**Nebraska Public Power District**
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NLS2016045
August 22, 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Nebraska Public Power District's Final Six-Month Status Report and Response to Request for Additional Information in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)
Cooper Nuclear Station, Docket No. 50-298, DPR-46

References:

1. NRC Order Number EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012

2. NRC Interim Staff Guidance JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," Revision 0, dated August 29, 2012

3. 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, dated August 2012

4. NPPD Letter, "Initial Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated October 26, 2012 (NLS2012111)

5. NPPD Letter, "Overall Integrated Plan in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 28, 2013 (NLS2013026)

6. NRC Letter, "Cooper Nuclear Station - Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC No. MF0971)," dated December 4, 2013

**COOPER NUCLEAR STATION**
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NRR

Dear Sir or Madam:

On March 12, 2012, the Nuclear Regulatory Commission issued an Order (Reference 1) to Nebraska Public Power District (NPPD). Reference 1 was immediately effective and directs NPPD to install reliable spent fuel pool level instrumentation. Specific requirements are outlined in Attachment 2 of Reference 1.

Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance (Reference 2) and an overall integrated plan pursuant to Section IV, Condition C. Reference 2 endorses industry guidance document Nuclear Energy Institute 12-02, Revision 1, (Reference 3) with clarifications and exceptions identified in Reference 2. Reference 4 provided NPPD's initial status report for Cooper Nuclear Station (CNS) regarding reliable spent fuel pool instrumentation. Reference 5 provided CNS' overall integrated plan.

Reference 1 requires submission of a status report at six-month intervals following submittal of the overall integrated plan. Reference 3 provides direction regarding the content of the status reports. The purpose of this letter is to provide NPPD's final six-month status report pursuant to Section IV, Condition C.2, of Reference 1, that delineates progress made in implementing the requirements of Reference 1. Attachment 1 provides an update of milestone accomplishments since the last status report, including any changes to the compliance method, schedule, or need for relief and the basis, if any. Attachment 2 provides NPPD's response to the request for additional information contained in Reference 6.

This letter contains no new regulatory commitments.

Should you have any questions regarding this report, please contact Jim Shaw, Licensing Manager, at (402) 825-2788.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 8/22/16

Sincerely,

Kenneth Higginbotham
General Manager of Plant Operations

/bk

Attachments:
1. Nebraska Public Power District's Final Six-Month Status Report for the Implementation of Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation
2. Nebraska Public Power District's Response to NRC Interim Staff Evaluation Request for Additional Information

cc: Regional Administrator, w/attachments
USNRC - Region IV

Director, w/attachments
USNRC - Office of Nuclear Reactor Regulation

Cooper Project Manager, w/attachments
USNRC - NRR Plant Licensing Branch IV-2

Senior Resident Inspector, w/attachments
USNRC - CNS

NPG Distribution, w/o attachments

CNS Records, w/attachments

**Attachment 1**

**Nebraska Public Power District's Final Six-Month Status Report for the Implementation of Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation**

## Introduction

Nebraska Public Power District (NPPD) developed an overall integrated plan for Cooper Nuclear Station (CNS) (Reference 2), documenting the requirements to install reliable spent fuel pool level instrumentation in response to Nuclear Regulatory Commission (NRC) Order Number EA-12-051 (Reference 1). This attachment provides an update of milestone accomplishments since the last status report (Reference 5), including any changes to the compliance method, schedule, or need for relief/relaxation and the basis, if any.

## Milestone Accomplishments

The following milestone(s) have been completed and are current as of August 15, 2016:

- Procedures created
- Training developed
- Training completed

## Milestone Schedule Status

The following table provides an update to the milestone schedule to support the overall integrated plan. The table provides the activity status of each item, and the expected completion date noting any change.

| Milestone | Target Completion Date | Activity Status | Revised Target Completion Date |
|---|---|---|---|
| Submit 60 Day Status Report | Oct 2012 | Complete | |
| Submit Overall Integrated Plan | Feb 2013 | Complete | |
| **Submit 6 Month Updates:** | | | |
| Update 1 | Aug 2013 | Complete | |
| Update 2 | Feb 2014 | Complete | |
| Update 3 | Aug 2014 | Complete | |
| Update 4 | Feb 2015 | Complete | |
| Update 5 | Aug 2015 | Complete | |

| Milestone | Target Completion Date | Activity Status | Revised Target Completion Date |
|---|---|---|---|
| Update 6 | Feb 2016 | Complete | |
| Update 7 | Aug 2016 | Complete | |
| **Modifications:** | | | |
| Complete Scoping Study | Feb 2013 | Complete | |
| Generate Detailed Design | Oct 2014 | Complete | |
| Complete Refueling 28 Outage Walkdowns | Nov 2014 | Complete | |
| Complete Procurement of Parts | Dec 2014 | Complete | |
| Complete Final Detailed Design | Oct 2015 | Complete | |
| Complete Installation Outage | Oct 2016 | Complete | |
| Complete Installation/Testing Outage | Nov 2016 | Complete | |
| In-service/Mod Complete | Nov 2016 | Complete | |
| **Procedures:** | | | |
| Create Procedures | June 2016 | Complete | |
| **Training:** | | | |
| Develop Training | Aug 2016 | Complete | |
| Training Complete | Oct 2016 | Complete | |

**Changes to Compliance Method**

None other than those previously identified.

**Need for Relief/Relaxation and Basis for the Relief/Relaxation**

NPPD expects to comply with the Order implementation date and no relief/relaxation is required at this time.

**Requests for Additional Information (RAI)**

In Reference 3, the NRC issued the interim staff evaluation (ISE) for CNS. In a public meeting on November 26, 2013 (Reference 4), the NRC clarified that questions contained in the ISE supersede any previous requests for information issued by the Staff concerning the spent fuel pool instrumentation. Attachment 2 to this letter provides NPPD's responses to the RAI.

**Potential Draft Safety Evaluation Impacts**

There are no potential impacts to the Draft Safety Evaluation identified at this time.

**References**

1. NRC Order Number EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012

2. NPPD Letter, "Overall Integrated Plan in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 28, 2013

3. NRC Letter, "Cooper Nuclear Station - Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC No. MF0971)," dated December 4, 2013

4. NRC Memorandum, "Summary of the November 26, 2013, Public Meeting to Discuss Industry Responses to Staff Interim Evaluations for Spent Fuel Pool Instrumentation," dated December 26, 2013

5. NPPD Letter, "Nebraska Public Power District's Sixth Six-Month Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 16, 2016

**Attachment 2**

**Nebraska Public Power District's Response to NRC Interim Staff Evaluation Request for Additional Information**

By letter dated December 4, 2013, the Nuclear Regulatory Commission (NRC) issued Nebraska Public Power District (NPPD) an interim staff evaluation and request for information (RAI) regarding Cooper Nuclear Station's (CNS) overall integrated plan for implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation. This attachment provides the RAI responses previously provided to the NRC as part of the onsite audit conducted at CNS from May 23 through May 26, 2016. Responses are unchanged except for editorial changes, including changes for clarification, and replacement of future tense wording with past tense wording, as necessary, to reflect the completed status of the associated actions.

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***NRC RAI #1:***

*Please provide a clearly labeled sketch depicting the elevation view of the proposed typical mounting arrangement for the portions of instrument channel consisting of permanent measurement channel equipment (e.g., fixed level sensors and/or stilling wells, and mounting brackets). Indicate on this sketch the datum values representing Level 1, Level 2, and Level 3 as well as the top of the fuel racks. Indicate on this sketch the portion of the level sensor measurement range that is sensitive to measurement of the fuel pool level, with respect to the Level 1, Level 2, and Level 3 datum points.*

**NPPD RESPONSE:**

An elevation sketch (Figure 1) is provided at the end of this attachment.

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***NRC RAI #2:***

*Please provide the following:*

*a) A clearly labeled sketch or marked-up plant drawing of the plan view of the SFP area, depicting the SFP inside dimensions, the planned locations/placement of the primary and back-up SFP level sensors, and the proposed routing of the cables that will extend from the sensors toward the location of the local electronics cabinets and read-out/display devices in the main control room or alternate accessible location.*

*b) In Figure 1 of your submittal, it appears the sensors will be separated by a distance comparable to the longest side of the pool; however, your text states that they will be "separated by a distance that is comparable to the shortest side of the pool." Please clarify.*

**NPPD RESPONSE:**

a) A plan view sketch of the Spent Fuel Pool (SFP) area (Figure 2) is provided at the end of this attachment.

b) The separation of the sensors is closer to the longer side of the pool (40') rather than the shorter side (28'). Nuclear Energy Institute (NEI) 12-02, Section 3.2, discusses the location requirements of the sensors which include opposite sides or corners of the pool area or separated by a distance comparable to the shortest length of a side of the pool. The location of the sensors for CNS' pool meets or exceeds these requirements as they are located as close as practical to the opposite corners and are separated at a distance comparable to the longer sides of the pool. This configuration provides the maximum separation for the physical location of the sensors in the pool and meets the criteria specified in NEI 12-02, Section 3.2.

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***NRC RAI #3:***

*Please provide the following:*

*a) The design criteria that will be used to estimate the total loading on the mounting device(s), including static weight loads and dynamic loads. Describe the methodology that will be used to estimate the total loading, inclusive of design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.*

*b) A description of the manner in which the level sensor (and stilling well, if appropriate) will be attached to the refueling floor and/or other support structures for each planned point of attachment of the probe assembly. Indicate in a schematic the portions of the level sensor that will serve as points of attachment for mechanical/mounting or electrical connections.*

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

**NPPD RESPONSE:**

a) The SFP level indication probe demonstrates compatibility with CNS' seismic design bases. The qualification of the probe components and mounting bracket meets the qualification standards outlined in IEEE Standard 344-2004 (Sections 7, 8, 9, and 10) and Section III of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (2008).

A combination of hydrodynamic and static analyses was performed (NEDC 14-017, "Seismic Induced Hydraulic Response in the CNS SFP") to determine the estimated total loading on the probe and the mounting device to support the SFP probe. Generic hydrodynamic analysis of the controlling cases for the Utility Services Alliance, and site specific analysis including the dimensions of the CNS SFP, was performed using the computer code GOTHIC 8.0. The site specific analysis was performed by exciting the SFP pool inventory with acceleration time-

histories in each direction. The vertical 3D fluid velocity of the SFP fluid was extracted from this analysis and applied to the mounting bracket for stress analysis of the probe support system.

A finite element fluid-structure interaction (FSI) analysis of the probe and support system was performed (NEDC 14-018, "MOHR SFP-1 Site-Specific Seismic Analysis Report for CNS") in addition to the GOTHIC analysis. The 3-D time-history FSI analysis was performed using ANSYS Mechanical software. The results from this analysis were used to perform the stress qualification of the various components of the probe. The support reactions from the FSI analysis were used as input in the stress qualification of the mounting bracket which was also performed using the ANSYS Mechanical software.

Further details regarding the generic and site specific hydrodynamic and FSI analyses are outlined in the reports discussed in NPPD's response to RAI #4.

b) The SFP level indication probe consists of the probe body, flange mounting point, and a repairable head attached to the flange. The flange of the level probe is attached to an adapter plate via four structural bolts. The purpose of the adapter plate is to translate the forces from the four bolts on the flange into the three bolt configuration attaching the adapter plate to the bracket to allow for easy installation. The bracket consists of several varying thicknesses of stainless steel plates which are welded together using full penetration groove welds. It rests on the curb of the SFP pool and is securely anchored to the back face of the curb to minimize foreign material exclusion concerns. See Figure 1 provided at the end of this attachment.

c) Both bolting and welding were used to attach the SFP level probe to the bracket and subsequently the SFP curb. Structural bolts were used to attach the SFP probe to the adapter plate and bracket. Welded connections at various locations on the back side of the SFP curb were provided to ensure a secure connection of the bracket to the curb.

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***NRC RAI #4:***

*For RAI 3(a) above, please provide the analyses used to verify the design criteria and methodology for seismic testing of the SFP instrumentation and the electronics units, including design basis maximum seismic loads and the hydrodynamic loads that could result from pool sloshing or other effects that could accompany such seismic forces.*

**NPPD RESPONSE:**

The SFP EFP-IL units were primarily qualified by seismic shake table testing per IEEE 344-2004 requirements. The SFP instrument probe, mounting flange, and support brackets were analyzed using a combination of hydrodynamic, non-linear dynamic structural and static structural analyses techniques. A listing of various analyses performed for the qualification of the various SFP components is provided below:

- NEDC 14-009 which incorporates MOHR Document 1-0410-5, "MOHR EFP-IL SFPI System Shock and Vibration Test Report"

- NEDC 14-010 which incorporates MOHR Document 1-0410-6, "MOHR EFP-IL SFPI System Seismic Test Report"

- NEDC 14-014 which incorporates MOHR Document NAI-1725-004, "Seismic Induced Hydraulic Response in the CNS Spent Fuel Pool"

- NEDC 14-015 which incorporates MOHR Document 1-0410-9, "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report"

- NEDC 14-017 which incorporates MOHR Document NAI-1791-010, "Seismic Induced Hydraulic Response in the Cooper Nuclear Station Spent Fuel Pool"

- NEDC 14-018 which incorporates MOHR Document 1-0410-9.4, "MOHR SFP-1 Site-Specific Seismic Analysis Report: Nebraska Public Power District Cooper Nuclear Station (CNS)"

- NEDC 14-004 which incorporates Burns & McDonnell Document 75427-C-001, "Seismic/Stress Analysis of SFP Level Probe Mounting Bracket"

The mounting bracket that supports the probe flange was permanently installed by welding the bracket to the edge of SFP and is considered seismically rugged. The bracket is designed to withstand the hydrodynamic and sloshing associated with the probe during an event. NEDC 14-004 provides the analysis associated with these loads.

The hanger supports for the conduit installation were seismically mounted in accordance with:

- NEDC 14-005, "Conduit Routing and Support Design"

- NEDC 11-119, "Qualification of Existing Conduit Support 07-15 (Drawing EE-RBH3007-EE-RBH3015) for ADHR Instrumentation Conduit"

- NEDC 87-080, "Seismic Design Calculation for Conduit Hanger and Electrical Junction Box Supports for Torus Level Indicator"

- NEDC 15-068, "Conduit Hangers CBH2042, CBH2041, and CBH2069 Seismic Analysis"

- NEDC 90-065, "Seismic Analysis for RBH 2060, RBH 2063, RBH 1275, RBH 1276, RBH 1806T, and New STD Type F"

- NEDC 87-152, "Hanger Calculations for CNS Battery Replacement Project"

The components listed below were seismically mounted per the requirements specified in NEDC 14-005:

- CNS-0-FPC-LIT-1 MOHR EFP-IL
- CNS-0-FPC-LIT-2 MOHR EFP-IL
- CNS-9-FPC-BAT-1 MOHR EFP-BAT-44000
- CNS-9-FPC-BAT-2 MOHR EFP-BAT-44000
- CNS-9-FPC-UPS-1 MOHR EFP-RD-UPS
- CNS-9-FPC-UPS-2 MOHR EFP-RD-UPS
- CNS-9-FPC-BAT-1A MOHR EFP-BAT-44000
- CNS-9-FPC-BAT-2A MOHR EFP-BAT-44000
- CNS-0-FPC-LI-2 Yokogawa Indicator (not credited to meet the Order)

FPC-XFMR-1 and FPC-XFMR-2 are power conditioners that were seismically mounted per the requirements of NEDC 14-005 using a Type A hanger configuration.

The rack associated with the equipment in the Cable Spreading Room is also addressed in NEDC 14-005.

FPC-LI-2 terminal box was seismically mounted using the Type A hanger which is addressed in NEDC 14-005. The indicator was then mounted inside the terminal box. However, the indicator is not credited to meet the Order.

There were no changes to the seismic analysis associated with Control Room recorder RHR-TR-131.

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***NRC RAI #5:***

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

**NPPD RESPONSE:**

Probe to Bracket: Forces (from the hydrodynamic and structural analysis of the SFP probe) were applied to the mounting flange, and subsequently the adapter plate. These forces were then translated to the bolted connection of the probe to the bracket. Applied stresses on the mounting bracket assembly were examined and compared to ASME code allowable stress values to ensure qualification of the components.

Bracket to SFP Curb: Forces (from the hydrodynamic and structural analysis of the SFP probe) were applied to the bracket. These forces were then translated to the SFP curb by a continuous fillet weld on the back face of the SFP curb. The weld stresses were examined and compared to code allowable values to ensure its qualification.

Signal/Battery Units to Control Building: Two sets of signal and battery units were placed in the Control Building at different locations to provide reliable reading sources of the SFP. Both units were mounted to supports, which were then mounted to the Control Building structure (floor and wall). The forces seen from dead load and safe shutdown earthquake loading were applied to the supports which were then translated into the anchor bolts attaching the supports to the structure. Applied forces and bending moments were examined and compared against the allowable code values to ensure qualification of the support system designs. The same methodology was followed for qualification of conduit attachment to permanent plant structures.

The Control Building and the Reactor Building are the structures that the secondary and primary instrument channels were routed and secured to. Both buildings are seismic I structures. As such, all equipment is mounted to seismic I criteria.

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***NRC RAI #6:***

*Please provide the following:*

*a) A description of the specific method or combination of methods to be used to demonstrate the reliability of the permanently installed equipment under BDB ambient temperature, humidity, shock, vibration, and radiation conditions.*

*b) A description of the testing and/or analyses that will be conducted to provide assurance the equipment will perform reliably under the worst-case credible design basis loading at the location where the equipment will be mounted. Include a discussion of this seismic reliability demonstration as it applies to:*

*i. the level sensor mounted in the SFP area, and*
*ii. any control boxes, electronics, or read-out and re-transmitting devices that will be employed to convey level information from the level sensor to the plant operators or emergency responders.*

*c) A description of the specific method or combination of methods that will be used to confirm the reliability of the permanently installed equipment such that following a seismic event the instrument will maintain its required accuracy.*

**NPPD RESPONSE:**

a) The SFP Level Indication (SFPLI) system was tested by the manufacturer, MOHR Test & Measurement, LLC, using a series of tests as described below:

- NEDC 14-006 which accepts MOHR Document 1-0410-1, "Temperature and Humidity Test Report": Tested the signal processor and back-up battery pack to a temperature range of -9° C to 55° C and a humidity range of 5% to 95% relative humidity. These ranges encompass CNS' requirements.

- NEDC 14-007 which accepts MOHR Document 1-0410-2, "MOHR SFP-1 Level Probe Assembly Materials Qualification Report": Evaluated the probe for temperature, water chemistry, and radiation conditions for conditions expected under beyond design basis (BDB) conditions based on the properties of all of the materials used in the probe's construction.

- NEDC 14-009 which accepts MOHR Document 1-0410-5, "MOHR EFP-IL SFPI System Shock and Vibration Test Report": Tested the signal processor and back-up battery pack for shock and vibration based on IEC 60068-2-27 (for shock requirements) and IEC 60068-2-6 (for vibration requirements).

The heat-up calculation for design basis is NEDC 93-054, "Control Room Heatup During 24 Hour Period," and calculation for BDB heat-up is NEDC 15-002, "Review of Tetra Tech Portable Equipment Calculations in support of CNS FLEX Strategy." NEDC 88-299A, "Review of S&L Calc. No. COOLC-01, Rev. 6, HVAC Load Calculation for Control Building EL 903'-6"," established the maximum allowable temperature for the Control Building 903 corridor at 117.5° F during loss on non-essential ventilation. The analysis of the 903 Control Building corridor heat-up for extended loss of AC power (ELAP) (secondary channel) is bounded by this 117.5 ° F for the ELAP and with a 60% relative humidity (Tetra Tech calculation 194-4959-02 contained in NEDC 15-002) the temperature in the analysis is 101.4° F which is very near its steady state temperature.

The analysis of the 918 Control Building Cable Spreading Room heat-up for ELAP (primary channel) is bounded by 120° F for the ELAP and with a 60% relative humidity (Tetra Tech calculation 194-4959-02 contained in NEDC 15-002) the temperature in the analysis is 99.56° F in a 24-hour time frame which is very near its steady state temperature.

The signal processor and battery packs are not located in the vicinity of the SFP. Therefore, there is no need to qualify them for the temperature, humidity, water chemistry, or radiation produced by boiling the SFP.

Calculation NEDC 13-030 "Spent Fuel Pool Instrumentation Total Integrated Dose Calculation," quantified the total integrated dose for the EPDM rubber insulator located inside the wall of the MOHR Liquid Level Measurement Probe. The probe is mounted in the SFP, and the total integrated dose over 30 years and 7 days of Level 3 accident scenario (pool water even with the top of the spent fuel racks) is calculated to be $1.15 \times 10^9$ rad at 3 ft above the rack. This level is significant in that it is the closest installation of the EPDM rubber spacer within the probe. EPDM rubber is qualified for a radiation dose of $2.0 \times 10^9$ rad. Therefore, the dose of $1.15 \times 10^9$ rad is encompassed.

The following table provides the parameters; in all cases the equipment meets or exceeds the CNS parameters:

| | CNS Parameter | Equipment |
|---|---|---|
| Reactor Building 1001' probe | | |
| Dose | Total Integrated Dose $1.15 \times 10^9$ | $2.0 \times 10^9$ |
| Temperature | 212° F (pool) 188° F (general area) | 212° F |
| Humidity | 100 % | 100% |
| Control Building 918 | | |
| Temperature | 120° F | 123° F |
| Humidity | 60% | 95% |
| Control Building 903 corridor | | |
| Temperature | 117.5° F | 123° F |
| Humidity | 60% | 95% |

b) i & ii) The response to RAI #3 provides the seismic reliability demonstration discussion for the level probe.

Both seismic and shock/vibration testing were performed on the signal unit and battery box associated with the signal unit. In order to provide reasonable assurance that the instrumentation will provide reliable service in a nuclear power plant, the system must demonstrate compatibility with anticipated seismic effects according to relevant standards. IEEE Standard 344-2004 was used and was referenced to develop a suitable seismic test plant meeting the requirements of IEEE 344-2004 and triaxial shake-table testing to 10 CFR Part 50 Appendix B quality requirements. Additionally shake and vibration testing were performed to demonstrate compatibility with anticipated non-seismic mechanical shock and vibration loadings. The testing, performed utilizing a shock/vibration table, followed IEC 60068-2-27 for shock requirements, and IEC 60068-2-6 for vibration requirements.

c) Seismic testing of the signal processor and back-up battery packs was performed by MOHR based on the guidance in IEEE 344-2004. This testing is documented in the EFP-IL SFPI System Seismic Test Report, MOHR Document 1-0410-6 (NEDC 14-010). This testing included taking baseline functional data, visual observation of the equipment during seismic testing, and collection of post-seismic functional data. This testing was performed at both the site-specific test levels as well as the limits of the test table.

Due to the physical restrictions of testing the probe, the probe was seismically qualified by analysis based on guidance in IEEE 344-2004. See responses to RAIs #3 and #4 for additional details regarding the hydrodynamic and seismic analyses.

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***NRC RAI #7:***

*For RAI #6 above, please provide the results for the selected methods, tests and analyses used to demonstrate the qualification and reliability of the installed equipment in accordance with the Order requirements.*

**NPPD RESPONSE:**

Post-test data for the equipment under test showed a maximum shift in calibration of +0.1 inches at both the site-specific test levels and the table limits. This data is documented in MOHR Document 1-0410-6 (NEDC 14-010).

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***NRC RAI #8:***

*Please provide the following:*

*a) A description of the manner in which the two channels of the proposed level measurement system meets the independence requirement, to minimize, to the extent practicable, the potential for a common cause event to adversely affect both channels.*

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

**NPPD RESPONSE:**

a) The level sensors and fixed components of each channel on the refueling floor are physically separated from the other channel by a distance that is comparable to the shorter side of the SFP. The signal processor, uninterruptible power supply (UPS), and back-up battery packs for each channel are located in diverse locations.

Each channel is powered from a separate and independent source from the other. The primary channel is powered from the UPS for the Plant Management Information System (PMIS). The back-up channel is powered from a Division II lighting panel in the Auxiliary Relay Room.

For areas other than the refueling floor, no minimum physical separation distance is applied beyond that which is normally required to maintain the separation of the two divisions. Cable for each channel is routed in conduit and cable tray that is separate from the other channel. Division I tray is used for the primary channel, Division II tray is used for the back-up channel.

The separation of the two channels, as described above, will minimize the potential for a common cause to adversely affect both channels and maintains the independence of the two channels as described in Section 3.5 of NEI 12-02.

b) The electronics package (i.e., signal processor) for each channel of the SFPI system is located separately from that of the other channel. The signal processor for the primary channel is located in the cable spreading room which is within the Control Room Emergency Filter system boundary. The signal processor for the back-up channel is located in the Control

Building corridor on the ground floor. This separation will prevent failure of both channels due to a common missile or other physical threat.

The power source for each channel is separate and independent of the other. The primary channel power (UPS for the PMIS) is normally powered from the 12.5 kV ring bus. The back-up channel is powered from a Division II lighting panel in the Auxiliary Relay Room.

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***NRC RAI #9:***

*Please provide the following:*

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

*b) The results of the calculation depicting battery backup duty cycle requirements, demonstrating battery capacity is sufficient to maintain the level indication function until offsite resource availability is reasonably assured.*

**NPPD RESPONSE:**

a) The electrical AC power source for the secondary channel is powered from lighting panel LPCB2. The power path for LPCB2 is via 4160V SWGR Critical Bus 1F to (DIV 1) 480V SWGR Critical Bus 1F to MCC F to LPCB2.

The electrical AC power source for the primary channel is powered from PMIS UPS Main Panel UPS1A. The power path for EE-PNL-UPS1A is via EE-XFMR-MPF2, to EE-SWBR-MPF2, 480V MDP2 to EE-PNL-UPS1A. This supply also has an emergency feed to 480V MCC L. Other power sources used in the two channels are DC via the MOHR UPS units or via additional battery external connection after MOHR battery use.

b) MOHR Test & Measurement LLC has tested the battery packs with the EFP-IL system to show that in the "Low Power" mode of operation, the batteries will supply 7 days of power provided SFP level measurements are restricted to no more than 15 samples per hour. This sample rate is programmed into the "Low Power" configuration of the system to ensure this rate is maintained. The test results are documented in MOHR Document 1-0410-7 (NEDC 14-011, "MOHR EFP-IL SFPI Battery Life Report").

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***NRC RAI #10:*** Number not used.

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***NRC RAI #11:***

*Please provide the following:*

*a) An estimate of the expected instrument channel accuracy performance under both:*

*i. normal SFP level conditions (approximately Level 1 or higher) and*
*ii. at the BDB conditions (i.e., radiation, temperature, humidity, post-seismic and post-shock conditions) that would be present if the SFP level were at the Level 2 and Level 3 datum points.*

*b) A description of the methodology to be used for determining the maximum allowed deviation from the instrument channel design accuracy under normal operating conditions.*

**NPPD RESPONSE:**

a) i) The acceptance criteria for accuracy of the level indication system provided in all of the vendor's testing documentation is ± 1 inches. This is not affected by the water level, so this accuracy holds throughout the range of the instrument. The accuracy that will be required of this system by CNS is ± 3 inches.

a) ii) Under BDB conditions, the accuracy shift that occurs can be expected to be within the maximum deviations that were observed during qualification testing by the vendor. The maximum deviations that were observed during testing were:

- Seismic: +0.1" (MOHR Document 1-0410-6)
- Temperature: -0.4" (MOHR Document 1-0410-1)
- Humidity: -0.2" (MOHR Document 1-0410-1)
- Shock/Vibration: +0.2" (MOHR Document 1-0410-5)

Only the probe may be exposed to significant amounts of radiation. Since it acts only as a wave guide, it will have no impact on the accuracy of the system so long as it remains intact. Thus, radiation will not affect the accuracy of the system.

b) The measurement tolerance that is allowed for determination of the three key levels under NEI 12-02 is ± 1 ft (± 12 inches). The bottom of the range will be 6 inches above the top of the racks (Level 3). This leaves 6 inches of allowable measurement tolerance for determination of Level 3 while still remaining within the requirements of NEI 12-02.

The calibration tolerance being specified for the CNS system is ± 3 inches. So, the maximum deviation that is allowed from this tolerance, and still within the requirements of NEI 12-02, is 3 inches.

***NRC RAI #12:***

*Please provide the following:*

*a) A description of the capability and provisions the proposed level sensing equipment will have to enable periodic testing and calibration, including how this capability enables the equipment to be tested in-situ.*

*b) A description of the way such testing and calibration will enable the conduct of regular channel checks of each independent channel against the other, and against any other permanently-installed SFP level instrumentation.*

*c) A description of the functional checks to be performed, and the frequency at which they will be conducted. Describe how calibration tests will be performed, and the frequency at which they will be conducted. Discuss how these surveillances will be incorporated into the plant surveillance program.*

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

**NPPD RESPONSE:**

a) CNS uses MOHR equipment which provides the capability to perform in-situ testing. CNS uses Procedures 14.41.1.1, "FPC-LIT-1 Testing," and 14.41.1.2, "FPC-LIT-2 Testing," to perform testing and calibration associated with the MOHR equipment.

Periodic testing and calibration is performed at the signal processor using standard calibration equipment (time-domain reflectometer, oscilloscope, 50Ω male TNC terminator, test cable). The signal processor for each channel is located in a mild, non-radiological environment.

Although checkout/testing procedures are required to be performed on the probe before and after installation and prior to initial use, these procedures are performed one time only. They are not part of the periodic calibration.

b) Channel checks are enabled by regular readings taken by Operations personnel from each channel and actual Fuel Pool level obtained locally. A weekly channel check by Operations is performed, comparing the level reading from each channel with actual Fuel Pool level. These functional checks are incorporated into the plant surveillance program. The channel checks are performed per Procedures 2.1.12, "Control Room Data," 2.1.11.1, "Turbine Building Data," and 2.1.11.2, "Reactor Building Data."

There are no existing permanently-installed level instruments located in a remote location that provide a continuous readout of the SFP level.

c) A channel functional test will be performed by Maintenance personnel prior to each planned refueling outage. Fuel Pool level instrumentation is functionally tested using both onboard generated test signals and calibrated test equipment. This channel functional test will be incorporated into CNS' surveillance program.

A calibration test will be performed by Maintenance personnel at the frequency recommended by the Vendor Manual. The calibration check will use the calibration menu to enable inserting a 4-20mA signal to the recorder and the indicator. In addition, the calibration will incorporate a two point check from the probe using the shorting pin and actual level as the two points. This calibration test will be incorporated into the plant surveillance program.

Preventive Maintenance (PM) Plan 800000048932 currently consists of two Maintenance Items, 88882 for the primary channel and 88883 for the secondary channel. Each Maintenance Item includes a 6 month and a 12 month maintenance frequency action. Frequencies are as follows:

- Procedure 14.41.1.1 (primary channel procedure) and Procedure 14.41.1.2 (secondary channel procedure); 6 month - Section 4 Login, Section 5 Memory Test, Section 6 Battery Test, and Section 7 Scan Test; 12 month - Sections 4, 5, 6, 7, and Section 8 Loop Cal; 24 month - Maintenance Plan Change Request (MPCR) 11232321 is currently in process and will be incorporated into PM 800000048932 once approved.

  MPCR 11232321 will add tasks for the Primary System and the Back-up System components. The following functional locations are being added to the Objects Tab for the new Maintenance Items:

  Primary Channel
  CNS-9-FPC-BAT-1
  CNS-9-FPC-BAT-1A
  CNS-9-FPC-LE-1
  CNS-0-FPC-LIT-1
  CNS-9-FPC-UPS-1
  CNS-0-RHR-TR-131 Ch 11

  Secondary Channel
  CNS-9-FPC-BAT-2
  CNS-9-FPC-BAT-2A
  CNS-9-FPC-LE-2
  CNS-0-FPC-LI-2
  CNS-0-FPC-LIT-2
  CNS-9-FPC-UPS-2

The 24 month PM will address the replacement of the batteries for the EFP-IL and the signal battery pack. It will also perform a verification of the internal clock battery and check for excess drift. The memory card will be replaced and a health check consisting of a scan of the probe and the signal cable will also be performed.

d) In accordance with the vendor's recommendation in the EFP-IL Signal Processor Technical Manual (MOHR Document 1-0410-13) Section 6, the following PM tasks will be performed at the frequencies recommended by the vendor manual:

- Replace back-up batteries
- Verification of processor clock batteries
- Replace memory card
- Perform a diagnostics check (scan) of the probes and signal cables

These PM tasks will be performed using an Instrument & Control procedure and the vendor manuals. These items are controlled via the CNS PM process and not the surveillance program. In addition, the exterior surfaces of the equipment enclosures will be cleaned with a damp cloth, and the LCD screen cleaned with Windex or isopropyl alcohol on an as-needed basis.

Procedures 14.41.1.1 and 14.41.1.2 are used in PM 800000048932 as described in c) above.

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***NRC RAI #13:***

*Please provide the following:*

*a) The specific location for each of the primary and backup instrument channel displays.*

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

**NPPD RESPONSE:**

a) The main indication for the primary channel is on the signal processor located on the south side of the Cable Spreading Room below the Control Room. This channel feeds a secondary signal to a remote indication on an existing Control Room recorder, RHR-TR-131. The remote indication located in the Control Room is not credited to meet the Order. The credited indication is on the MOHR equipment.

The main indication for the back-up channel is on the signal processor located on the south wall of the Control Building corridor on the ground floor (903 elevation). This channel feeds a secondary signal to a remote outdoor indicator on the outside wall of the northeast corner of the Control Building. The remote outdoor indicator is not credited to meet the Order. The credited indication is on the MOHR equipment.

b) The primary channel has a readout in the Control Room and one in the Cable Spreading Room which is located directly below the Control Room and is easily accessible from the Control Room. The primary channel display will be periodically monitored.

The secondary channel has an outdoor remote readout located on the northeast corner of the Control Building. This is intended for use by personnel that are providing make-up water to the SFP from a location that is remote from the SFP as required by NRC Order EA-12-049 and NEI 12-06. The indication on the secondary signal processor is located on the ground floor of the Control Building in the corridor which is easily accessible from the outdoor indication via the Turbine Building.

The Operator's path to get to the credited indication is similar. The secondary credited indicator is the further of the two credited indicators (located 903 Control Building vs 918 Control Building). The conservative time frame for the Operator to reach the secondary indicator is under a 15 minute time frame taking account for any potential loss of lighting and obstructions caused by debris.

These locations are considered to be mild environment areas and are well within vendor specifications for the equipment. The heat-up calculation for design basis is NEDC 93-054 and for BDB heat-up is NEDC 15-002. NEDC 88-299A establishes the maximum allowable temperature for the Control Building 903 corridor at 117.5° F during loss of non-essential ventilation. The analysis of the 903 Control Building corridor heat-up for ELAP (secondary channel) is bounded by this 117.5° F for the ELAP and with a 60% relative humidity (Tetra Tech calculation 194-4959-02 contained in NEDC 15-002) the temperature in the analysis is 101.4° F which is very near its steady state temperature.

The analysis of the 918 Control Building Cable Spreading Room heat-up for ELAP (primary channel) is bounded by 120° F for the ELAP and with a 60% relative humidity (Tetra Tech calculation 194-4959-02 contained in NEDC 15-002) the temperature in the analysis is 99.56° F in a 24-hour time frame which is very near its steady state temperature.

No radiological concerns exist for these areas during an ELAP event.

The level indication will be periodically checked by operations per FLEX Support Guide 5.10FLEX 11, Spent Fuel Pool Supply FLEX Operations.

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***NRC RAI #14:***

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

**NPPD RESPONSE:**

CNS procedures that will be used to operate, test, maintain, and inspect the SFPLI system are:

- Procedure 2.1.11.1, Turbine Building Data - Equipment Operator logs to record readings from the EFP-ILs.
- Procedure 2.1.11.3, Radwaste and Augmented Radwaste Building Data - Equipment Operator logs to record readings from the back-up channel remote readout.
- Procedure 2.1.12, Control Room Data - Control Room logs to record readings on the primary channel remote readout.
- Procedure 2.2A_120LTG.DIV0, Station Lighting System Non-Divisional Power Checklist - Breaker lineup checklist for power to back-up channel.
- Procedure 2.2.32, Fuel Pool Cooling and Demineralizer System - Operation of the Fuel Pool Cooling and Demineralizer System, including the EFP-ILs.
- Procedure 2.2.32A - Fuel Pool Cooling and Demineralizer System Component Checklist - Component Checklist for 2.2.32.
- Procedure 2.4FPC, Fuel Pool Cooling Trouble - Abnormal response procedure for Fuel Pool Cooling.
- Procedure 2.2.63A, PMIS Uninterruptible Power Supply Component Checklist - Breaker lineup checklist for power to primary channel.
- Procedure 2.3_9-4-2, Panel 9-4 - Annunciator 9-4-2 - Verifies pool level when Fuel Pool trouble alarms due to level.
- Procedure 5.1RAD, Building Radiation Trouble - Will utilize remote indication to verify level of the pool when high radiation levels occur in the area.
- Procedure 14.41.1, Fuel Pool Cooling System Instrument Calibration - Provides instructions to calibrate Fuel Pool Cooling System instruments.
- Procedure 14.41.1.1, FPC-LIT-1 Testing - Provides instructions to perform instrument calibrations on the Spent Fuel Pool FLEX Level Indicating Loop and Transmitter FPC-LIT-1.
- Procedure 14.41.1.2, FPC-LIT-2 Testing - Provides instructions to perform instrument calibrations on the secondary Spent Fuel Pool FLEX Level Indicating Loop and Transmitter FPC-LIT-2.

- Procedure 6.LOG.601, Daily Surveillance Log - Modes 1, 2, and 3 - Provides instructions for Operations personnel to perform high frequency Technical Specifications (TS), Technical Requirements Manual (TRM), and Off-site Dose Assessment Manual (ODAM) surveillance requirements during Modes 1, 2, and 3.

- Procedure 6.LOG.602, Daily Surveillance Log - Modes 4 or 5 - Provides instructions for Operations personnel to perform high frequency TS, TRM, and ODAM surveillance requirements during Modes 4 or 5.

- Procedure 5.3SBO, Station Blackout - Provides Operator guidance for a loss of all AC power (on and offsite). Attachment 2, RPV and Containment Parameter Monitoring, has a proposed change to install a back-up battery to the SFPLI per FLEX Support Guide 5.10FLEX.06.

- FLEX Support Guideline 5.10FLEX.06, Fuel Pool Level Instrument Electrical Tie-In - Establishes 12 VDC back-up power supply for continued use of SFP level instrumentation.

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***NRC RAI #15:***

*Please provide the following:*

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

*b) A description of the guidance in NEI 12-02 Section 4.3 on compensatory actions for one or both non-functioning channels will be addressed.*

*c) A description of the compensatory actions are planned in the event that one of the instrument channels cannot be restored to functional status within 90 days.*

**NPPD RESPONSE:**

a) The regular maintenance and testing of the two systems will be evaluated, established, and controlled via the CNS PM and surveillance programs. Functional checks will be performed as described in NPPD's response to RAI #12(c).

b) Both SFPI channels incorporate permanent installation of relatively simple and robust equipment. Permanent installation coupled with stocking of adequate spare parts reasonably diminishes the likelihood that a single channel (and greatly diminishes the likelihood that both channels) is (are) out-of-service for an extended period of time.

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.

For a single channel that is not expected to be restored, or is not restored within 90 days, the compensatory actions will include steps necessary to ensure availability of normal alarms and proper function of the remaining indication channel validated by direct visual monitoring. If both channels become non-functional, then actions will be initiated within 24 hours to restore one of the channels of instrumentation and to implement compensatory actions within 72 hours. Compensatory actions will include steps necessary to ensure availability of normal alarms and increased direct visual monitoring of SFP level.

Once the SFPI is incorporated into the TRM as part of FLEX strategy, the required actions and completion times will be driven by the TRM. The proposed TRM change (proposed excerpt below) requires that for a single channel that does not meet the functional requirements, the required action is to restore the channel to functional status within 90 days or implement compensatory measures. In the case of both channels not meeting functional requirements, the required action is to initiate actions to restore one channel within 24 hours and implement compensatory measures.

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. The primary or secondary spent fuel pool level instrument does not meet the functional requirements. | A.1 Restore spent fuel pool level instrument to FUNCTIONAL status. | 90 days |
| B. Action A.1 completion time not met. | B.1 Implement compensatory measures. | Immediately |
| C. The primary and secondary spent fuel pool level instruments do not meet the functional requirements. | C.1 Initiate actions to restore one of the channels of instrumentation.<br><br>AND<br><br>C.2 Implement compensatory measures. | 24 hours<br><br>72 hours |

c) For a single channel that is not expected to be restored, or is not restored within 90 days, the compensatory actions will include steps necessary to ensure availability of normal alarms and proper function of the remaining indication channel validated by direct visual monitoring.

***NRC RAI #16*** *(Note - This RAI originated from the Safety Evaluation Tracker for the May 2016 onsite audit):*

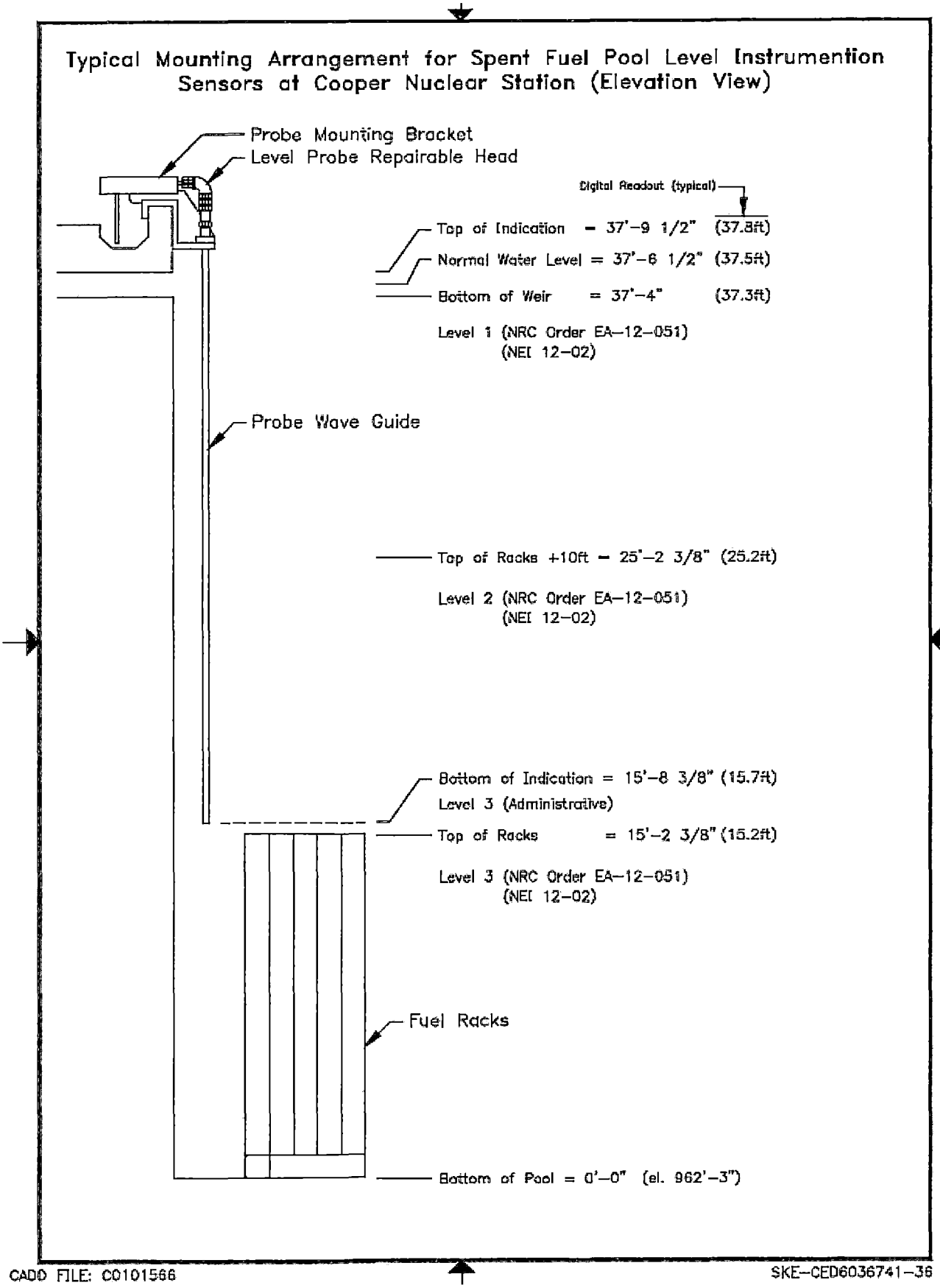
*Please describe the impact of recent MOHR's SFPI equipment failures (failure of the filter coil (or choke) in particular) on Cooper's SFP level instrument. Also, any actions/measures Cooper plans to implement to address this equipment failure.*

**NPPD RESPONSE:**

CNS's SFPI equipment was upgraded and tested prior to the system installation.

Qualification Report "EFP-IL MOD 1 Modification Package," provides the evaluations of the replacement parts. Section 3.2 of this document specifically addresses the choke failure and the solution for the fix.

# Spent Fuel Pool Level Instrumentation - Figure 1



# Spent Fuel Pool Level Instrumentation - Figure 2

## Figure 2

**Mounting Arrangement for Spent Fuel Pool Level Instrumentation Sensors at Cooper Nuclear Station (Plan View)**