PSEG Nuclear LLC

RELIABLE SPENT FUEL POOL INSTRUMENTATION

OVERALL INTEGRATED PLAN

PSEG NUCLEAR LLC

HOPE CREEK NUCLEAR GENERATING STATION

SL-011679
Revision 3
February 25, 2013

Prepared by: _____ **Date:** 2/25/13

Reviewed by: _____ **Date:** 2/25/13

Approved by: R. Mosher For S. Jannetty **Date:** 2/25/13

Hope Creek Integrated Plan with Regard to Reliable Spent Fuel Pool Instrumentation

I. Introduction

Following the earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in Japan during March 2011, the NRC established a senior-level task force referred to as the Near-Term Task Force (NTTF). The NTTF conducted a systematic and methodical review of the NRC regulations and processes to determine if the agency should make safety improvements in light of the events in Japan. As a result of this review, SECY 11-0124, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," were issued to establish the NRC staff's prioritization of the NTTF recommendations. Recommendation 7.1, concerning reliable Spent Fuel Pool (SFP) instrumentation, was determined to be a high-priority action.

Existing SFP level instrumentation designs, at most U.S. nuclear power plants, typically only provide narrow range indication and, therefore, are only capable of monitoring normal and slightly off-normal conditions. As a result, NRC Order EA-12-051 dated March 2012 requires all licensees to install a reliable means of remotely monitoring wide-range SFP levels to support effective prioritization of event mitigation and recovery actions in case a Beyond-Design-Basis (BDB) external event were to occur. In this order, the NRC provided certain design features, testing features, training requirements and other administrative and/or quality related requirements necessary for licensees to meet the order. Specifically, the objective of this order is to ensure licensees provide reliable level instrumentation for monitoring SFP wide range level, such that key decision makers have sufficient information available to effectively allocate station resources in the event of a BDB event.

Subsequent to issuance of the order, the Nuclear Energy Institute (NEI) led an industry supported task force that developed NEI 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, ‘To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation’”. Revision 1 of this document was recently issued in August 2012. The NRC has since issued JLD-ISG-2012-03 Revision 0 in which the NRC staff considered methodologies and guidance provided in NEI 12-02, Revision 1, subject to certain clarifications and exceptions, as an acceptable means of meeting the requirements of Order EA-12-051.

This integrated plan provides the PSEG Nuclear LLC (herein after referred to as PSEG) approach to comply with Order EA 12-051 for the Hope Creek Nuclear Generating Station. PSEG will use those methods described in JLD-ISG-2012-03 as the acceptable means of meeting the requirements in EA-12-051. The information provided in this plan is based on the conceptual engineering design information as documented in Conceptual Design Specification H-1-EC-IDI-0132 (Reference 8), plant design basis documentation, and technical information related to the selected technology.

As the detailed design progresses, this plan may be revised to reflect any differences between the conceptual design and the final design. Significant differences will be communicated in the six-month update reports following submittal of this plan. Also communicated in the six-month update reports will be implementation progress, any updates to the schedule and requests for relief and/or changes to the design basis should they be required.

II. Identification of Spent Fuel Pool Water Levels

1) **Level 1 – This is the water level required to support operation of the normal fuel pool cooling system.** Indicated SFP level on either the Primary or Back-up instrument channels of greater than approximately elevation 200' – 0" based on the level at which loss of reliable suction occurs due to uncovering of the SFP weir.

2) **Level 2 – This is the water level required to provide substantial radiation shielding for personnel standing on the SFP operating deck.** Indicated SFP level on either the Primary or Back-up instrument channels of greater than approximately elevation 185'- 6" (+/- 1' – 0")**.** This elevation is approximately 10' above the top of the fuel racks and ensures a minimum of 10' above the top of the fuel. This water level ensures there is a sufficient depth for a minimum shielding depth over the top of the stored fuel and provides substantial radiation shielding for personnel to respond to Beyond-Design-Basis external events and initiate any SFP makeup strategies.

3) **Level 3 – This is the water level required such that the spent fuel remains covered**. Indicated SFP level on either the Primary or Back-up instrument channels of greater than approximately elevation 175'-6" (+/- 1' – 0"). This water level ensures that there is adequate water level above the stored fuel seated in the fuel racks.

For Hope Creek, the SFP is a reinforced concrete structure that forms an integral part of the Containment Enclosure Building. The SFP has a volume of approximately 57,960 cubic feet and is filled with demineralized water to a normal depth of 40' - 0". This provides about 25' of water above the top of stored fuel assemblies when filled to normal operating level and about 9' of water above the active fuel in transit.

III. Schedule

The implementation schedule for providing reliable SFP Instrumentation at Hope Creek is consistent with the requirements of Order EA-12-051 in that the new systems will be installed and functional no later than two refueling cycles following submittal of this overall integrated plan or December 2016, which ever occurs first. The current projected milestone completion dates are:

Milestone Dat	**e**
Conceptual Design	Complete
Submit Integrated Plan	Feb 28, 2013
Issue SFPI Equipment Purchase Order	2Q2013
Complete Detailed Design	2Q2014

Milestone	Date
Begin Installation	3Q2014
Installation Complete, SFPI Channels Fully Functional	2Q2015 (RF19)

IV. Instruments

Design of the SFP wide range level instruments will meet the guidelines of JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1, as discussed in the following sections.

The Hope Creek SFP Primary and Backup instrument channels will utilize Guided Wave Radar (GWR) based level measurement technology. GWR level measurement instruments work based on the Time Domain Reflectometry (TDR) principal. The device transmits low-intensity electromagnetic pulses along a rigid or flexible conductor where pulses move at the speed of light. When the pulses reach the surface of the medium to be measured, a portion of the signal is reflected back to the electronics. The instrument measures the time from when the pulse is transmitted to when it is received; half of the measured time will be equivalent to the distance from the reference point of the device to the surface of the measured process. The time value will be representative of the measured level and converted for use in displaying level information.

Both the primary and backup channels will utilize a fixed instrument providing continuous level measurement over the entire range. The measured range will be from approximately elevation 175'-11" to approximately elevation 201'– 4" for a total indicated range of 25'- 5" (305" +/- 12"). The exact range will be determined during the detailed engineering design.

Reliability

Reliability of both the primary and back-up instrument channels will be assured through conformance with the guidelines of JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1, as discussed further in the following sections.

Instrument Channel Design

Both the primary and backup Instrument channels will be designed in accordance with the guidelines of JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1.

V. Arrangem ent

The primary and backup channel level sensor probes will be installed in different locations of the SFP for a maximum separation within the limits of the existing SFP design. The primary and backup channels will be physically separated in accordance with the guidelines provided in NEI 12-02 Revision 1. In the conceptual design, the SFP probes bolt to mounting plates for installation at the corner of the SFP, or along the side of the SFP. This mounting will allow the probe to be installed within a few inches of the SFP liner without penetrating the liner thereby minimizing the chances of interference with other structures, and occupying limited space of the SFP deck. Existing barriers will be used to provide a level of protection for the sensor and

interconnecting cable located along the SFP wall or on the refueling floor. These physical barriers will protect the instrument sensors and cables from potential missile hazards generated by an event. The final sensor mounting design and cable routing will maintain a low profile to ensure that there is no interference with the existing fuel handling equipment. Specific details will be developed during the detailed design phase.

The primary and backup channel indicating transmitters (electronics) will be located in an environment providing adequate protection from temperature, humidity, and radiation. The conceptual design locates the indicating transmitter electronics in a readily accessible area of the Auxiliary Building. The primary display is integral to the electronics enclosure which is available to personnel for providing prompt information to decision makers. Additional indicators may be provided in the Main Control Room. Specific details will be developed during the detailed design phase.

All cabling associated with each channel's sensor, power supply, and indicator will be independently routed in separate raceways from cabling associated with the other channel.

VI. Mounting

Installed equipment will be qualified to withstand the maximum seismic ground motion considered in the design of the plant area where the equipment will be installed. The basis for the seismically designed mountings will be the plant seismic design basis at the time of the submittal of this integrated plan. The instrument sensors mounted in the SFP will be designed to Seismic Category I.

VII. Qualif ication

General

The sensors and cables for both channels will be reliable at temperature, humidity, and radiation levels consistent with the SFP water at saturation conditions. Post event temperature at sensors and for cabling located above the SFP is assumed to be 212°F. Post event humidity in the fuel pool floor area near and above the SFP is assumed to be 100% with condensing steam.

The sensors and cables will be qualified for expected conditions at the installed location assuming the SFP water is at saturation. The sensors and cables located in the vicinity of the SFP will be qualified to withstand peak and total integrated dose radiation levels for their installed location based on post event SFP water level equal to Level 3.

Sensor cable terminations will be unaffected by pool overflow. The mounting and cable connecting the sensors will be qualified to the SFP environment described above. Conduit design in the SFP area will be installed to augmented quality requirements. Existing barriers will be used to provide a level of protection for the exposed cable located on or near the refueling floor from seismically generated missiles that may be generated by an event. The raceway used to route the sensor cable to the indicating transmitters (electronics) enclosures will be installed to augmented quality requirements.

Instrument channel reliability will be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the following sets of parameters:

- Conditions in the area of instrument channel components used for all instrument components;
- Effects of shock and vibration on instrument channel components used during and following any applicable event for installed components; and
- Seismic effects on instrument channel components used during and following a potential seismic event for all instrument channel components.

Non-safety related Commercial-Off-The-Shelf (COTS) components will be used to meet the requirements of the order. All non-safety related equipment installed will be implemented so that they do not degrade existing safety related functions. Augmented quality requirements will be applied to the project for the installation of new components, conduit and cable. If safety related Structures Systems or Components (SSC) are interfaced or affected, then the appropriate quality requirements will be applied.

Conditions

Temperature, humidity, and radiation levels consistent with conditions in the vicinity of the SFP and the area of use considering normal operational, event and post-event conditions for no fewer than seven days post event or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049 (Reference 2) will be addressed in the engineering and design phase. Examples of post event BDB conditions that will 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°F and 100% relative humidity environment,
- Boiling water and/or steam environment, and
- The impact of FLEX mitigating strategies (Reference 5).

These requirements will be used as design input to drive the detailed design, final equipment and vendor selection, and final implementation.

Shock and Vibration

Components of the instrument channels installed in the SFP area will be qualified for shock and vibration using one or more of the following methods:

- Components are supplied by manufacturers using commercial quality programs (such as ISO9001, *Quality management systems – Requirements* (Reference 6)) with shock and vibration requirements included in the purchase specification at levels commensurate with portable hand-held device or transportation applications;
- Components have a substantial history of operational reliability in environments with significant shock and vibration loading, such as portable hand-held device or transportation applications; or
- Components are inherently resistant to shock and vibration loadings, such as cables.

These requirements will be used as design input for the detailed design, final equipment and vendor selection, and final implementation.

Seismic

For seismic effects on instrument channel components used after a potential seismic event for only installed components, the following measures will be used to verify that the design and installation is adequate. Applicable components of the instrument channels are rated by the manufacturer (or otherwise tested) for seismic effects at levels commensurate with those of postulated design basis event conditions in the area of instrument channel component use using one or more of the following methods:

- Adequacy of seismic design and installation is demonstrated based on the guidance in Sections 7, 8, 9, and 10 of IEEE Standard 344-2004, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*, (Reference 7), or a substantially similar industrial standard;
- Demonstration that proposed devices are substantially similar in design to models that have been previously tested for seismic effects in excess of the plant design basis at the location where the instrument is to be installed (g-levels and frequency ranges); or
- Seismic qualification using seismic motion consistent with that of existing design basis loading at the installation location.

These requirements will be used as design input for the detailed design, final equipment and vendor selection, and final implementation.

VIII. Independence

The primary instrument channel will be independent of the back-up instrument channel. Both the primary and back-up instrument channels will be of the same technology and manufacturer and model.

Independence will be achieved through physical separation of the final installed devices. The two (2) permanently installed instrument sensors will be separated by a distance comparable to the shortest length of a side of the SFP, to the extent practical, based on the existing SFP geometry and construction. The interconnecting cabling associated with each channel will follow separate and independent routes back to the indicating transmitter (electronics) enclosure. The normal AC power source for each channel will be provided from independent and separate sources.

Specific details will be developed during the detailed design phase.

IX. Po wer Supplies

The normal power supply for each channel will be provided by independent AC or DC power sources such that loss of one power source will not result in the loss of both channels. In addition to the normal plant AC or DC power supply to each channel, a back-up power source will also be provided in the form of a back-up battery independent of the normal AC or DC power sources. The back-up power will have sufficient capacity to support reliable instrument channel operation

through the use of replaceable batteries until appropriate off-site resource availability is reasonably assured.

Specific details will be developed during the detailed design phase.

X. Accurac y

The instrument channels will maintain their designed accuracy following a power interruption or change in power source without requiring recalibration. The instrumentation channels utilize COTS components and, therefore, the final design will ensure vendor published instrument design accuracies are acceptable in accordance with the guidelines of NEI 12-02 Revision 1. Accuracies will be sufficient to allow trained personnel to determine when the actual level exceeds the specified lower level of each indicating range (Levels 1, 2 and 3) without providing conflicting or ambiguous information.

Accuracy requirements will consider all SFP conditions (e.g., saturated water, steam environment).

Specific details regarding instrument accuracy will be obtained from the supplier during the procurement and detailed design phases.

XI. Testing

The instrument channel design will provide for routine testing and calibration. Installed sensors will be designed to allow testing and/or calibration via in-situ methods while mounted in the SFP. Removal of the sensor from the SFP will not be required for calibration.

Instrument channel design will provide for routine testing and calibration consistent with Order EA-12-051 and the guidance in NEI 12-02 Revision 1. Details will be finalized upon receipt of final vendor information during the detailed design phase.

Specific details regarding testing procedures and requirements will be reviewed and determined with the supplier during the detailed design phase.

XII. Display

Trained personnel will be capable of monitoring the SFP water level from a location remote to that of the SFP area. The selected location for the display(s) will ensure information related to SFP level is promptly available to plant staff and key decision makers.

The primary display associated with each of the permanently installed (fixed) instrument channels (both Primary and Backup) will be integrated into the instrument transmitter (electronics) enclosure. The electronic enclosure will be located in an appropriate and accessible area to allow the display location to meet 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
- Outside of any very high radiation area or locked HIGH RAD area during normal operation

Each instrument channel (Primary and Backup) will also have the capability to drive an external remote instrument loop that can be used to provide level indication at a second display location or be used as an input to the plant computer. Failure of the external remote instrument loop signal will not adversely impact the primary display located in the transmitter (electronics) enclosure.

The conceptual design locates the electronic enclosure and primary display in readily accessible area located within the Auxiliary Building. Specific details regarding the display and display location(s) will be finalized during the detailed design phase.

XIII. Training

Standard plant training processes will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service.

Specific details regarding training will be reviewed and determined between the plant and the supplier as part of the procurement process for the new instruments.

XIV. Procedure s

Procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the new SFP instrumentation. These procedures will be completed following completion of the detailed design package.

Procedures will address a strategy to ensure SFP water level addition is initiated at an appropriate time consistent with implementation of NEI 12-06 Revision 0, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* (Reference 5).

Procedures will also address the following situations:

- If, at the time of an event or thereafter until the unit is returned to normal service, an instrument channel ceases to function, its function will be recovered within a period of time consistent with the emergency conditions that may apply at the time.
- If, at the time of an event or thereafter until the unit is returned to normal service, an instrument channel component must be replaced, commercially available components that may or may not meet all of the qualifications (Section VII) to maintain the instrument channel functionality may be used.

XV. Testing and Calibration

Processes will 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 as described in JLD-ISG-2012-03 and the guidance in NEI 12-02 Revision 1. Testing and calibration of the instrumentation will be consistent with vendor recommendations and any other documented basis.

XVI. Need for Relief and Basis

PSEG Nuclear LLC is not requesting relief from any requirement of Order EA-12-051 or the guidance in JLD-ISG-2012-03 for Hope Creek at this time.

Consistent with the requirements of Order EA-12-051 and the guidance in NEI 12-02 Revision 1, the six-month reports will delineate progress made, any proposed changes in our compliance methods, updates to the schedule, and if needed, requests for relief and their bases.

XVII. References

1) US Nuclear Regulatory Commission Order EA-12-051, “Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” March 12, 2012

2) US Nuclear Regulatory Commission Order 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

3) NRC Interim Staff Guidance JLD-ISG-2012-03, “Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation,” Revision 0, August 29, 2012

4) NEI 12-02, “Industry Guidance for Compliance with NRC Order EA-12-051, ‘To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,’” Revision 1, August 2012

5) NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” Revision 0, August 2012

6) ISO9001, “Quality management systems – Requirements”

7) IEEE Standard 344-2004, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations”

8) H-1-EC-IDI-0132 Revision 0 – “Reliable Wide Range Spent Fuel Pool Instrumentation” Conceptual Design, dated December 19, 2012

9) Hope Creek Generating Station UFSAR