Xcel Energy®

Prairie Island Nuclear Generating Plant
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U.S. Nuclear Regulatory Commission
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Prairie Island Nuclear Generating Plant Units 1 and 2
Docket Numbers 50-282 and 50-306
Renewed Facility Operating License Nos. DPR-42 and DPR-60

Prairie Island Nuclear Generating Plant's Fifth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)
(TAC Nos. MF0832 and MF0833)

References:

1. NRC Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (ADAMS Accession No. ML12054A682).

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 (ADAMS Accession No. ML12221A339).

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 (ADAMS Accession No. ML12240A307).

4. NRC Letter to NSPM, Prairie Island Nuclear Generating Plant, Units 1 and 2 – Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC NOS. MF0832 and MF0833)," dated November 14, 2013 (ADAMS Accession No. ML13311A486).

5. NSPM Letter to NRC, "Initial Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated October 29, 2012 (ADAMS Accession No. ML12305A313).

6. NSPM Letter to NRC, "Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 26, 2013 (ADAMS Accession No. ML13060A363).

7. NSPM Letter to NRC, "Prairie Island's First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated August 26, 2013 (ADAMS Accession No. ML13239A093).

8. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated February 26, 2014 (ADAMS Accession No. ML14057A647).

9. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated August 25, 2014 (ADAMS Accession No. ML14237A485).

10. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 26, 2015 (ADAMS Accession No. ML15057A306).

11. NRC Letter, "Nuclear Regulatory Commission Audits of Licensees Responses to Reliable Spent Fuel Pool Instrumentation Order EA-12-051," dated March 26, 2014 (ADAMS Accession No. ML14083A620).

On March 12, 2012, the Nuclear Regulatory Commission (NRC) staff issued Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," (Reference 1) to all NRC power reactor licensees and holders of construction permits in active or deferred status. Reference 1 was immediately effective and directed Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, to have a reliable indication of the water level in the spent fuel storage pool for Prairie Island Nuclear Generating Plant (PINGP) Units 1 and 2. Specific requirements are outlined in Attachment 2 of Reference 1.

Pursuant to Condition C of Section IV, Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance (ISG), an overall integrated plan, and status reports at six-month intervals following the submittal of the overall integrated plan. The ISG (Reference 2) endorses, with exceptions and clarifications, the methodologies described in a guidance document from the Nuclear Energy Institute (NEI), NEI 12-02, "Industry Guidance for Compliance with Order EA-12-051, 'To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,'" Revision 1 (Reference 3). Reference 4 provided the NRC interim staff evaluation of the overall integrated plan (Reference 6) and request for additional information.

Reference 5 provided the PINGP initial 60-day status report regarding reliable spent fuel pool instrumentation. Reference 6 provided the overall integrated plan for PINGP. References 7, 8, 9, and 10 provided the first, second, third, and fourth six-month status reports, respectively, for the overall integrated plan, per Condition C.2 of Section IV of Reference 1.

The purpose of this letter is to provide the fifth six-month status report pursuant to Section IV, Condition C.2 of Reference 1, which delineates the progress made in implementing the requirements of the Reference 1 Order. The Enclosure 1 report provides an update of milestone accomplishments since the overall integrated plan was submitted, including changes to the compliance method, schedule, or the need and basis for relief, if any. Enclosures 2 and 3 provide responses to the NRC Staff's requests for additional information (RAI) of Reference 4 and the bridging document. The responses to the RAI were initially provided in the online reference portal as directed by Reference 11.

Please contact Lynne Gunderson, Licensing Engineer, at 651-267-7421, if additional information or clarification is required.

Summary of Commitments

This letter makes no new commitments and no revisions to existing commitments.

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

Executed on August 25, 2015.

Kevin Davison
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (3)

cc: Administrator, Region III, USNRC
Director of Nuclear Reactor Regulation (NRR), USNRC
Project Manager, Prairie Island Nuclear Generating Plant, USNRC
Resident Inspector, Prairie Island Nuclear Generating Plant, USNRC

**ENCLOSURE 1**

**Prairie Island Nuclear Generating Plant, Units 1 and 2
Fifth Six-Month Status Report for Implementation of Order EA-12-051,
Order Modifying Licenses with Regard to Requirements for
Reliable Spent Fuel Pool Instrumentation**

## 1.0 Introduction

The Nuclear Regulatory Commission (NRC) issued Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," on March 12, 2012 (Reference 1). The Order requires licensees to have reliable indication of the water level in associated spent fuel pools capable of supporting identification of the following spent fuel 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. The Order required licensees to submit an overall integrated plan (OIP), including a description of how the requirements in Attachment 2 of the Order would be achieved. Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, submitted the OIP (Reference 2) for the Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2, on February 26, 2013. References 4, 5, 9, and 10 provided the first, second, third, and fourth six-month status reports for the OIP, per Condition C.2 of Section IV of Reference 1.

On July 11, 2013, the NRC Staff provided requests for additional information (RAI) in Reference 6 regarding the Spent Fuel Pool Instrumentation (SFPI) overall integrated plan. Reference 3 provided the NSPM responses to NRC Requests for Additional Information (RAIs) regarding the OIP for PINGP.

On November 14, 2013, the NRC issued an Interim Staff Evaluation (ISE) for PINGP's SFPI OIP (Reference 7). The ISE documents the NRC Staff's review and provides feedback on NSPM's OIP. The ISE also includes RAIs, response to which the NRC Staff needs to complete their review. The RAIs issued by the NRC in the ISE supersede the RAIs reported in the Reference 6.

This Enclosure provides the PINGP, Units 1 and 2, fifth six-month status report. This status report includes an update of milestone accomplishments since the previous six-month status report was submitted, including any changes to the compliance method, schedule, or the need and basis for relief, if any.

## 2.0 Milestone Accomplishments

The original milestone schedule, with target dates, was provided in Section 2.0 of Reference 2. The following milestones have been completed since the February 26, 2015, fourth six-month status report (Reference 10). This information is current as of July 31, 2015.

- Commence Installation
- Reliable Spent Fuel Pool Instrumentation Operational

## 3.0 Milestone Schedule Status

The following table provides an update of the milestone schedule to support the OIP. This includes a brief milestone status and a revised target date if the date has changed. The dates are planning dates subject to change as design and implementation details are developed. No target completion dates for milestones are changed for this six-month status report. NSPM provided the responses to the ISE RAIs through use of the online reference portal by March 31, 2015 instead of in the February 2015 six-month status report. Formal responses to the ISE RAIs are provided in Enclosure 2 of this fifth six-month status letter.

**Table 1 – Overall Integrated Plan Milestone Schedule**

| Milestone | Target Completion Date | Activity Status | Revised Target Completion Date |
|---|---|---|---|
| Submit 60 Day Status Report | October 2012 | Complete | |
| Submit Overall Integrated Plan | February 2013 | Complete | |
| Select Instrument Vendor (Target date 1st Quarter 2013) | 1st Quarter 2013 | Complete | |
| Submit First Six-month Status Update | August 2013 | Complete | |
| Commence Engineering Design | 3rd Quarter 2013 | Complete | |
| Submit Second Six-Month Status Update | February 2014 | Complete | |
| Submit Third Six-Month Status Update | August 2014 | Complete | |

| | | | |
|---|---|---|---|
| Submit Fourth Six-Month Status Update (includes responses to Requests for Additional Information (RAIs)) | February 2015 | Complete (see Section 6.0 below ) | |
| Commence Installation | 2nd Quarter 2015 | Complete | |
| Submit Fifth Six-Month Status Update (includes responses to remaining RAIs) | August 2015 | Complete with this submittal (see Section 6.0 below) | |
| Reliable Spent Fuel Pool Instrumentation Operational | End of 2R29 | Complete(1) | |
| Submit Report that Full Compliance is Achieved | 1st Quarter 2016 | Not Started | |

Note 1: The SFP level instrumentation is installed and the equipment has been turned over to the Operations department for use. However, compliance with the Order EA-12-051 will not be achieved until all procedures that rely on the SFPI level instrumentation for recovery action in the event of a BDBEE are issued, which is scheduled at the end of 2R29. The procedures associated with use during a BDBEE are tied with FLEX strategies that will be implemented during 2R29.

## 4.0 Proposed Changes to Compliance Method

There is one change proposed to the compliance method described in the OIP (Reference 2). This compliance method change affects Section 3.5, "Independence," of the SFPI OIP. The OIP included the following statements in Section 3.5 regarding the routing of the cables through existing embedded conduit:

> *"In the vicinity of the spent fuel pool, existing embedded conduit will be used for entry and exit of cables from the spent fuel pool structure."*

During the modification process, it was determined no embedded conduits are available on the east side of the spent fuel pool (SFP) enclosure to route the primary SFPI channel cables. Therefore, the routing for the primary channel inside the SFP enclosure will not use embedded conduits. Rather, the primary channel cables are routed in new conduits on the east wall inside the SFP enclosure. The new primary channel cable routing continues to meet the requirements of NRC Order EA-12-051 (Reference 1) and the NRC-endorsed guidance of NEI 12-02, Revision 1 (References 11 and 12).

## 5.0 Need and Basis for Relief from the Requirements of the Order

NSPM expects to comply with the Order implementation date and requirements and no relief is required at this time.

## 6.0 Open Items from Overall Integrated Plan and Interim Staff Evaluation

NSPM did not identify any open items in the OIP for PINGP. The OIP did contain future actions to ensure compliance with the Order. The future actions were identified internally and were tracked through NSPM's corrective action program (CAP).

On November 14, 2013, the NRC issued the ISE for PINGP's SFPI OIP (Reference 7). The ISE identified RAIs that were necessary for the NRC to determine the acceptability of NSPM's plans for implementing the requirements of Order EA-12-051. In Reference 8, the NRC notified each licensee participating in the audit process to not formally submit their RAI responses on the docket. Instead, licensees were instructed to upload the RAI responses and any other supporting information to the licensee's online reference portal by the date identified in the licensee's ISE. In accordance with this NRC guidance, NSPM provided the responses to the ISE RAIs on the online reference portal prior to the onsite NRC audit. Several of the ISE RAIs were supplemented following the onsite audit and provided on the online reference portal.

All ISE RAI responses, including the supplements from the audit, are complete and provided in summary form in Enclosure 2 of this letter. Previous six-month status reports contained a Table (Table 2), which provided a status of the ISE RAI responses. Based on all responses to RAIs being provided in Enclosure 2, the table provided in previous six-month status reports has been eliminated from this six-month status report.

## 7.0 Potential Draft Safety Evaluation Impacts

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

## 8.0 References

1. NRC Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (ADAMS Accession No. ML12054A682).

2. NSPM Letter to NRC, "Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 26, 2013 (ADAMS Accession No. ML13060A363).

3. NSPM Letter to NRC, "Responses to Requests for Additional Information Regarding Prairie Island Nuclear Generating Plant's Overall Integrated Plan Submitted in Response to March 12, 2012 Commission Order

Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated August 6, 2013 (ADAMS Accession No. ML13219A859).

4. NSPM Letter to NRC, "Prairie Island's First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated August 26, 2013 (ADAMS Accession No. ML13239A093).

5. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated February 26, 2014 (ADAMS Accession No. ML14057A647).

6. NRC Email to NSPM, "Prairie Island Units 1 and 2 - Draft RAI RE: OIP for Reliable SFP Instrumentation (TAC Nos. MF0832 and MF0833)," dated July 11, 2013 (ADAMS Accession No. ML13205A355).

7. NRC Letter to NSPM, "Prairie Island Nuclear Generating Plant, Units 1 and 2 – Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC Nos. MF0832 AND MF0833)," dated November 14, 2013 (ADAMS Accession No. ML13311A486).

8. NRC Letter, "Nuclear Regulatory Commission Audits of Licensees Responses to Reliable Spent Fuel Pool Instrumentation Order EA-12-051," dated March 26, 2014 (ADAMS Accession No. ML14083A620).

9. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated August 25, 2014 (ADAMS Accession No. ML14237A485).

10. NSPM Letter to NRC, "Prairie Island Nuclear Generating Plant's Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 26, 2015 (ADAMS Accession No. ML15057A306).

11. NRC JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," Revision 0 (ADAMS Accession No. ML12221A339).

12. 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 (ADAMS Accession No. ML12240A307).

# ENCLOSURE 2

## Prairie Island Nuclear Generating Plant, Units 1 and 2
## Completion of Required Action by NRC Order EA-12-051
## Reliable Spent Fuel Pool Instrumentation

## Responses to Requests for Additional Information

## 1.0 INTRODUCTION

On July 11, 2013, the NRC Staff provided requests for additional information (RAI) in Reference 1 regarding the Spent Fuel Pool Instrumentation (SFPI) overall integrated plan (OIP) for the Prairie Island Nuclear Generating Plant, Units 1 and 2 (PINGP). Reference 2 provided the NSPM responses to NRC RAI regarding the OIP for PINGP.

On November 14, 2013, the NRC issued an Interim Staff Evaluation (ISE) for PINGP's SFPI overall integrated plan (Reference 3). The ISE documented the NRC Staff's review and provided feedback on NSPM's OIP. The ISE also included RAIs, to which the NRC Staff needed a response to complete their review. The RAIs issued by the NRC in the ISE superseded the RAIs reported in the Reference 1 email.

The responses to the RAIs were initially provided to the NRC through the online reference portal. Several RAI responses were supplemented during the onsite audit and again uploaded into the online reference portal. The RAI responses are unchanged with the exception of editorial changes, formatting changes, and replacement of future tense statements with past tense statements as necessary to reflect the completed status of the associated actions. The responses in RAI 16 have been updated to discuss the final changes to the procedures listed and include discussion of one additional Fleet procedure. Note that preventive maintenance tasks (calibrations and maintenance discussed in RAIs 13, 14, 15 and 17) have been initiated through the formal NSPM processes.

## 2.0 NRC QUESTIONS AND NSPM RESPONSES

Background:

The spent fuel pool (SFP) at PINGP is a shared or common pool comprised of two storage pools (referred to as SFP #1 and SFP #2) and a fuel transfer canal. These three compartments are separated by slots in the walls that can be isolated by use of pneumatically sealed gates. A general layout of the SFP configuration was provided in the OIP (Reference 29), Figure 1.

The Spent Fuel Pool Instrumentation (SFPI) System consists of signal processors/indicators (referred to as the EFP-IL signal processors/indicators or as the displays), batteries (referred to as the EFP-BATT batteries), the probe assemblies (referred to as the SFP-1 probe assemblies), and the coaxial cables used to transmit signals between the EFP-IL signal processors and SFP-1 probe assemblies. The EFP-IL signal processors or displays and EFP-BATT batteries are installed in the Control Room behind the control panels. The probe assemblies are installed at the SFP locations. Specifically, the primary channel probe assembly is installed at the northeast corner of SFP #2 and the backup channel probe assembly is installed at the northwest corner of SFP #1. Figure 1 below provides a simple summary of SFPI equipment locations.

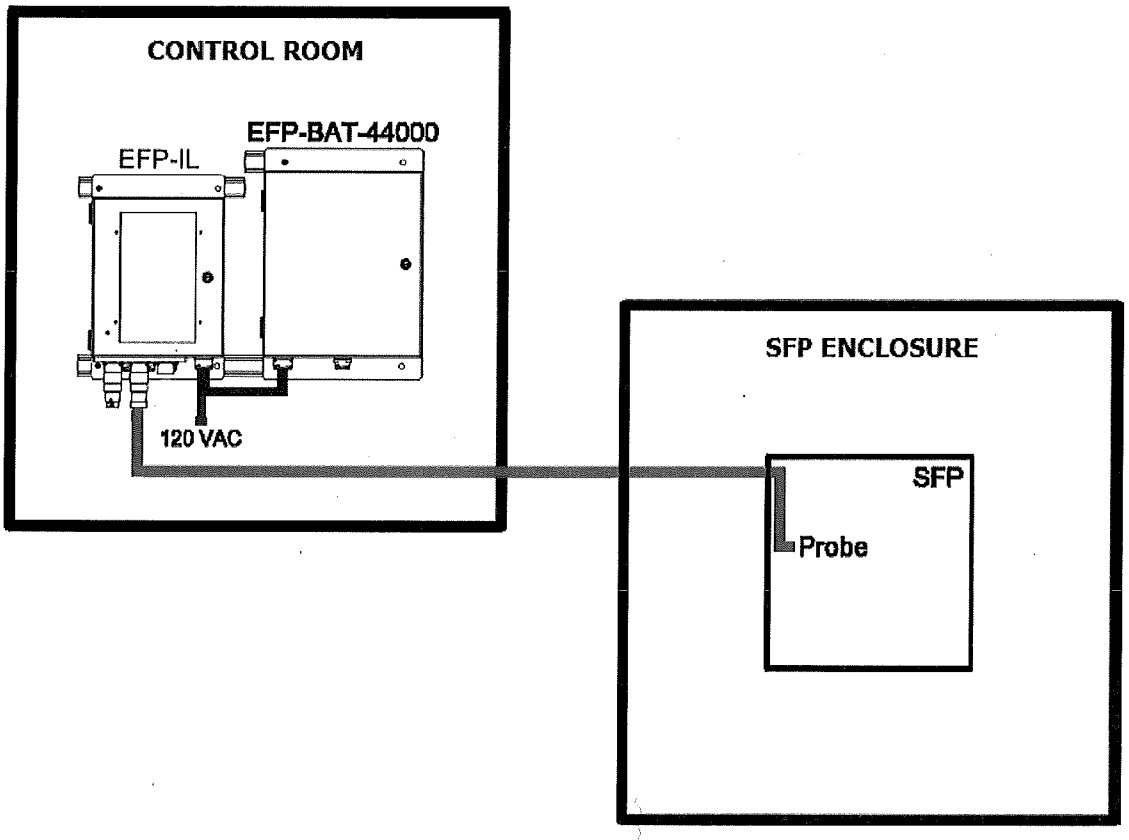


Figure 1 – Locations of SFPI Equipment

**NRC RAI 1:**

**Please provide the results of the calculation used to determine the water elevation necessary for the pump's required NPSH to confirm that Level 1 has been adequately identified.**

**NSPM Response:**

NEI 12-02 Guidance (Reference 4), Section 2.3.1, includes two options for defining water level monitoring requirements at Level I for the spent fuel pool (SFP).

1. The level at which reliable suction loss occurs due to uncovering of coolant inlet pipe, weir or vacuum breaker (depending on the design), or
2. 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.

NSPM selected option 1 for the technical design requirement to develop the spent fuel instrumentation. As part of the design process, NSPM performed a calculation to determine the net positive suction head (NPSH) of the spent fuel pit pump. The calculation concludes that adequate NPSH is maintained at Elevation 749.86 feet, which is the minimum elevation that maintains the coolant inlet pipe covered. Adequate operation of the normal SFP cooling system is maintained at this level.

The design then uses a water level height of elevation 750 feet minimum for Level 1, which is above the minimum water height elevation for adequate NPSH. This elevation provides conservatism for the design of the SFP instrumentation. This level is adequate to support operation of the normal fuel pool cooling system. An alarm is triggered at the display units installed in the Control Room when Level 1 is reached to notify Operation personnel that Level 1 is lost.

**NRC RAI 2:**

**Please provide the results of the evaluation to be performed to determine the projected dose rate impact and the appropriate Level 2 value as a result of other hardware stored in the SFP.**

**NSPM Response:**

NSPM evaluated the projected dose rate impact of other hardware in the SFP. Due to the location of the other hardware stored in the SFP and the conservative assumptions associated with the fuel stored in the SFP, the evaluation concluded

that the source strength of the other hardware would be lower than the spent fuel source term. Therefore, consistent with the guidance in NEI 12-02, the Level 2 setpoint of at least 10 feet above the fuel racks. This level provides sufficient shielding without requiring an analysis of the dose rate in the vicinity of the spent fuel pool.

**NRC RAI 3:**

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

**NSPM Response:**

The use of the SFP gates divides the common SFP into two separate pools, which are each monitored by one channel of SFP level instrumentation. Installing the SFP pneumatic sealed gates is treated the same as if an instrument is out of service for any reason per the guidance in NEI 12-02, Section 4.3. This includes a 90-day limitation on use of the pool divider gates that isolate the common pool into pools 1 and 2.

Implementation of this requirement is accomplished by instructions in the procedure used to install the weir gates and in the procedure used to ensure necessary compensatory measures are in place for equipment important to BDB compliance that is removed from service. Compensatory measures if the weir gates are installed include steps necessary to ensure availability of normal alarms and proper functioning of the indication channel in each pool validated by direct visual monitoring.

**NRC RAI 4:**

**Please provide a clearly labeled sketch or marked-up plant drawing of the plan view of the SFP area, depicting the proposed routing of the cables that will extend from the sensors toward the location of the read-out/display device.**

**NSPM Response:**

The instrument arrangement and redundant cable routing of the spent fuel instrumentation system meets the requirements of NRC Order EA-12-051 (Reference 5) and the guidance of NEI 12-02 (Reference 4). Those requirements include:

- Maintain instrument channel separation within the spent fuel pool area,
- Cabling for power supplies and indications for each channel should be routed separately from cabling for the other channels.

NSPM has installed a fixed probe in each of the two connected spent fuel storage pools at PINGP. The probes are mounted in the northwest corner of SFP #1 and in the northeast corner of SFP #2. Both the primary and backup displays are located in the control room. The primary SFPI cable routing from the SFP #2 to the Unit 1 Control Room uses existing penetrations and cable trays. The backup SFPI cable routing from the SFP #1 to Unit 2 Control Room uses existing embedded conduits, penetrations and cable tray system. Cable for each channel is routed in separate conduits and cable trays to provide additional redundancy.

Field walkdowns, performed as part of the design process, verified the cable routing met the channel separation requirements. Documents and drawings that provide the SFP instrument system design and layout sketches were provided to the NRC for audit.

**NRC RAI 5:**

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

**NSPM Response:**

As discussed in the response to RAI 4, the SFP level probes are mounted in the northwest corner of SFP #1 and in the northeast corner of SFP #2. This arrangement provides separation of the probes by a distance that is greater than the longest length of a side of the larger of the two connected pools. The NEI guidance provides that separation by a distance comparable to the shortest length of a side of the pool is acceptable. This arrangement also uses the inherent protection provided by the pool walls. Additionally, the entire spent fuel pool at PINGP is enclosed in a Class 1 structure designed to protect the pool from tornado generated missiles. Therefore, the location and arrangement of probes meets the NEI 12-02 guidance.

Cables for each channel are routed in separate conduits and cable trays to provide separation, which meets the NEI 12-02 arrangement guidance for missile protection. The displays are located in the Control Room, which is missile protected.

**NRC RAI 6:**

**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.**

d) **A description of how other material stored in the SFP will not create adverse interaction with the fixed instrument location(s).**

**NSPM Response:**

a) A site-specific structural calculation documents the design of the structural support bracket for the SFPI level probes at PINGP. The SFP level probes and the associated support brackets are classified as non-safety related. However, the support design considers the site-specific seismic loading requirements for Class I equipment. The site-specific requirements for Class I equipment are described in the PINGP USAR, Section 12.2.5.

   The structural members of the brackets are designed using a static equivalent force that is assumed to bound the actual forces in all directions due to seismically induced fluid forces acting on the bracket. The vertical static equivalent force acting on the bracket is then superimposed with the inertial

and hydrodynamic forces and moments acting on the probe, which were all provided by the vendor.

A dynamic analysis was performed using seismically induced water impact forces on the supporting bracket structure. The results of the dynamic analysis were reconciled with the site-specific structural calculation.

The supporting structure for the probes is designed as a rigid support. The basis for acceptance of the structural components, welds, etc., is the AISC Manual of Steel Construction, 9$^{th}$ edition. Only the properties of new structural members are per AISC Manual of Steel Construction, 13$^{th}$ edition.

As described in the PINGP USAR, Section 12.2.1.4.3.1.1, the stresses resulting from both the horizontal and vertical acceleration are combined to obtain the resulting earthquake stresses. The resultant combination, even for design basis earthquakes, is relatively small based on the support bracket member's small weight. A conservative vertical static equivalent seismic acceleration of 1.0 is used and bounds the effects of the bracket's seismic forces acting in the horizontal direction.

The support bracket's natural frequency is greater than 55 Hz. The actual horizontal acceleration of the Auxiliary Building at the 755 foot elevation for a natural frequency greater than 33 Hz is $g_h = 0.244$. The actual vertical acceleration of the Auxiliary Building for natural frequency greater than 33 Hz is $g_v = 0.125$. Therefore, using a vertical acceleration of 1.0 bounds the actual design basis value.

The seismically induced fluid force is the controlling design load and this condition is similar to the maximum (design basis) earthquake load. Thus, the allowable stresses are limited to 150 percent of AISC allowables for structural members in accordance with the PINGP USAR Table 12.2-5.

For the design of the structural connections (welds and bolts), the allowable stresses are conservatively limited to 100 percent of normal code allowables. Stainless steel Hilti Kwik Bolt 3 allowables are based on the ultimate value per the North American Product Technical Guide, Hilti Catalog, 2011 Edition using a safety factor of 4.0. The structural support component properties are adjusted to an environmental design temperature of 212°F.

The supporting bracket was analyzed and designed using STAAD.PRO, V8i program.

The calculation concludes that the probe support and the existing support structure are structurally adequate.

b) The mounting bracket is attached to the refueling floor using four one-inch diameter by 12 inch long Hilti Kwik Bolt 3 bolts with a nine inch minimum embedment in the structural concrete. The SFP probe support bracket is made up of ASTM A240 plate material and ASTM A554 HSS shapes. Welding is in accordance with AWS D1.6.

c) Bolts are used to secure the instrument probe to the spent fuel bracket supports. A construction change was issued in order to include a slot in the bracket to facilitate the installation of the probe per a recommendation from the probe vendor. Construction drawings that showed the interface were made available for audit.

d)

The Spent Fuel Pool Enclosure is designated as a Level 1 Foreign Material Exclusion Area (FMEA) such that there are no loose items or equipment near or in the SFP which would impact the fixed probes. Work is controlled by procedure D21.1, "Foreign Material Control of the Spent Fuel Pool Enclosure," form QF1811, "Material Accountability Log," and form QF1813, "Foreign Material Exclusion Good Practices."

The lowest portion of the SFP bridge crane provides clearance above the top of the mounting bracket for the SFP probes. There are six inches of clearance between the bottom of the crane and the refuel floor. The top of the mounting bracket is 4 ¼ inches above the floor. Therefore, there is 1 ¾ inches of clearance between the mounting bracket and the SFP crane.

Therefore, other material will not create adverse interactions with fixed instruments in these locations.

**NRC RAI 7:**

**For RAI 6(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.**

**NSPM Response:**

The new SFP level instruments meet the seismic requirements for equipment mounting and seismic component qualification of NRC Order EA-12-051

(Reference 5), NEI 12-02 (Reference 4), and JLD-ISG-2012-03 (Reference 6). The installed SFP level instruments are provided by MOHR Test and Measurement LLC. MOHR has seismically tested and evaluated this equipment and has documented the seismic qualification results in the following documents:

- MOHR 1-0410-9, Revision 2, "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report," (Reference 17)
- MOHR 1-0410-6, Revision 1, "MOHR EFP-IL SFPI System Seismic Test Report," (Reference 14)
- MOHR 1-0410-16, Revision 0, "MOHR SFP-1 Level Probe Assembly Shock and Vibration Test Report," (Reference 23)
- MOHR 1-0410-5, Revision 0, "EFP-IL SFPI System Shock and Vibration Test Report," (Reference 13)

Spent Fuel Probe Assembly – Component Seismic Qualification

MOHR Report 1-0410-9 (Reference 17) discusses that several utility customers have provided detailed Required Response Spectrum (RRS) to MOHR. MOHR developed a Safe Shutdown Earthquake (SSE) RRS that corresponds to the combination of two plants' SSE RRS that was then modified conservatively to bound United States nuclear facilities.

Seismic qualification on the basis of MOHR 1-0410-9 is predicated on a seismic event bounded by the 5.384g "Reference RRS". This assumes the probe being located within 12 inches of the pool wall in both horizontal axes and the starting nominal operating water level being no greater than 18 inches from the flange of the probe. The PINGP installation meets the requirements of the MOHR report.

The seismic event evaluated with a five percent damping ratio within the MOHR 1-0410-9 report bounds the seismic acceleration values evaluated for the PINGP Auxiliary Building at a similar elevation and matching damping ratio. Therefore, the seismic values within the MOHR report bound design conditions at PINGP.

The MOHR report 1-0410-9 concluded that the instrument assembly meets JLD-ISG-2012-03 and IEEE 344:2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

MOHR Display Unit and Battery – Component Seismic Qualification

MOHR seismically tested and evaluated the display unit and battery and documented the results in MOHR report 1-0410-6 (Reference 14). In order to prove reasonable assurance that the instrumentation will provide reliable service in a nuclear power plant environment, MOHR tested the system to demonstrate its

compatibility with anticipated seismic effects according to JLD-ISG-12-03 and IEEE 344:2004.

MOHR report 1-0410-6 provides two seismic test series that were performed; the first is based on site specific requirements and bounded by RRS values from other utilities, and the second is based on limits from an accredited laboratory, QualTech NP. MOHR's tests concluded the EFP-IL SFPI System meets JLD-ISG-12-03 and IEEE 344:2004.

As part of the design, NSPM developed a calculation that documents the seismic qualification of the MOHR Liquid Measurement Device Enclosure (EFP-IL) and the External Battery Enclosure (EFP-BATT). Both meet the requirements of IEEE Standard 344-2004 and the Prairie Island RRS. The calculation concluded that the MOHR EFP-IL and EFP-BAT enclosures are seismically qualified based on the MOHR 1-0410-6 seismic test report.

Spent Fuel Probe Assembly –Seismic Mounting

As part of the design, PINGP developed a calculation that documents the structural integrity of the support brackets for the level probes. The results of the calculation determined that the probe supports and existing supporting structures are structurally adequate.

MOHR Display Unit and Battery – Seismic Mounting

The display unit is mounted to the Control Room walls by 3/8 inch diameter Hilt Kwik Bolt 3 concrete expansion anchors with a minimum embedment of 1-5/8 inches through a Unistrut P1000 (or an approved equivalent). Anchors are located to provide rigid support mounting to approximate the tested configuration in the MOHR report 1-0410-6. The displays are located in the Control Room at the 735'-0" elevation of the Auxiliary Building. The envelope of the SSE North-South and East-West horizontal accelerations for 34 Hz frequency (rigid) for the next highest elevation of the Auxiliary Building is 0.236 g. The vertical acceleration is 0.124 g. The Signal Processor measures 10.0 inches by 12.0 inches by 8.3 inches and weighs 27.9 lbs. The battery enclosure measures 12.0 inches by 14.0 inches by 6.3 inches and weighs 41.6 lbs. The capacity of a single 3/8 inch diameter Hilti Kwik Bolt 3, with minimum embedment of 1-5/8 inches and a factor of safety of 4, is 855 lbs in tension and 1197 lbs in shear. The shear and tension loads from display unit and battery are very small compared to the large capacity of the anchors. Therefore, the 3/8 inch diameter Hilti Kwik Bolt 3 anchors are acceptable for the applied loading.

**NRC RAI 8:**

**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.**

**NSPM Response:**

Each SFP Level Probe is mounted to a support bracket that is anchored to the SFP operating deck. The support brackets are attached consistent with Seismic Class I mounting practices. The support bracket design and Seismic Class I mounting analysis are documented in a calculation. Design inputs include the weight of the probes, the seismic forces, and hydrodynamic forces from pool sloshing effects. The calculation was provided to the NRC for audit.

**NRC RAI 9:**

**Please provide the following:**

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

b) **A description of the testing and/or analyses that will be conducted to provide assurance that the equipment will perform reliably under the worst case credible design basis loading at the location where the equipment will be mounted. Include a discussion of this seismic reliability demonstration as it applies to a) the level sensor mounted in the SFP area, and b) any control boxes, electronics, or read-out and re-transmitting devices that will be employed to convey the level information from the level sensor to the plant operators or emergency responders.**

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

**NSPM Response:**

a) Reliability under BDB conditions:

MOHR SFP-1 Level Probe Assembly

Table RAI 5-1 - Spent Fuel Pool Area Environmental Conditions

| Environmental Condition | Value | Reference |
|---|---|---|
| Normal Humidity Range | 20-90% | PINGP Environmental Specification |
| Peak Normal Temperature | 105 °F | PINGP Environmental Specification |
| 40 Year Total Integrated Dose (TID) | 1E03 Rads | PINGP Environmental Specification |
| Peak BDBEE Humidity | 100% | NEI 12-02 |
| Peak BDBEE Temperature | 212 °F | NEI 12-02 |
| BDBEE TID at Probe | 1.04E09 Rads | Site-Specific Calculation |

Temperature and Humidity:

Post design basis external event, the SFP is expected to remain at or above the minimum ambient temperature of the Auxiliary Building (65°F) as called out in the site-specific PINGP Environmental Specification. Maximum accident condition temperature and humidity directly above the SFP will likely be in a condensing steam environment, which conservatively will be no greater than 212°F (the temperature of boiling water at atmospheric pressure) and 100% non-condensing relative humidity. The SFP cooling is restored or makeup water is provided to the SFP during phase 3 of an event as described in PINGP's OIP (Reference 29). The temperature is not expected to be greater than 194°F for more than 500 days after the event. Based on the vendor analysis results in MOHR Report 1-0410-2 (Reference 9), the sensitive materials in the probe head will not be challenged under the conditions of following a BDBEE. MOHR Report 1-0410-2 was reviewed during the NRC's audit of MOHR (Reference 24).

Radiation:

Based on MOHR Report 1-0410-2 (Reference 9) the most radiation sensitive component is qualified to 1E10 Rads. A site-specific calculation evaluated several cases with different pool configurations to determine the limiting dose rate at the location of the limiting probe material. Using the highest dose rate, the total integrated dose for the limiting probe material is 1.04E09 Rads. Therefore, the SFP level probe assembly is suitable for the service life in the spent fuel pool environment.

Shock and Vibration:

MOHR report 1-0410-16, "MOHR SFP-1 Level Probe Assembly Shock and Vibration Test Report" (Reference 23) documents the test procedures performed to demonstrate that requirements outlined in NEI 12-02 for shock and vibration have been met. MOHR Report 1-0410-16 was reviewed during the NRC's audit of MOHR (Reference 24).

The new probe mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. The probes are affixed to the bracket using a screw connection designed with proper thread engagement and lock washers. The probes and repairable heads were evaluated for resilience against shock and vibration and were found to meet the requirements of NEI 12-02 for shock and vibration resistance.

Additionally, the NRC Audit Report for MOHR (Reference 24) concludes that the shock and vibration test results were satisfactory.

MOHR EFP-IL and EFP-BATT (Display and Battery)

Table RAI 5-2 - Control Room Environmental Conditions

| Environmental Condition | Value | Reference |
|---|---|---|
| Normal and Post-Accident Relative Humidity | 50% | PINGP Environmental Specification |
| Peak Normal Temperature | 82.5 °F | PINGP Environmental Specification |
| Peak BDBEE Temperature | 120 °F | Site-Specific Evaluation |

Temperature and Humidity:

The electronics enclosures are installed within the Control Room. As noted in Table RAI 5-2 above, the minimum and maximum design temperatures under normal and post-accident conditions are $65^0$F and $120^0$F, respectively. Additionally, the relative humidity for the Control Room during normal and post-accident conditions is 50%. MOHR has successfully tested its system electronics for a temperature range of 14°F to 131°F and a relative humidity range of 5% to 95%. The MOHR values for temperature and relative humidity bound the conditions shown in Table RAI 5-2 above. Therefore, the electronics enclosures are capable of continuously performing their required function under the expected conditions. The results of the vendor testing are documented in MOHR 1-0410-1 (Reference 8). MOHR Report 1-0410-1 was reviewed during the NRC's audit of MOHR (Reference 24).

Radiation:

Control Room is considered a mild environment with no expected radiation.

Shock and Vibration:
The system is required to demonstrate compatibility with anticipated non-seismic mechanical shock and vibration loading. As discussed above, MOHR 1-0410-5 (Reference 13) contains the shock and vibration test documentation. The MOHR 1-0410-5 report was reviewed during the NRC's audit of MOHR (Reference 24) and the report concluded that the shock and vibration test results were satisfactory.

The indicator and battery enclosures are mounted in the Control Room. The equipment is not affixed or adjacent to any rotating machinery that would cause vibration effects in the area of installation. The new instrument mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. Similarly, the effects of shock on the supporting fixtures for the Control Room instruments are not a concern. The equipment adjacent to the display and battery box has been installed to resist seismic loading, which prevents impact from the adjacent objects during the design basis earthquake requirements imposed by NEI 12-02.

b) The SFP level probe assembly has been tested and evaluated to justify the acceptability of use for the application. MOHR 1-0410-9 (Reference 17) concludes that the level probe assembly meets JLD-ISG-12-03 and IEEE 344:2004 requirements for adequacy of seismic design and installation for SFPI with attention to seismic and hydrodynamic effects. Physical testing documented in MOHR report 1-0410-9 demonstrates that impact with the pool liner does not affect probe performance and is unlikely to damage the pool liner.

Seismic qualification on the basis of the MOHR report discussed above is predicated on 1) a seismic event bounded by the 5.384 g required response spectra described within the report, 2) the installation of the probe within 12 inches of the pool wall in both horizontal axes, and 3) the seismic event starting with a nominal operating water level being at or above 18 inches from the flange of the probe. The 5.384 g seismic event evaluated with a 5% damping ratio within the MOHR report bounds the site-specific seismic acceleration values of 0.244g horizontally and 0.125g vertically within the Auxiliary Building. The PINGP installation meets the requirements of the MOHR report, including locating the probe within 12 inches of the pool wall and the probe flange being 18 inches from the nominal operating water level.

A site-specific calculation performed for the SFPI Level Probe Mounting Bracket accounts for seismic loads and demonstrates the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified. Similarly, a calculation performed for the electronics enclosures that are installed in the Control Room accounts for seismic loads and shows that the mounting of the electronics enclosures is structurally adequate and seismically qualified.

c) MOHR 1-0410-15 (Reference 22) concludes that the EFP-IL signal processor and EFP-BATT batteries have been qualified for specified seismic loads per IEEE 344-2004. The signal processor and batteries have also been qualified for suitable shock and vibration loads per IEC 60068-2-27 and IEC 60068-2-6. The testing demonstrates that seismic and industrial shock and vibration loading produce no significant effect on level measurement.

The SFP-1 probe has been qualified for specified seismic and hydrodynamic loads using IEEE 344-2004 methodology. No significant effect on level measurement is anticipated due to seismic and hydrodynamic loading of the probe in the SFP environment.

Additionally, the SFP level instrumentation transitions from AC power to batteries in the event of loss of power. The transition is automatic and bumpless per MOHR 1-0410-12 (Reference 19). There is no effect on accuracy or calibration when switching between power modes or sources as discussed in MOHR-1-0410-10 (Reference 18). There are redundant channels (primary and backup) for the SFP that provide reasonable assurance that at least one channel will be available to perform spent fuel pool level readings.

**NRC RAI 10:**

**For RAI #9 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.**

**NSPM Response:**

For response to RAI 9, the results are included in the following reports and analyses from MOHR Test and Measurement, LLC. These reports and analyses were reviewed during the NRC audit of MOHR (Reference 24):

- MOHR 1-0410-1, Revision 1, "MOHR EFP-IL 1SFPI System Temperature and Humidity Test Report," (Reference 8)

- MOHR 1-0410-2, Revision 2, "MOHR SFP-1 Level Probe Assembly Materials Qualification Report," (Reference 9)
- MOHR 1-0410-3, Revision 0, "MOHR EFP-IL System Proof of Concept Report," (Reference 10)
- MOHR 1-0410-4, Revision 2, "MOHR EFP-IL SFPI System EMC Test Report," (Reference 11)
- MOHR 1-0410-4-S1, "MOHR EFP-IL SFPI System Supplemental EMC Information," (Reference 12)
- MOHR 1-0410-5, Revision 0, "MOHR EFP-IL SFPI System Shock and Vibration Test Report," (Reference 13)
- MOHR 1-0410-6, Revision 1, "MOHR EFP-IL SFPI System Seismic Test Report," (Reference 14)
- MOHR 1-0410-7, Revision 2, "MOHR EFP-IL SFPI System Battery Life Report," (Reference 15)
- MOHR 1-0410-8, Revision 2, "MOHR EFP-IL SFPI System Boric Acid Deposition Report," (Reference 16)
- MOHR 1-0410-9, Revision 2, "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report," (Reference 17)
- MOHR 1-0410-10, Revision 1, "MOHR EFP-IL SFPI System Power Interruption Report," (Reference 18)
- MOHR 1-0410-15, Revision 0, "MOHR EFP-IL SFPI System Uncertainty Analysis," (Reference 22)
- MOHR 1-0410-16, Revision 0, "MOHR EFP-1 Level Probe Assembly Shock and Vibration Test Report," (Reference 23)

Additionally, the following report and analysis were made available for audit in the NSPM PINGP online reference portal:

- 201404984-2, MOHR Report - Material Testing, (Reference 25)
- NAI-1725-004, Revision 3, "Seismic Induced Hydraulic Response," (Reference 26)
- EVAL-194-4812-01, Revision 2, "MOHR EFP-IL, Liquid Level Measurement System Failure Modes and Analysis (FMEA)," (Reference 27)

**NRC RAI 11:**

**Please provide the following:**

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

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

**NSPM Response:**

a) To provide redundancy between channels, the normal power to the two SFP level display units is supplied by two separate 120V uninterruptible power supplies (UPS) in two separate panels. The circuits of these panels were reconfigured by installing two new termination boxes in the control room. Each new terminal box houses DIN RAIL mounted terminal boards with two 5A and one 15A miniature circuit breakers that are used to split the 120V power. Each EFP-IL unit is connected to one 5A circuit breaker in the terminal board by 120V power cables. A set of 4-20mA output channels is available on each of the signal processors. One channel on each unit outputs a level signal for display on the Emergency Response Computer System (ERCS). The 4-20mA loops are powered by new 120V power supplies mounted within a new termination box near the display unit. The power supplies are connected to the terminal board through a 5A circuit breaker.

b) The design provides two identical, non-safety related, wide-range level instruments that feed two independent trains of non-safety related cable and indicators to provide a highly reliable remote display of SFP water level. Physical separation of the two channels is accomplished by mounting the probes in separate corners of the SFP and separately routing cable and conduit. The indicators (displays) are located in the Control Room behind the control panels. The normal power supply to the instruments is provided by different sources such that a loss of a distribution panel does not result in the loss of both channels. During a BDBEE, each channel has independent battery systems that supply the channels with power for seven days.

**NRC RAI 12:**

**Please provide the following:**

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

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

**NSPM Response:**

a & b)

The level indicating channels are independent and redundant. Power sources and capabilities are as follows:

- Primary power for the level indicating channels and the displays are installed in the Control Room.
- Each channel is normally powered by an independent 120VAC source. Therefore, loss of any one power supply does not result in loss of normal 120VAC power for both instrument channels.
- Each channel is provided with a battery back-up power supply capable of powering the channel for seven days. This provides adequate time to allow the batteries to be replaced with a fresh battery or until off-site resources can be deployed by the mitigating strategies of Order EA-12-049 (Reference 28).
- On loss of normal 120VAC power, each channel automatically transfers to a dedicated backup battery. If normal power is restored, the channel will automatically transfer back to the normal AC power. Instrument accuracy and performance are not affected by restoration of power or sources.

Sample rate estimates have been developed by the vendor using conservative instrument power requirements and measured battery capacity with draw-downs during and following exposure of the batteries to their maximum operating temperature for up to seven days. The instrument is configured for an automated sample rate when under battery power that is consistent with seven days operation. Permanently installed battery capacity for seven days operation of the system without reliance on or crediting of potentially more rapid flexible strategies (FLEX) is consistent with NEI 12-02. Batteries are readily replaceable by spare stock without the need for recalibration to maintain accuracy of the instrument.

These measures ensure adequate power capacity and margin.

**NRC RAI 13:**

**Please provide the following:**

a) **An estimate of the expected instrument channel accuracy performance under both (a) normal SFP level conditions (approximately Level 1 or higher) and (b) at the BDB conditions (i.e., radiation, temperature, humidity, post-seismic and post- shock conditions) that would be present if the SFP level were at the Level 2 and Level 3 datum points.**

b) **A description of the methodology that will be used for determining the maximum allowed deviation from the instrument channel design accuracy that will be employed under normal operating conditions as an acceptance criterion for a calibration procedure to flag to operators and to technicians that the channel requires adjustment to within the normal condition design accuracy.**

**NSPM Response:**

a) The published minimum accuracy specification under (a) normal SFP conditions (Level 1) and also (b) BDBEE conditions (Level 2 and 3) is approximately +/- 3 inches based on the vendor's system uncertainty analysis. This exceeds the NEI 12-02 water level measurement accuracy requirement of +/-1 foot.

   The level measurement system's expected typical absolute accuracy, excluding boric acid deposition effects, is +/- 1.0 inch. The maximum absolute accuracy, excluding boric acid deposition effects, is +/- 3.0 inches.

b) In general, any applicable calibration procedure tolerances or acceptance criteria are established based on manufacturer's recommended reference or design accuracy. The methodology used is formally captured in the request to create and schedule these procedures.

   MOHR Signal Processor Technical Manual (Reference 20) was used as input to calibration procedures to ensure the instruments are maintained within the design accuracy. The system is not significantly affected by borated water or boric acid that might deposit on the probe surface. However, the maintenance strategy includes instructions to perform a washout procedure per the MOHR Level Probe Assembly Technical Manual (Reference 21) if a significant error in level measurement is found (greater than or equal to 3 inches) during calibration.

In order to maintain the channel accuracy of 3 inches, level verification check is performed periodically to verify the accuracy of a channel. If significant error (i.e ≥ 3 inches of measurement error) is detected, a calibration and/or a routine boric acid deposition washout is performed in accordance with vendor's recommended procedures to maintain the channel accuracy of 3 inches. The surveillance performance frequency is controlled through tasks in the PM program. The request to add these tasks to the PM program has been formally made within the current NSPM process.

**NRC RAI 14:**

**Please provide the following:**

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

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

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

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

**NSPM Response:**

a) MOHR's vendor manual (Reference 20) provides a description of the capability and provisions the level sensing equipment has for periodic testing and calibration, including how this capability enables the equipment to be tested in-situ. Periodic testing and calibration of the SFP level instrumentation has been established in conjunction with the requirements of the MOHR vendor operation and technical manuals (References 19, 20, and 21). The

request to add these tasks to the PM program has been formally made within the current NSPM process.

The NRC staff audited MOHR's SFP instrumentation design at the MOHR facility during the week of May 26, 2014 and issued an audit report (Reference 24). The NRC audit report included a review of calibration and testing, and states, in part, the following:

- Section 4: "MOHR's SFPI design can be calibrated in-situ without removal from its installed location. The system is calibrated using a CT-100 device and processing of vendor scanned files."
- Section 4: "The NRC staff found the instructions and recommendations for calibration of the SFPI to be thorough and user-friendly."

b) The SFP level indication consists of two redundant fixed channels. This provides reasonable assurance that at least one channel is available to monitor SFP level. Each instrument electronically logs a record of measurement values over time in non-volatile memory that can be compared to demonstrate consistency, including any changes in pool level, such as that associated with the normal evaporative loss/refilling cycles. The channel level measurements are directly compared to each other (i.e., regular cross-channel comparisons). Control Room Logs are used to record the levels daily for each channel. Recorded level measurements and/or level histories and log files are compared to each other. If a significant difference in level is detected between the two channels, corrective actions are initiated to investigate and resolve the cause of the level difference between the two channels. Existing permanently installed SFP level instrumentation and direct SFP level measurements may be used for diagnostic purposes if cross-channel comparisons are anomalous.

c) Functional checks are automated and/or semi-automated requiring limited operator or technician interaction. The functional checks are performed through the instrument menu software and initiated by the operator or technician. There are a number of other internal system tests that are performed by system software on an essentially continuous basis without user intervention but can also be performed on an on-demand basis with diagnostic output to the display for the operator or technician to review. Other tests, such as menu button tests, level alarm, and alarm relay tests, are only initiated manually by the operator or technician. At a minimum, functional checks are performed at a frequency commensurate with vendor requirements.

Control Room Logs have been updated to verify on a once per day basis that there are no errors and that the batteries are fully charged. This ensures that

there are no system faults, that the normal power is available, and that the battery system is charged on a daily basis.

Calibration checks are described in detail in the Vendor Operator's Manual, and the applicable information is contained in plant procedures or preventive maintenance tasks. At a minimum, calibration checks are performed at a frequency commensurate with vendor requirements.

d) Formal calibration checks are recommended by the vendor on a two-year interval to demonstrate calibration to external National Institute of Standards and Technology traceable standards. Formal calibration and testing surveillance interval and timing have been established consistent with vendor requirements. Per MOHR's technical manual, maintenance of the SFP level instrumentation includes replacement of the batteries and the memory card on a six-month interval. At a minimum, maintenance is performed at a frequency commensurate with vendor requirements.

Level verification check is performed periodically (e.g. quarterly) to verify the accuracy of a channel. If significant error (i.e ≥ 3 inches of measurement error) is detected, a calibration and/or a routine boric acid deposition washout are performed in accordance with vendor's recommended procedures to ensure the channel accuracy of 3 inches is maintained.

Diagnostic tests on the SFP level probe signal processor/indicator device, which includes a Memory Test, Battery Test, Temperature Compensation Test, and Scan Test, are performed every six months to verify system functionality per vendor's recommendation.

Channel calibration tests, which include a time-domain reflectometer(TDR) calibration check, probe and transmission cable health checks, and clock calibration are performed every two years per vendor's recommendation and within 60 days of a planned refueling outage considering allowances (e.g. 25 percent) per NEI 12-02, Section 4.3.

**NRC RAI 15:**

**Please provide the following:**

**a) The specific location for the primary and backup instrument channel display.**

**b) For any SFP level instrumentation displays located outside the main control room, please describe the evaluation used to validate that the**

**display location can be accessed without unreasonable delay following a BDB event. Include the time available for personnel to access the display as credited in the evaluation, as well as the actual time (e.g., based on walk-throughs) that it will take for personnel to access the display. Additionally, please include a description of the radiological and environmental conditions on the paths personnel might take. Describe whether the display location remains habitable for radiological, heat and humidity, and other environmental conditions following a BDB event. Describe whether personnel are continuously stationed at the display or monitor the display periodically.**

**NSPM Response:**

a) The primary and backup instrument channel displays are located in the Control Room behind the control panels.

b) As stated in a), the primary and backup instrument channel displays are located within the main control room. Therefore, no response to RAI 15.b is necessary.

**NRC RAI 16:**

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

**NSPM Response:**

The following are existing procedures that are revised to incorporate the SFPI design change:

1. Operations Procedure C16 AOP1, Loss of SFP Inventory: The new SFP level indicators are referenced and procedure steps added to inform operators that level indication can be taken via Control Room indicators or ERCS.

2. Operations Procedure C17, Fuel Handling System: Since level probes are installed in the corners of the SFP, a note has been added to this procedure to avoid contact with the probes and brackets during fuel handling and while using tools near the probes.

3. Emergency Operating Procedures 1 E-0 (Unit 1) and 2E-0 (Unit 2), Reactor Trip or Safety Injection: SFP level indication is available in the Control Room as well as on ERCS. This procedure is updated to include discussion of indicators and ERCS points.

4. Emergency Operating Procedure 1 ECA-0.0 (Unit 1) and 2ECA-0.0 (Unit 2), Loss of All Safeguards AC Power: SFP level indicators are available in the Control Room as well as on ERCS. This procedure is updated to include discussion of indicators and ERCS points.

5. Emergency Operating Procedure 1 ES-0.1 (Unit 1) and 2ES-0.1 (Unit 2), Reactor Trip Recovery: SFP level indication is available in the Control Room as well as on ERCS. This procedure is updated to include discussion indicators and ERCS points.

6. Heavy Loads Procedure D58.5.3, Spent Fuel Pool (Divider) Gate Removal/Replacement: Level probes are placed in each of the two SFPs. NEI 12-02 provides guidance to take compensatory actions if closure of a gate divides the required instrument channels. This procedure is in the formal site change process to add a note that compensatory actions must be taken if a channel is out of service or gates that divide the channels are placed into service for more than 90 days.

7. Maintenance Procedure D5.1, Spent Fuel Pit Fuel Handling Operations: Level probes are installed within the corners of the SFPs. A note is added to avoid contact with the probes while using tools and handling fuel.

8. Maintenance Procedure D5.2 AOP3, Decreasing Refueling Water Level During Refueling: Procedure is updated to reference SFP level indicator readings as an indication of decreasing water level.

9. Unit 1 Control Room Log, PINGP 97, and Unit 2 Control Room Log, PINGP 1087: The new SFP level indicator has a self-check status system that can be used to detect errors. These forms for Control Room Logs are updated to verify that there are no errors and that the battery system is fully charged once per day.

10. Fleet Procedure FP-BDB-EQP-01, Equipment Important to BDB Compliance: The procedure has an attachment that discusses the SFPI requirements including conditions and required actions. A procedure change request (PCR) tracks the incorporation of the condition and required actions for the installation of the gates that isolate the pools. The PCR also incorporates clarifications to the required actions for channels being out of service or SFP gates being installed.

The following Preventative Maintenance Change Request (PMCR) tracks the creation of calibration and maintenance tasks and procedures for the SFP level instruments:

11. PMCR 1431335, New Maintenance PM for Spent Fuel Pool Instrumentation: Spent Fuel Pool Instrumentation channel preventative maintenance and calibration are being established in accordance with PINGP processes and procedures. Maintenance and calibration activities are being created within the Preventative Maintenance (PM) process with frequencies established in consideration of vendor recommendations.

    - PM for EFP-IL signal processor/indicator device: Diagnostic tests on the EFP-IL signal processor/indicator device, which include Memory Test, Battery Test, Temperature Compensation Test, and Scan Test are performed every six months to verify system functionality per vendor's recommendation.

    - PM for EFP-IL signal processor/indicator and EFP-BATT battery devices: Equipment maintenance, and calibration tests, which include battery replacement, memory card replacement, TDR calibration check, probe and transmission cable health checks, and clock calibration are performed every two years per vendor's recommendation and are within 60 days of a planned refueling outage considering allowances (e.g., 25%) per NEI 12-02 section 4.3.

    - PM for EFP-IL signal processor/indicator and SFP-1 probe devices: Level verification check is performed periodically to verify the accuracy of a channel. If significant error (i.e., ≥ 3 inches of measurement error) is detected, a calibration and/or a routine boric acid deposition washout are performed in accordance with vendor's recommendation procedures to ensure the channel accuracy of 3 inches is maintained.

In addition to the above, procedures for the use of the instruments during a BDBEE are coordinated with the mitigating strategies modifications at the site. These will be implemented in the next refueling outage scheduled to begin fall of 2015.

**NRC RAI 17:**

**Please provide the following:**

**a) Further information describing the maintenance and testing program the licensee will establish and implement to ensure that regular testing and**

**calibration is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. Please include a description of the plans for ensuring that necessary channel checks, functional tests, periodic calibration, and maintenance will be conducted for the level measurement system and its supporting equipment.**

**b) Information describing compensatory actions when both channels are out-of-order, and the implementation procedures.**

**c) Additional information describing expedited and compensatory actions in the maintenance procedure to address when one of the instrument channels cannot be restored to functional status within 90 days.**

**NSPM Response:**

a) Functional checks are automated and/or semi-automated and are performed through the instrument menu software and initiated by the operator. There are a number of other internal system tests that are performed by system software without user intervention but can also be performed on an on-demand basis with diagnostic output to the display for the operator to review. The self-checking function will detect any errors in the system and provide alerts on the display. Control Room Logs are updated to verify that there are no error alerts and that the batteries are fully charged once per day. This ensures that there are no system faults, that the normal power is available, and that the battery system is charged on a daily basis.

Functional checks are described in detail in the Vendor Technical Manual (Reference 20), and the applicable information is being created in plant procedures and preventive maintenance tasks. Functional tests are planned to be performed periodically at appropriate frequencies established equivalent to, or more frequently than, vendor requirements.

Spent fuel pool instrumentation (SFPI) channel/equipment maintenance/preventative maintenance and calibration requirements to ensure design and system readiness are being established in accordance with NSPM processes and procedures and in consideration of vendor recommendations. This ensures that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance are performed.

Maintenance and calibration activities are being established within appropriate processes and associated frequencies established in consideration of vendor recommendations.

b) 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 of the spent fuel pool level.

The use of the SFP gates divides the SFP into two separate pools, which are each monitored by one channel of SFP level instrumentation. If the gate is placed into service, then the above actions apply. See RAI #3 for more information.

If both channels become non-functioning then actions are initiated within 24 hours to restore one of the channels of instrumentation and to implement compensatory actions within 72 hours. Compensatory actions include steps necessary to ensure availability of normal alarms and increased direct visual monitoring of spent fuel pool level.

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

## 3.0 REFERENCES

1. NRC Email to NSPM, "Prairie Island Units 1 and 2 - Draft RAI RE: OIP for Reliable SFP Instrumentation (TAC Nos. MF0832 and MF0833)," dated July 11, 2013 (ADAMS Accession No. ML13205A355).

2. NSPM Letter to NRC, "Responses to Requests for Additional Information Regarding Prairie Island Nuclear Generating Plant's Overall Integrated Plan Submitted in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0832 and MF0833)," dated August 6, 2013 (ADAMS Accession No. ML13219A859).

3. NRC Letter to NSPM, "Prairie Island Nuclear Generating Plant, Units 1 and 2 – Interim Staff Evaluation and Request for Additional Information Regarding

the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC Nos. MF0832 AND MF0833)," dated November 14, 2013 (ADAMS Accession No. ML13311A486).

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, dated August 2012 (ADAMS Accession No. ML12240A307).

5. NRC Order EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (ADAMS Accession No. ML12054A682).

6. NRC JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," Revision 0 (ADAMS Accession No. ML12221A339).

7. NRC Letter to NSPM, "Prairie Island Nuclear Generating Plant, Units 1 and 2 – Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan for Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC NOS. MF0832 and MF0833)," dated November 14, 2013 (ADAMS Accession No. ML13311A486).

8. MOHR 1-0410-1, "MOHR EFP-IL 1SFPI System Temperature and Humidity Test Report," Revision 1, dated March 11, 2014.

9. MOHR 1-0410-2, "MOHR SFP-1 Level Probe Assembly Materials Qualification Report," Revision 2, dated March 13, 2014.

10. MOHR 1-0410-3, "MOHR EFP-IL System Proof of Concept Report," Revision 0, dated October 17, 2013.

11. MOHR 1-0410-4, "MOHR EFP-IL SFPI System EMC Test Report," Revision 2, March 13, 2014.

12. MOHR 1-0410-4-S1, "MOHR EFP-IL SFPI System Supplemental EMC Information," Revision 0, dated November 22, 2013.

13. MOHR 1-0410-5, "MOHR EFP-IL SFPI System Shock and Vibration Test Report," Revision 0, October 19, 2013.

14. MOHR 1-0410-6, "MOHR EFP-IL SFPI System Seismic Test Report," Revision 1, dated February 6, 2014.

15. MOHR 1-0410-7, "MOHR EFP-IL SFPI System Battery Life Report," Revision 2, Dated March 26, 2014.

16. MOHR 1-0410-8, "MOHR EFP-IL SFPI System Boric Acid Deposition Report," Revision 2, March 14, 2014.

17. MOHR 1-0410-9, "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report," Revision 2, dated May 12, 2014.

18. MOHR 1-0410-10, "MOHR EFP-IL SFPI System Power Interruption Report," Revision 1, dated January 10, 2014.

19. MOHR 1-0410-12, "MOHR EFP-IL Signal Processor Operator's Manual," Revision 1.1 dated February 13, 2015.

20. MOHR 1-0410-13, "MOHR EFP-IL Signal Processor Technical Manual," Revision 2, dated February 13, 2015.

21. MOHR 1-0410-14, "MOHR SFP-1 Level Probe Assembly Technical Manual," Revision 3, dated February 13, 2015.

22. MOHR 1-0410-15, "MOHR EFP-IL SFPI System Uncertainty Analysis," Revision 0, dated May 22, 2014.

23. MOHR 1-0410-16, "MOHR EFP-1 Level Probe Assembly Shock and Vibration Test Report," Revision 0, dated July 8, 2014.

24. NRC Letter, "Donald C. Cook Nuclear Plant, Units 1 and 2- Report for the Onsite Audit of MOHR Regarding Implementation of Reliable Spent Fuel Pool Instrumentation Related to Order EA-12-051 (TAC NOS. MF0761 and MF0762)", dated August 27, 2014 (ADAMS Accession No. ML14216A362).

25. Test Report Number 201404984 Revision 2, dated May 14, 2014.

26. NAI-1725-004, "Seismic Induced Hydraulic Response in the CGS Spent Fuel Pool," Revision 3, dated May 16, 2014.

27. EVAL-194-4812-01, "MOHR EFP-IL, Liquid Level Measurement System Failure Modes and Analysis (FMEA)," Revision 2, dated June 26, 2014.

28. NRC Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-

Basis External Events," dated March 12, 2012 (ADAMS Accession No. ML12054A735).

29. NSPM Letter to NRC, "Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," dated February 26, 2013 (ADAMS Accession No. ML13060A363).

# ENCLOSURE 3

## Prairie Island Nuclear Generating Plant, Units 1 and 2
## Completion of Required Action by NRC Order EA-12-051
## Reliable Spent Fuel Pool Instrumentation

## Bridging Document Between Vendor Technical Information and Prairie Island Nuclear Generating Plant Site Specific Considerations

(6 pages to follow)

| # | Topic | Parameter Summary | Vendor Reference Document # | Additional Comments | Test or Analysis Results | Licensee Evaluation |
|---|---|---|---|---|---|---|
| 1 | Design Specification | Spent Fuel Pool Instrument (SFPI) requirements derived from References 1, 2 and 3 | References 4-13, 23, and 26-28 | | N/A | Evaluation of the vendor information was completed under Engineering Change 23555 (Reference 38) in accordance with procedure FP-E-MOD-02 (Reference 41). |
| 2 | Test Strategy | Per requirements in References 1, 2, & 3 | References 4, 6-12, 23, and 28 | | N/A | The equipment testing performed for the SFP instrument has been found to be acceptable based on the current design requirements. |
| 3 | Environmental Qualification for Electronics Enclosure with Display | 65 - 120 degrees Fahrenheit (References 1,2, 33, and 34) | Reference 4 | | 14 - 131°F | The electronics enclosures are installed within the Control Room. Per Engineering Evaluation EVAL-XCELPI12-02 (Reference 33) and Environmental Qualification H8-H, Rev.7 (Reference 34), the minimum and maximum design temperatures under accident conditions are conservatively 65°F and 120°F respectively. The SFPI vendor, MOHR, has successfully tested its system electronics to a nominal temperature range of 14°F to 131°F. The electronics enclosures are capable of continuously performing its required function under the expected temperature conditions. Results of the vendor testing are available in proprietary MOHR report 1-0410-1 (Reference 4), MOHR EFP-IL SFPI System Temperature and Humidity Report. |
| | | 50% Relative Humidty (RH) (Reference 34) | Reference 4 | | 5% - 95% RH | The electronics enclosures are installed within the Control Room. Per Environmental Qualification H8-H, Rev. 7 (Reference 34), section 2.11, the RH for the Control Room during Normal and Post Accident is 50%. The SFPI vendor, MOHR, has successfully tested its system electronics to a nominal RH range of 5%-95%. The electronics enclosures are capable of continuously performing its required function under the expected humidity conditions. Results of the vendor testing are available in MOHR report 1-0410-1 (Reference 4), MOHR EFP-IL SFPI System Temperature and Humidity Report. |
| | | No radiation effects | | | N/A | The Prairie Island Control Room is considered a mild environment with no expected radiation. |
| 4 | Environmental Testing for Level Sensor components in SFP area - Submerged Portion of Probe Body | 65 - 212°F (References 1, 2 & 34) | Reference 5 | The Total Integrated Dose (TID) is the total 40 year dose plus the seven day worst case accident dose at the lowest spacer location on the probe body | 480°F long-term for poly-ether-ether-ketone (PEEK) insulators | The NRC Audit Report for MOHR (Reference 29) concludes that the SFP-1 probe is suitable for operation in the SFP environmental. |
| | | Submerged component (References 1 & 2) | Reference 5 | | PEEK insulators capable of long term submergence | The SFP is expected to remain at or above the minimum ambient temperature of the Auxiliary Building (65°F) as called out in the Environmental Qualification H8-H, Rev.7 (Reference 34) section 2.5. An accident condition assumes that the SFP is in a boiling condition, thus the boiling temperature of water at atmospheric pressure (212°F) is indicated. The limiting critical components of the probes are the PEEK spacers. Based on this evaluation the PEEK spacers are acceptable for the application. |
| | | $1.04 \times 10^9$ rads TID (References 1, 2 & 30) | Reference 5 | | PEEK: $1 \times 10^{10}$ rads | The NRC Audit Report for MOHR (Reference 29) concludes that the SFP-1 probe is suitable for operation in the SFP environmental.<br><br>Calculation 178599.51.2011 (Reference 30) defines a worst-case dose rate of approximately $1.04 \times 10^9$ rads to the probe via the applicable requirements of References 1 and 2. The PEEK spacers are qualified to $1 \times 10^{10}$ rads. As such, the PEEK spacers are expected to be suitable for the application. |

| # | Topic | Parameter Summary | Vendor Reference Document # | Additional Comments | Test or Analysis Results | Licensee Evaluation |
|---|---|---|---|---|---|---|
| 5 | Environmental Testing for Level Sensor Electronics Housing- Probe Head located Above the SFP | Design Temperature: 65-105°F (References 34)<br><br>Maximum accident condition temperature: 212°F (References 1, and 2) | Reference 5 | Rad TID is the total 40 year dose plus the seven day worst-case accident dose at the location of the probe head | PEEK: 480°F long-term,<br><br>EPDM: 194°F long-term, 500 days @ 232°F, 12 days @ 311°F | The NRC Audit Report for MOHR (Reference 29) concludes that the SFP-1 probe is suitable for operation in the SFP environmental.<br><br>The SFP is expected to remain at or above the minimum ambient temperature of the Auxiliary Building (65°F) as called out in the Environmental Qualification H8-H, Rev.7 (Reference 34) section 2.5. Maximum accident condition temperature and humidity directly above the SFP will likely be in a condensing steam environment which conservatively will be no greater than 212°F, the temperature of boiling water at atmospheric pressure. The SFP cooling will be restored or makeup water will be continued to be provided to the SFP during phase 3 of an event per Prairie Island's Overall Integrated Plan (Reference 42). The temperature is not expected to be greater than 194°F for more than 500 days after the event. Based on the vendor analysis results the sensitive materials in the probe head will not be challenged under the expected conditions of Reference 1, 2 & 34 and are acceptable.<br><br>For coaxial transmission cable beyond the probe head, MOHR uses class 1E Nuclear Safety Related RSCC Wire & Cable RSS-6-110A/LE which meets the requirements of Institute of Electrical and Electronics Engineers (IEEE) 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations" and is acceptable per NRC audit of MOHR regarding implementation of reliable Spent Fuel Pool Instrumentation related to Order EA-12-051 (Reference 29). |
| | | 0% - 100% RH Condensing (References 1, and 2) | Reference 5 | | 0% - 100% RH for PEEK, and EPDM | The NRC Audit Report for MOHR (Reference 29) concludes that the SFP-1 probe is suitable for operation in the SFP environmental.<br><br>100% non-condensing RH is a conservative humidity range for normal operating conditions. Based on the vendor analysis results, the sensitive materials in the probe head will not be challenged under the expected conditions of References 1 & 2 and are acceptable. |
| | | $1.04 \times 10^9$ rads TID (Reference 30) | Reference 5 | | PEEK: $1 \times 10^{10}$ rads<br>EPDM: $2 \times 10^9$ rads | The NRC Audit Report for MOHR (Reference 29) concludes that the SFP-1 probe is suitable for operation in the SFP environmental.<br><br>Calculation 178599.51.2011 (Reference 30) defines a worst-case dose rate of approximately $1.04 \times 10^9$ rads to the probe via the applicable requirements of References 1 and 2. Based on the vendor analysis results, the sensitive materials in the probe head will not be challenged under the required conditions of References 1, 2 and 30; and are acceptable. |
| 6 | Thermal & Radiation Aging - Organic Components in SFP area | See Topics 4 & 5 above | Reference 5 | | See Topics 4 and 5 above | Vendor test analysis bounds licensee parameters, see discussion in Topics 4 and 5 above. |
| 7 | Basis for Dose Requirement | References 1 & 2 | N/A | | | Calculation Procedure FP-E-CAL-01 (Reference 19) was used to develope calculation Calculation 178599.51.2011 (Reference 30) based on the requirements of NEI 12-02 (Reference 2) and EA-12-051 (Reference 1). The calculation determines the dose rates for key instrument locations and SFP water levels for both a seven day accident scenario and 40 year TID. |

| # | Topic | Parameter Summary | Vendor Reference Document # | Additional Comments | Test or Analysis Results | Licensee Evaluation |
|---|---|---|---|---|---|---|
| 8 | Seismic Qualification | Seismic Class I (References 1, 2, 3, 18, and 40) | References 8, and 11 | | Seismic Class I | Acceptable, MOHR has prepared a series of generic seismic qualification reports (References 8 and 11) for the SFP level instrument which bound Prairie Island's seismic criteria documented in USAR section 12 (Reference 18) and calculation 00Q4159-C-001 (Reference 40). The qualification reports (References 8 and 11) envelop all components of the new SFP level instrumentation required to be operational following a BDBEE and post-event.<br><br>Calculation S-12385-080-01 (Reference 31) accounts for seismic loads and shows that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified.<br><br>Calculation S-12385-080-2 (Reference 39) shows that the mounting of the electronics enclosures installed inside the Control Room are structrually adequate and seismically qualified. |
| 9 | Sloshing | Water induced motion from seismic event does not cause equipment structural failure | References 8, 11, 26, and 27 | See Topic 8 | | Acceptable, MOHR generic seismic qualification reports (References 8 and 11) in combination with NAI reports NAI-1725-003 and NAI-1725-004 (References 26 and 27) adequately bound the hydrodynamic loads associated with sloshing for Prairie Island.<br><br>Calculation S-12385-080-01 (Reference 31) accounts for sloshing and shows that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified. |
| 10 | SFP Instrumentation System Functionality Test Procedure | System must allow for routine, in situ functionality testing (References 1 and 2) | References 14, 15, and 16 | | | The system features on board electrical diagnostics. SFPI channel/equipment maintenance/preventative maintenance and testing program requirements to ensure design and system readiness will be established in accordance with Xcel Energy's processes and procedures and in consideration of vendor recommendations to ensure that appropriate of vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance are performed (and available for inspection and audit). The instrument has in-situ testing/calibration. |
| 11 | Boron Build-Up | Buildup cannot produce error greater than 1 foot including all other error source terms (References 1 and 2) | Reference 10 | | Boron buildup can produce a maximum error of 2.5 inches | Acceptable, MOHR report 1-0410-8 (Reference 10) concludes that the presence of borated water and/or boric acid deposits will not significantly impair the ability of the MOHR EFP-IL SFPI system to accurately measure water level in the SFP environment. A quarterly surveillance for measurement error related to boric acid precipitation will be performed and routine boric acid deposit mitigation will be executed when significant error is detected. The threshold for mitigation efforts is $\geq$ 3 inches (instrumentation system absolute maximum accuracy - see Topic 16) |
| 12 | Pool-side Bracket Seismic Analysis | Seismic Class I (References 1, 2, 18, and 40) | References 11 & 12 | See Topic 8 | Seismic Class I | Calculation S-12385-080-01 (Reference 31) accounts for seismic loads and shows that the SFPI Probe Mounting Bracket is structurally adequate and seismically qualified. |
| 13 | Additional Brackets (Sensor Electronics and Electronics Enclosure) | Seismic Class I (References 1, 2, 18 and 40) | Reference 8 | SeeTopic 8 | Seismic Class I | Calculation S-12385-080-2 (Reference 39) accounts for seismic loads and shows that the mounting of the electronics enclosures installed inside the Control Room are structrually adequate and seismically qualified. |

| # | Topic | Parameter Summary | Vendor Reference Document # | Additional Comments | Test or Analysis Results | Licensee Evaluation |
|---|---|---|---|---|---|---|
| 14 | Shock & Vibration | (References 1, 2, and 3)<br><br>MIL-STD-167-1 (Reference 20) for vibration and MIL-STD-9010 (Reference 21) for shock | References 7, and 28 | | IEC 60068-2-27 (2008-02) (Reference 24)<br><br>IEC 60068-2-6 (2007-12) (Reference 25) | Acceptable, the NRC Audit Report for MOHR (Reference 29) concludes that the shock and vibration test results were satisfactory. The report also acknowledges that the testing performed in MOHR report 1-0410-16 (Reference 28) is sufficient to close the open item identified during the MOHR audit.<br><br>MOHR report 1-0410-5 (Reference 7) adequately addresses the requirements for general robustness of the enclosures. The probes and repairable heads were evaluated to be adequately designed for resilience against shock and vibration expected in the area of use.<br><br>The new probe mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. The probes are affixed to the bracket using a screw connection designed with proper thread engagement and lock washers.<br><br>The indicator and battery enclosures are mounted in the Control Room. The equipment is not affixed or adjacent to any rotating machinery that would cause vibration effects in the area of installation. The new instrument mounting components and fasteners are seismically qualified and designed as rigid components inherently resistant to vibration effects. Similarly, the effects of shock on the supporting fixtures for the Control Room instruments is not a concern. The equipment adjacent to the display and battery box has been installed to resist seismic loading, which prevents impact from the adjacent objects during the design basis earthquake requirements imposed by NEI 12-02. |
| 14 | Requirement Tracebility Matrix | Software Traceability Matrix Required for Software Evaluation of Equipment | References 13 and 35 | | | The instrument software Verification and Validation has been performed by MOHR by Revision 2 of MOHR report 1-0410-11 (Reference 13). |
| 15 | Factory Acceptance Testing | Must demonstrate functionality of full EFP-IL and SFP-1 | MOHR Factory Acceptance Test Procedure | | References 36 and 37 | Acceptable, channel factory acceptance tests have been completed successfully |
| 16 | Channel Accuracy | ± 1 foot (Reference 2) | References 10, 14, and 17 | | 3 inches maximum | Acceptable, the system possesses an absolute maximum accuracy of +/- 3.0 inches, below the 12 inches required by NEI 12-02 (Reference 2). Per vendor's recommendation documented in MOHR 1-0410-15 (Reference 17) and 1-0410-8 (Reference 10), a quarterly surveillance for measurement error related to boric acid precipitation will be performed and routine boric acid deposit mitigation will be executed when significant error (≥ 3 inches) is detected to ensure the channel accuracy of 3 inches maximum is maintained. |
| 17 | Power Consumption | 120 VAC, 60 Hertz (Reference 18) | References 9 & 12 | | 85 - 264 VAC<br>47 - 63 Hertz | Acceptable, the NRC Audit Report for MOHR (Reference 29) concludes that no deficits were identified with respect to function reliability, accuracy, or calibration as a result of power interruption.<br><br>The power requirements for the instrument are met by the power supply that will provide normal AC power to the units.<br><br>MOHR report 1-0410-10 (Reference 12) concludes that the accuracy is not affected by an interruption in power. |
| | | Seven day battery life required | Reference 9 | | Seven day battery life at 15 samples per hour rate | Acceptable, the NRC Audit Report for MOHR (Reference 29) concludes that battery life capability is satisfactory.<br><br>The instrument testing demonstrates the battery capacity is sufficient for the maximum duration required by References 1 and 2. |
| 18 | Technical Manual | N/A | References 15 and 16 | | | Acceptable, the technical manuals have been provided by the vendor, MOHR, in References 15 and 16. |

| # | Topic | Parameter Summary | Vendor Reference Document # | Additional Comments | Test or Analysis Results | Licensee Evaluation |
|---|---|---|---|---|---|---|
| 19 | Calibration | Must allow for in-situ calibration | References 14, 15, and 16 | System is calibrated using CT-100 device and processing of scan files by vendor. Dry scan from original installation must be maintained. | | Acceptable, the manuals have been provided by the vendor, MOHR, in References 14, 15, and 16. Previous Topic #10 already discusses maintenance/preventative maintenance requirements being established in consideration of vendor recommendations.<br><br>The instrumentation has capability to be calibrated in-situ. |
| 20 | Failure Modes and Effects Analysis (FMEA) | System provides reliable indication of fuel pool level, consistent with this requirement of References 1 & 2. | Reference 32 | | SFP instrument system will meet requirements of References 1 & 2 | Acceptable, the FMEA provided adequately addresses failure modes and effects for the full instrument channel with credit taken for the use of two redundant channels provided the installation meets all requirements stipulated in References 1 and 2. |
| 21 | Emissions Testing | Electric Power Research Institute (EPRI) TR-102323, Revision 3 (Reference 22) | References 6 and 23 | | EPRI TR-102323, Revision 3 (Reference 22) | Acceptable, MOHR reports 1-0410-4 (Reference 6) and 1-0410-4-S1 (Reference 23) demonstrate the new SFPI satisfies the EMI/RFI compliance guidlines of Revision 3 of EPRI TR-102323 (Reference 22). It addresses the applicable testing for Non Safety equipment. (Reference 6)<br><br>Electro Static Discharge (IEC 61000-4-2:2008), Electrical Fast Transient (IEC 61000-4-4:2004) and Surge (IEC 61000-4-5:2005) immunity, which are optional tests for non-safety equipment per Rev 3 of EPRI TR-102323, are addressed by similitude with the MOHR CT-100. The MOHR CT100 electronic hardware has been incorporated as the level measurement system in the EFP-IL SFP instrument system without modification, and the MOHR EFP-IL includes a metal enclosure compared to the plastic enclosure of the CT-100 which provides superior shielding properties.<br><br>The CT-100 TDR demonstrates no anomalies from 80-1000 MegaHertz and from 1400-2700 MegaHertz at test levels 3 Volts/meter. Radiated immunity testing was performed in accordance with IEC 61000-4-3:2008. This provides reasonable assurance that radiofrequency interference from radio handsets or other commonly encountered commercial or industrial sources of interference will not impact system performance (Reference 23).<br><br>The electronics enclosures are installed in a radio restriction area inside the Control Room. Hence, the aforementioned equipment is not expected to be affected by radio usage within close proximity of the electronics enclosures. |

References:

1) ADAMS Accession No. ML12056A044, NRC Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," Nuclear Regulatory Commission, March 12, 2012
2) ADAMS Accession No. ML12240A307, NEI 12-02 (Revision 1), "Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" August, 2012
3) ADAMS Accession No. ML12221A339, Revision 0, JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, August 29, 2012, Nuclear Regulatory Commission Japan Lessons - Learned Project Directorate
4) 1-0410-1 "MOHR EFP-IL SFPI System Temperature and Humidity Test Report"
5) 1-0410-2 "MOHR SFP-1 Level Probe Assembly Materials Qualification Report"
6) 1-0410-4 "MOHR EFP-IL SFPI System EMC Test Report"
7) 1-0410-5 "MOHR EFP-IL SFPI System Shock and Vibration Test Report"
8) 1-0410-6 "MOHR EFP-IL SFPI System Seismic Test Report"
9) 1-0410-7 "MOHR EFP-IL SFPI System Battery Life Report"
10) 1-0410-8 "MOHR EFP-IL SFPI System Boric Acid Deposition Report"
11) 1-0410-9 "MOHR SFP-1 Level Probe Assembly Seismic Analysis Report"
12) 1-0410-10 "MOHR EFP-IL SFPI System Power Interruption Report"
13) 1-0410-11 "MOHR EFP-IL SFPI System Software Verification and Validation"
14) 1-0410-12 "MOHR EFP-IL Signal Processor Operator Manual"
15) 1-0410-13 "MOHR EFP-IL Signal Processor Technical Manual"

16) 1-0410-14 "MOHR SFP-1 Level Probe Assembly Technical Manual"
17) 1-0410-15 "MOHR EFP-IL SFPI System Uncertainty Analysis"
18) USAR, Rev 34P, "Prairie Island Updated Safety Analysis Report"
19) FP-E-CAL-01, Rev. 12, "Calculations"
20) MIL-STD-167-1 "Mechanical Vibrations of Shipboard Equipment (Type 1- Environmentally and Type II- Internally Excited)
21) MIL-S-901D "Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems"
22) EPRI TR-102323 "Guidelines for Electromagnetic Interference ofPower Plant Equipment" Rev. 3"
23) 1-0410-4-SI "MOHR EFP-IL SFPI Supplemental EMC Information"
24) IEC 60068-2-27 (2008-02) Environmental Testing - Part 2-27: Tests-Test Ea and Guidance: Shock"
25) IEC 60068-2-6 (2007-12) Environmental Testing – Part 2-6: Tests-Test Fc: Vibration (sinusoidal)"
26) NAI-1725-003 Rev 0 "GOTHIC Verification and Sensitivity Studies for Predicting Hydrodynamic Response to Acceleration in Rectangular Shaped Pools"
27) NAI-1725-004, Rev 3 "Seismic Induced Hydraulic Response in the CGS Spent Fuel Pool"
28) 1-0410-16, "MOHR SFP-1 Level Probe Assembly Shock and Vibration Test Report"
29) Donald C. Cook Nuclear Plant, Units 1 and 2 - Report for the Onsite Audit of MOHR Regarding Implementation of Reliable Spent Fuel Pool Instrumentation Related to Order EA-12-051 (TAC NOS. MF0761 and MF0762) dated August 27, 2014
30) Calculation 178599.51.2011, Prairie Island - Dose at SFP Level Instrument
31) Calculation S-12385-080-01, Evaluation of the Mounting Brackets for the Spent Fuel Pool Level Probe Assembly
32) EVAL-194-4812-01, "MOHR EFP-IL Liquid Level Measurement System Failure Modes and Effects Analysis (FMEA)"
33) Engineering Evaluation EVAL-XCELPI12-02, "Main Control Room, Cable Spreading Room and Computer Room PRA Room Heat-up Evaluation with Loss of HVAC,"
34) H8-H, Rev. 7, "PINGP Environmental Specification"
35) 1-0451-4, MOHR EFP-IL SFPI System Software Traceability Matrix
36) EFP-IL00047, Factory Acceptance Test Liquid Level Sensing System, for Prairie Island
37) EFP-IL00048, Factory Acceptance Test Liquid Level Sensing System, for Prairie Island
38) EC 23555, "Fukushima Response Spent Fuel Pool Instrumentation"
39) Calculation S-12385-080-2, "Seismic Qualification of MOHR EFP-IL Electronics Enclosure and Battery Box"
40) Calculation 00Q4159-C-001, "Prairie Island Nuclear Generating Plant Floor Response Spectra"
41) FP-E-MOD-02, Rev. 16, "Engineering Change Control"
42) Prairie Island Nuclear Generating Plant's Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)