noted below.] Specifically, the channels will be designed as discussed below.

Primary (fixed) instrument channel: The primary instrument channel level sensing component[s] will be located in [the cask loading pit]. [For locations outside of the spent fuel pool a description of the how the location provides the appropriate water level coupling to the spent fuel pool should be provided.} The primary instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. [The continuous level indication will be provided by a [pressure transmitter~~] and the~~]./The discrete level indication will be provided by [level switches~~]~~.]].

Backup instrument channel: The backup instrument channel level sensing component[s] consist of [both portable and fixed] components. [The [portable components will be deployed in [spent fuel pool A], and the fixed components are located in the [transfer canal adjacent to spent fuel pool A]. The backup instrument channel will provide [continuous level indication over a range from [x feet] to [x feet]][and][discrete level indications at [x feet and x feet]] above the top of stored fuel seated in the storage racks. The continuous level indication will be provided by a [portable ultrasonic level detector]] and the discrete level indication will be provided by [level switches~~].~~].] Instrumentation channel independence is achieved in the following manner: [Plant specific response]

Reliability:

Reliability of the primary and backup instrument channels will be assured by conformance with~~:~~ ~~a quality assurance program consistent with the guidance~~ the guidelines of ~~[*Appendix A to*~~ NRC JLD-ISG-2012-03 and NEI 12-02~~] applied to all instrument channel components to provide reasonable assurance of reliability following postulated beyond design basis external events~~

~~the design and programmatic criteria, including procurement~~[, with the exceptions and ~~qualification criteria, described in [*NRC ISG*~~]clarifications noted below:]

~~• the following criteria for reasonable protection against beyond design basis external events:~~

~~○ all components of the instrument channels are protected against shock, seismic motion, and vibration by one of the following methods:~~

~~▪ commercial design and testing for operation in environments where significant shock and vibration loadings are common, such as for portable hand-held devices or transportation applications~~

~~▪ substantial operational history in environments with significant shock and vibration loading, such as transportation applications~~

~~▪ components inherently resistant to shock and vibration loadings, such as Cables~~

~~○ all components located less than [*x feet*] above the design basis flood elevation for the site are commercially designed for submerged operation or located within sealed conduit commercially designed for submergence assuming a water level [*x feet*] above the site design basis flood elevation~~

~~○ all components located outside safety-related structures and away from the spent fuel pool area are protected against missiles and high winds by locating components within trenches or are otherwise protected consistent with the site design basis.~~

[plant specific response]

Instrument Channel Design Criteria:

Consistent with the guidelines of NRC JLD-ISG-2012-03 and/~~or~~ NEI 12-02;[, with the exceptions and clarifications noted below:

Arrangement: [Plant specific response]

Mounting: [Plant specific response]

Qualification: [Plant specific response]

Power Supplies: [Plant specific response]

The power supplies for the instrument channels are arranged as follows. [The primary instrument channel normally receives power from plant ~~*vital*~~ [alternating current] AC power, and this power supply can be separated from the channel with a disconnect switch and replaced by battery power for intermittent monitoring. The backup instrument channel components are all powered by batteries maintained in a charged state by commercial-grade uninterruptible power supplies.]

Accuracy:

~~The instrumentation system minimum resolution is as specified in Item 2.3 of the ISG.~~
~~The channel design accuracy for the instrumentation is as follows: [*Plant specific response*] [*The accuracy of the instrument channel for Level 3 will be maintained less than +/- x feet to avoid ambiguous indication because the sensor is located in the cask loading pit at an elevation x feet above the bottom of the cask pit gate. This configuration assures that the instrument channel indication at Level 3 unambiguously demonstrates the stored fuel is covered with water despite the location of the sensing components in the cask loading pit.*]~~

The accuracy will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Testing

Testing will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Display:

[The primary instrument display will be located in the control room. The backup instrument channel display will use wireless data transmission to a portable, battery-powered display.] The display will be consistent with the guidelines of NRC JLD-ISG-2012-03 and NEI 12-02[, with the exceptions and clarifications noted below:]

[plant specific response]

Instrument Channel Program Criteria:

~~Training~~The program criteria will be consistent with the guidelines of NRC JLD-ISG~~.~~ ~~[Maintenance staff members will be designated as staff that would install the portable components of one instrument channel~~-2012-03 and ~~ensure the proper operation of both instrument channels.] Procedures will be consistent~~NEI 12-02[, with the ~~guidelines of NRC ISG with no~~ exceptions~~. Testing~~ and ~~Calibration will be consistent with the guidelines of NRC ISG with no exceptions~~clarifications noted below:]

[plant specific response]

Need for Relief and basis, if any.