Keith J. Polson
Site Vice President

DTE Energy Company
6400 N. Dixie Highway, Newport, MI 48166
Tel: 734.586.6515 Fax: 734.586.4172
Email: polsonk@dteenergy.com

DTE Energy

10 CFR 2.202

January 20, 2016
NRC-16-0004

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) 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)

3) NRC letter, "Fermi 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 No. MF0771)," dated November 21, 2013 (ADAMS Accession No. ML13309B129)

Subject: Fermi 2 Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) and Response to Request for Additional Information

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued an order (Reference 2) to DTE Electric Company (DTE). Reference 2 was immediately effective and directed DTE to install reliable spent fuel pool (SFP) level instrumentation. Specific requirements for reliable SFP level instrumentation at operating reactor sites were provided in Attachment 2 of Reference 2. Enclosure 1 of this letter provides a summary of DTE's compliance with the requirements in Attachment 2 of Reference 2.

Enclosure 2 of this letter provides DTE's response to the NRC staff request for additional information provided in Reference 3. The response in Enclosure 2 includes information previously provided to the NRC staff as part of the SFP level instrumentation audit process, with updated information consistent with implementation of NRC Order EA-12-051 at Fermi 2. Enclosure 3 provides a comparison of vendor testing assumptions and site requirements, commonly referred to as a "Design Bridge" document.

This letter, along with the enclosures, provides the notification required by section IV.C.3 of the Order that full compliance has been achieved for Fermi 2.

This letter contains no new regulatory commitments.

Should you have any questions or require additional information, please contact Mr. Kevin Burke, Manager, Industry Interface at (734) 586-5148.

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

Executed on January 20, 2016

Keith J. Polson
Site Vice President

Enclosures:
1. Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation
2. Response to Interim Staff Evaluation Request for Additional Information
3. Design Bridge Document

cc: Director, Office of Nuclear Reactor Regulation
NRC Project Manager
NRC Resident Office
Reactor Projects Chief, Branch 5, Region III
Regional Administrator, Region III
Michigan Public Service Commission
Regulated Energy Division (kindschl@michigan.gov)

Enclosure 1 to
NRC-16-0004

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation

Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation

1 Background

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Reference 6.1), to DTE Electric Company (DTE). This Order was effective immediately and directed Fermi 2 to install reliable spent fuel pool (SFP) level instrumentation as outlined in Attachment 2 of the Order. The information provided herein documents full compliance for Fermi 2 in response to the Order.

2 Compliance

Fermi 2 has installed two independent full scale level monitors on the SFP in response to Reference 6.1. Fermi 2 is a single unit with one spent fuel pool.

DTE submitted the Fermi 2 Overall Integrated Plan (OIP) by letter dated February 28, 2013 (Reference 6.2). By letter dated November 21, 2013 (Reference 6.3), the NRC provided its interim staff evaluation and requested additional information necessary for completion of the review. The additional information requested by NRC is included in Enclosure 2 of this letter. Enclosure 3 of this letter provides a comparison of vendor testing assumptions and site requirements, commonly referred to as a “Design Bridge” document.

3 Actions Completed

Identification of Levels of Required Monitoring – Complete
Fermi 2 has identified the three required levels for monitoring SFP level in compliance with Order EA-12-051. The instrument range of the installed SFP level monitors encompasses these three required levels.

Instrument Design Features – Complete
The design of the instruments installed at Fermi 2 complies with the requirements specified in the Order and described in NEI 12-02, Revision 1, “Industry Guidance for Compliance with NRC Order EA-12-051.” (Reference 6.4) The instruments have been installed in accordance with the station design control process.

The instruments have been arranged to provide reasonable protection against missiles. The instruments have been mounted to retain design configuration during and following the maximum expected ground motion. The instruments will be reliable during expected environmental and radiological conditions when the SFP is at saturation for extended periods. The instruments are independent of each other and have separate and diverse power supplies. The instruments will maintain their design accuracy following a power interruption and are designed to allow for routine testing and calibration.

The instrument display is readily accessible during postulated events and allows for SFP level information to be promptly available to decision makers.

Program Features – Complete
SFP level instrumentation training has been completed in accordance with an accepted training process as recommended in NEI 12-02, Section 4.1 (Reference 6.4).

Operating and maintenance procedures for the Fermi 2 SFP level instrumentation have been developed and integrated with existing procedures. Procedures have been verified and are available for use in accordance with the site procedure control program.

Site processes have been established to ensure the instruments are maintained at their design accuracy.

4 Milestone Schedule – Items Complete

Milestone	Status
Submit 60 Day Status Report	Complete
Submit Overall Integrated Plan	Complete
Submit Response to Request for Additional Information (RAI)	Complete
Submit 6 Month Updates:	
Update 1	Complete
Update 2	Complete
Update 3	Complete
Update 4	Complete
Update 5	Complete
Modifications:	
Design Engineering	Complete
Implementation	Complete
Procedures:	
Create Procedures	Complete
Training:	
Develop Training Plan	Complete
Training Complete	Complete
SFP level instrumentation Implementation	Complete
Submit Completion Report	This document

5 Compliance Elements Summary

A summary of DTE compliance with Reference 6.1 is provided as follows:

Order Requirement
In accordance with NRC Order EA-12-051, Fermi 2 shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel:

(1) level that is adequate to support operation of the normal fuel pool cooling system,
(2) level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck, and
(3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

Fermi 2 Compliance
Fermi 2 has identified the three required levels for monitoring SFP level in compliance with Order EA-12-051. The instrument range of the installed SFP level monitors encompasses these three required levels.

Order Requirement
1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.

Fermi 2 Compliance
The SFP level instrumentation consists of a primary and backup channel, both of which are permanent, fixed instrument channels.

Order Requirement
1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.

Fermi 2 Compliance
The SFP level instrumentation is provided with reasonable protection from missiles that may result from damage to the structure over the SFP. The primary level instrument is located in the northeast corner of the SFP and the backup level instrument is in the northwest corner of the

SFP. Cable routing in the SFP area for the two instruments is run separately in dedicated steel conduits.

Order Requirement

1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

Fermi 2 Compliance

The mounting of the primary and backup instruments was designed using Fermi 2 criteria for seismic category I components and has been seismically qualified to withstand the maximum seismic ground motion considered in the design of the SFP structure.

Order Requirement

1.4 Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

Fermi 2 Compliance

The SFP level instrumentation is designed to provide reliable operation at temperature, humidity and radiation levels consistent with beyond design basis conditions using the NRC-endorsed guidance of NEI 12-02, Revision 1, and is subject to the DTE augmented quality process.

Order Requirement

1.5 Independence: The primary instrument channel shall be independent of the backup instrument channel.

Fermi 2 Compliance

Each SFP level instrumentation channel is independent of the other, consisting of separate sensor probes and electronics packages.

Order Requirement

1.6 Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication function until offsite resource availability is reasonably assured.

Fermi 2 Compliance

The SFP level instrumentation primary and backup channels are permanently installed and powered from separate power supplies. Each channel is powered from a separate 120 Volt (V) Alternating Current (AC) power source. Each channel has replaceable battery backup in the event of a loss of normal power. The SFP level instrument system provides at least seven days of battery life assuming typical use and accounting for postulated post-event environmental conditions.

Order Requirement

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

Fermi 2 Compliance

The SFP level instrumentation channels maintain their accuracy following the transition from normal AC power to the battery backup, as demonstrated by power interruption testing.

Order Requirement

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

Fermi 2 Compliance

The SFP level instrumentation design supports routine testing and calibration and permits in-situ testing.

Order Requirement

1.9 Display: Trained personnel shall be able to monitor the spent fuel pool water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of spent fuel pool water level.

Fermi 2 Compliance

The primary instrument channel remote display is located in the Main Control Room and the backup instrument channel remote display is located on the Reactor Building second floor near the FLEX SFP refill station. The SFP level instrumentation is designed to provide continuous indication when powered by normal power and on-demand indication when powered by backup battery power.

Order Requirement

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

Fermi 2 Compliance

Fermi 2 personnel participated in training provided by the SFP level instrumentation vendor. Training for the operations, maintenance, and technical staff was provided by applying the systematic approach to training.

Order Requirement

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

Fermi 2 Compliance

Procedures are in place for testing, calibration, and use of the SFP level instrumentation. These procedures are maintained under the Fermi 2 procedure processes.

Order Requirement

2.3 Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy.

Fermi 2 Compliance

The SFP level instrumentation primary and backup channels are subject to Fermi 2 preventive maintenance processes for scheduling and implementing the testing and calibration activities to maintain the channels at their design accuracy.

6 References

6.1 NRC Order Number 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)

6.2 DTE Electric Company letter, NRC-13-0006, “DTE Electric Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051),” dated February 28, 2013 (ADAMS Accession No. ML13063A285)

6.3 NRC letter, “Fermi 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 No. MF0771),” dated November 21, 2013(ADAMS Accession No. ML13309B129)

6.4 Nuclear Energy Institute, NEI 12-02, Revision 1, “Industry Guidance for Compliance with NRC Order EA-12-051,” Revision 1, dated August 2012 (ADAMS Accession No. ML12240A307)

Enclosure 2 to
NRC-16-0004

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

Response to Interim Staff Evaluation Request for Additional Information

Response to Interim Staff Evaluation Request for Additional Information

Reference 6.3 of Enclosure 1 included a request for additional information (RAI). As part of the audit process, the information provided in this enclosure was provided to the U.S. Nuclear Regulatory Commission (NRC) via an Electronic Reading Room to provide NRC staff with an opportunity to review the responses and discuss information with DTE Electric Company (DTE). The final versions of these responses are provided here to docket this information.

RAI #1
Please provide the information regarding the projected dose rate impact and the appropriate Level 2 value as a result of other material stored in the spent fuel pool (SFP). Please include the results of the calculation to be performed to assess the habitability and equipment qualification as part of the design of the SFP Level Instrumentation system.

Response
Design calculation (DC) (DC-6543) was developed to determine the dose rates associated with varying spent fuel pool levels, considering both the spent fuel and other equipment in the pool. The design calculation determined a bounding total integrated dose (TID) for the SFP probe over a 40 year remaining plant life and a 6 hour drop in SFP level to the top of the fuel racks. This is consistent with Nuclear Energy Institute (NEI) 12-02, Revision 1, to consider the impact of diverse and flexible coping strategies (FLEX) mitigating strategies for equipment qualification.

Based on the calculation, Level 2 was selected as 18 feet above the top of the spent fuel racks (elevation 679’-1/8”). This water level corresponds to a dose rate to personnel on the refueling floor of 10 millirem per hour (mr/hr). This allows personnel to be present on the refueling floor without significant dose consequences. The normal spent fuel pool level (Level 1) is elevation 683’- 6”. The Level 2 elevation allows more than four feet of margin between normal pool level and a level where personnel dose considerations become a significant concern.

The TID for the SFP probe predicted by DC-6543 is bounded by the vendor’s Equipment Qualification.

DC-6543 Vol. I, Revision 0, Section 2.1.1, concluded that the SFP probe TID would be 1.325 x 10^6 Rad, which is below the probe’s acceptable TID of 2 x 10^9 Rad.

RAI #2
Please provide the results of 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.

Response
Seismic tests were performed on three different components of SFP level instrumentation system: 1) an SFP probe, 2) an SFP signal processor with battery pack, and 3) an SFP level indicator. Each of these components is installed in one primary unit and one back-up unit.

SFP Probe
The SFP Probe was qualified by analysis to the requirements of Institute of Electrical and Electronics Engineers (IEEE) standard IEEE-344-2004, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*. The original generic analysis applied a 3-D acceleration time history excitation, based on a composite response spectrum (5.384g Peak horizontal acceleration) from a number of other nuclear plants. SFP hydrodynamics were modeled in ANSYS, including sloshing effects. To account for potential inventory loss, the analysis considered water levels 18" below and 48" below flange. Hydrodynamic loads were verified by a separate analysis to be acceptable. The peak stresses calculated in the report were 27 kilopound per square inch (ksi) in the flange, and 37 ksi in the probe body. These stresses are both below the yield stress of the SFP probe tube metal and are acceptable.

A site specific analysis was performed for Fermi 2, using the mounting configuration of the probe used at Fermi, a response spectra based on Fermi Design Basis Earthquakes, and Fermi SFP parameters (3.2g peak horizontal acceleration). The analysis applied a 3-D acceleration time history excitation derived to meet twice the applicable Fermi Operating Basis Earthquake Required Response Spectra (RRS), which bounds the Fermi Safe Shutdown Earthquake (SSE) RRS. As was done in the original qualification, hydrodynamic loads developed in ANSYS were verified by a separate analysis of the Fermi SFP using site specific RRS and SFP geometry. Peak deflections and velocity of the SFP probe were found to be much smaller (0.5" to 0.7" deflection, 1.4 feet per second (ft/s) to 1.3 ft/s velocity) than those in the generic analysis, and were small enough that it is not expected that the probe will impact the liner of the SFP, as was found in the generic analysis. The stresses calculated in the site specific analysis were much smaller than those calculated in the original generic analysis. The maximum stress in the probe body was calculated to be 7.3 ksi, and the maximum calculated stress in the probe flange was 5.1 ksi, both well below the yield stress of these components. Based on these reports, the SFP probe is capable of withstanding seismic events beyond Fermi Design Basis Earthquakes while maintaining its structural integrity.

SFP Signal Processor and Battery Pack

Report 1-0410-6 contains the results of seismic qualification tests of the SFP signal processor and battery pack. As discussed in Appendix A of the report, qualification tests demonstrate the equipment is qualified to the Fermi seismic response spectra with considerable margin.

Two series of seismic qualification tests were performed. The first series were standard IEEE-344-2004 seismic qualification tests. The two instruments were subjected to five consecutive Operating Basis Earthquakes (OBEs) followed by an SSE. Peak horizontal OBE and SSE acceleration values during the tests were 5.77g and 5.94g, respectively. Instrument performance was monitored during the tests and thoroughly checked at the conclusion of tests. No deficiencies in instrument performance or the condition of instrument mounting hardware were identified.

The second test series were fragility tests. The purpose of these tests, which are not required by IEEE-344, was to determine the limits of the instruments and establish their design margin. Once again, the same two instruments were subjected to five consecutive OBEs followed by one SSE. Peak horizontal OBE and SSE acceleration values during the tests were 9.9g and 14.0g, respectively. Instrument performance was monitored during the tests and thoroughly checked at the conclusion of the tests. Despite being tested to table limits, no deficiencies in instrument performance or the condition of instrument mounting hardware were identified.

The above series of tests demonstrated that the SFP signal processor and battery pack are seismically rugged to seismic loading beyond that of the Fermi design basis earthquakes.

SFP Level Indicator

The OTEK LBD-N23 Series Digital Panel Meter (SFP Level Indicator) was seismically tested by application of random multi-frequency vibrations at a level, which enveloped the Fermi 2 OBE/SSE Horizontal and Vertical Response Spectra provided. Testing met the requirements of IEEE-344-2004, the applicable requirements of NEI 12-02, Revision 1, and Fermi specification 3071-296 “Seismic Qualification of Equipment.” The RRS provided was a composite of the worst case horizontal & vertical floor response spectra for OBE and SSE for the installed equipment, which were increased by a 10% margin, and then amplified by 1.5% to account for in panel amplification. The Test Response Spectra (TRS) for OBE and SSE far exceeded the RRS, by more than 10g at most frequencies. The indicator and its mounting hardware remained functional following testing.

RAI #3
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.

Response
Three components of SFP water level monitoring instrument system are attached directly or indirectly to plant structures: 1) an SFP probe, 2) an SFP signal processor with battery pack, and 3) an SFP level indicator. Each of these components is installed in one primary unit and one back-up unit.

All three components are mounted in a manner consistent with the manner they were mounted during seismic qualification by testing or analysis with the exception of the backup SFP indicator (see below).

SFP Probe Bracket
The mounting of the SFP Probe was evaluated and found to be acceptable in DC-6557 Vol I. The mounting components were analyzed using equivalent static analysis and Allowable Stress Design (ASD) methodology from *AISC Manual of Steel Construction*, 7th edition. Seismic and hydrodynamic loads are obtained from the MOHR analyses for the SFP Probe and applied to the components of the bracket and its anchorage. The minimum design margin of the bracket, other associated steel members, and anchorage (calculated stresses compared to allowable stresses) is 65.3%. The brackets and anchorage have sufficient capacity to withstand Fermi Design Basis Earthquakes while maintaining their structural integrity.

Loads imposed by the bracket on the north wall of the pool are relatively minor. The north wall of the pool was designed to support 79,000 pounds (lbs) of miscellaneous dead loads. Collectively, the two probes with brackets weigh 192 lbs. Including probes and brackets, actual miscellaneous dead loads on the pool's north wall are bounded by the design loads considered in the original analysis.

SFP Signal Processors with Battery Packs
SFP signal processors with battery packs have been mounted on new instrument racks located on the third floor of the Reactor Building (RB) and fourth floor of the Auxiliary Building (AB). The new racks and anchor bolts were analyzed with SFP instruments in place and found capable of withstanding loads due to self and instrument weight and seismic forces. ASD methodology was used in conjunction with, as applicable, the 7th Edition of the *AISC Manual of Steel Construction* and 1968 Edition of the *AISI Cold-Formed Steel Design Manual*. Considering all load combinations, the installed rack's design margin is 84%, and anchorage for the rack has a design margin of 50.8%. Considering the peak SSE acceleration for the worst floor response spectra, as well as a 1.5 multimode factor, the worst anticipated seismic acceleration experienced by the signal processor and battery pack would be 5.55g horizontally. This is well below the fragility test accelerations of over 50g, during which the equipment remained functional.

The net weight of the rack with instruments is 621 lbs. The ability of plant floors to support this additional weight during a seismic event was evaluated at each of the two locations where new racks have been installed. On the third floor of the RB, the design margin was 41% and, on the fourth floor of the AB, it was 23%. Ultimate Strength Design (USD) methodology and the 1971 Edition of American Concrete Institute (ACI) Building Code 318, *Building Code Requirements for Reinforced Concrete*, were used to evaluate the two floors.

SFP Level Indicator

The primary level indicator is mounted as it was tested in its seismic qualification report. It is mounted on the door of Panel H11P601 in the Main Control Room (MCR). As discussed in RAI #2, the RRS provided for testing was a composite of the worst case horizontal and vertical floor response spectra for OBE and SSE for the installed equipment, which were increased by a 10% margin, and then amplified by 1.5 to account for in panel amplification. TRS for OBE and SSE far exceeded the RRS, by more than 10g at most frequencies. The indicator and its mounting hardware remained functional following testing. Therefore, the mounting for the indicator is capable of maintaining its structural integrity following Fermi Design Basis Earthquakes. The impact of the indicator on the panel is evaluated as acceptable in Engineering Design Package (EDP) 37088, and is included in the seismic cumulative change calculation (DC-5152 Vol. I) for panel H11P601. The impact of this indicator is very minimal, as it represents an increase in weight of 2.5 lbs to a panel that weighs 5000 lbs.

The backup level indicator is mounted to an electrical box on the second floor of the RB. This does not match the configuration in the test report, where the indicator was mounted to a 48"x32", 3/16" steel plate, to simulate being mounted to the cabinet door in the control room. The electrical box is smaller than the door and consequently was found to have a higher natural frequency than the door, resulting in less amplification of seismic accelerations. In addition, the indicator was tested well beyond the RRS provided to the testing vendor. The installed configuration is conservative with respect to the tested configuration. The indicator, the electrical box, and mounting brackets impose a 32 lbs load on the RB wall. The wall has an area of 403 square feet (sf), resulting in an average load of 32/403 = 0.08 pounds per square foot (psf). Per calculation DC-SE-01-EF, RB concrete walls are designed for an attachment load of 20 psf. The actual attachment load on the wall is 7.8 psf. Therefore, the margin is 20.0 - 7.8 = 12.2 psf, of which the Backup Water Level Indicator will use 0.1 psf.

RAI #4
Please provide analysis of the maximum expected radiological conditions (dose rate and total integrated dose) to which the system electronics (including power boxes, signal processors, and display panels) will be exposed. Also, provide documentation indicating what is the maximum total integrated dose the electronics can withstand and how it was determined. Discuss the time period over which the analyzed total integrated dose was applied.

Response
The requirements of Order EA-12-051 addressed the use of the Spent Fuel Pool Instrumentation (SFPI) for remote monitoring of SFP levels during beyond design basis (BDB) external events consistent with conditions in the area of the SFPI equipment location. At Fermi 2, the SFPI system electronics (including back-up power supplies, signal processors, and displays) are located outside of the SFP area; and therefore, operate in the Normal and BDB environment.

The vendor documentation for the environmental qualification of the SFPI equipment does not contain information on the radiological dose that the SFPI electronics can withstand. This issue was addressed by locating the SFPI electronics outside the SFP area where the SFPI electronics will be exposed to the Normal and BDB environment only. In this environment, the SFPI electronics are expected to operate satisfactorily since the radiological conditions will be below 1.00×10^3 rad TID criteria. The specific information regarding the radiological conditions in the area of the SFPI equipment location is based on the radiological assessment documented in the Fermi 2 Equipment Qualification (EQ) Program. The radiological dose of 1.00×10^3 rad TID is the radiation threshold postulated for the commercial-off-the-shelf circuits. The maximum TID for the SFPI electronics is summarized in Table 1.

In order to calculate a 40-year integrated dose from the Radiation Protection Program dose rate for an EQ zone, the dose rate (mrem/hr) is converted to a total integrated dose for 40-years (rem). This total integrated dose is then converted from rem to rads (carbon) by multiplying by a factor of 0.83.

For example, the AB fourth floor where the primary signal processor is located is in an area where the TID under normal operating conditions is 1.46×10^2 rad for 40 years. The primary indicator is located in the MCR which is a low dose area. The backup signal processor located in RB on the third floor will be exposed to TID of 1.46×10^2 rad for 40 years under normal operating conditions. The backup indicator is located on the RB second floor and will be exposed to a TID of 1.46×10^2 rad for 40 years of normal operating conditions.

The top of the racks in the SFP is located at 661’-0.13’’ (above sea level). Consistent with the SFPI system design and assuming that the SFP water level is at the top of the fuel racks, dose rates associated with all SFPI electronic equipment will not be changed provided that the electronic equipment is located below the water level elevation in the SFP. This is due to the fact that a free-path (line-of-sight) thickness of normal concrete shielding between the electronics and the SFP fuel array for the SFPI electronics will not be changed from normal plant operation. In cases where items located on the rack associated with the primary channel power conditioner

(G4100S002A) reach an elevation of approximately 666’, which is five feet above the top of the racks, the equipment is protected by approximately 20’ of concrete shielding at its location on AB fourth floor near grid F-11. Under normal operating conditions, the dose rates at the SFP wall (6 foot thickness) are less than 1 mRem/hr. Since the equipment’s free-path is shielded by nominally 20 feet of concrete (vs. the 6 feet calculated), the dose to the equipment will not be significantly impacted by the reduction of water level.

In conclusion, during BDB conditions, the SFPI electronic equipment is exposed to the same dose rates that are expected under the normal plant conditions and, therefore, the SFPI electronics functions as designed.

Table 1 - Expected Radiological Conditions and Maximum TID.

Component (location)	40-year Normal TID (Rads)	Dose Rate (mrem/hr)	Elevation (Nominal)
Primary Signal Processor w/battery & power conditioner (AB 4th Fl.)	1.46×10^2	0.50	659’ 6”
Primary Remote Level Indicator (AB 3rd Fl., Main Control Room)	8.73×10^1	0.30	641’ 6”
Backup Signal Processor w/battery & power conditioner (RB 3rd Fl.)	1.46×10^2	0.50	641’ 6”
Backup Remote Level Indicator (RB 2nd Fl.)	1.46×10^2	0.50	613’6”

RAI #5
Please provide information indicating (a) the temperature ratings and whether the temperature ratings for the system electronics are continuous duty ratings; and, (b) the maximum expected ambient temperature in the rooms in which the system electronics will be located under BDB conditions, where there is no AC power available to run Heating Ventilation and Air Conditioning (HVAC) systems.

RAI #6
Please provide information indicating the maximum expected relative humidity in the rooms in which the system electronics will be located under BDB conditions, where there is no AC power available to run HVAC systems, and whether the sensor electronics are capable of continuously performing required functions under this expected humidity condition.

RAI #5 and RAI #6 Responses
The requirements of Order EA-12-051 addressed the use of the SFPI for remote monitoring of SFP levels during BDB external events consistent with conditions in the area of the SFPI equipment location. At Fermi 2, the SFPI system electronics (including back-up power supplies, signal processors, and displays) are located outside of the SFP area; and therefore, operate in the Normal and Extended Loss of AC Power (ELAP) BDB environment. The following response addresses RAI #5 and RAI #6 together.

The SFP electronics and batteries are installed remotely from the SFP area in various locations in the AB, RB and the MCR. Each location has different expected BDB environmental conditions. Both the remote and primary level indication systems are similar in design and are built around the MOHR EFP-IL SFPI System. In addition to the MOHR EFP-IL SFPI system components, OTEK Digital Indicators are used for the Primary and Backup level indication. Power conditioners/filters were used in the power input lines to the signal processors and level indicators. MOHR's SFPI system electronics is designed for installation in a normally mild environment outside of the SFP area. The SFPI system electronics and batteries are housed in NEMA Type-4X metallic enclosures designed for installation in this type of environment.

The expected temperature and humidity conditions for the SFPI electronics and batteries installed at Fermi 2 are summarized in Table 3 (at the end of this section). The formulations used to determine moist air properties as well as the psychrometric chart used to determine specific humidity values are based on the information published in the 1989 *ASHRAE Fundamentals Handbook*.

Temperature and humidity tests were performed on the SFPI electronics. Specific conditions for environmental testing did not envelope most site-specific conditions for the location of the SFPI electronics. MOHR addressed this issue by revising the temperature and humidity test levels in a manner appropriate to envelope the temperature and humidity in a normally mild-environment at the site. As a result, MOHR performed environmental testing at the following worst-case post-event environmental conditions of temperature -10 to +55 °C (14 to 131 °F) and 5 to 95% Relative Humidity (RH).

Before performing temperature and humidity tests, MOHR tested operability of the equipment under standard ambient conditions, which are defined as 25 ± 10 °C and 20 to 70% RH. This test established the performance characteristics of the system. MOHR also performed pre-qualification testing at 20 °C and 36% RH, adjusting the level for the probe to simulate 0 percent, 50 percent, and 100 percent immersion. The results obtained during pre-qualification were used as the acceptance criteria for temperature and humidity testing.

During the temperature test, which consisted of four separate sections designed to cover the specified temperature range, MOHR placed the equipment inside an environmental chamber and temperature was varied in accordance with the conditions defined in the test procedure. Conditions in each test section were maintained for one hour, after which operating tests were performed.

The humidity test also consisted of four separate sections designed to cover both the humidity and temperature ranges defined in MOHR's test procedures. The test conditions are summarized in Table 2, Temperature and Humidity Test Curve, below:

Table 2 - Temperature and Humidity Test Curve

Section	Temperature (°C / °F)	Relative Humidity (%RH)
1	25 ± 10 / 77 ± 18	20-70
2	55 / 131	40-50
3	40-50 / 104-122	70-80
4	30 / 86	95

The equipment under the test (EUT) was placed inside an environmental chamber. Conditions in each section were maintained for one hour, after which operating tests were performed. The test results showed the equipment operation was acceptable under the test conditions required. At the completion of the temperature and humidity tests, MOHR performed a post-test inspection to determine if degradation of the system could be observed. The test inspection was performed at 28 °C (82 °F) and 35% RH.

Results of the operating tests (summarized in Table 3) were compared to the results obtained during pre-qualification testing and the result showed the equipment operation was acceptable under the test conditions required. Based on the test results, the environmental conditions expected at the SFPI locations at the plant for the signal processors are bounded by the tested maximum temperature of 55 °C (131 °F) and humidity of 95% RH. The temperature and humidity ratings for the SFPI system electronics were not defined by the vendor as continuous duty ratings. However, consistent with the reported test results, the SFPI system electronics are capable of performing required functions under the temperature and humidity conditions that are expected during the postulated BDB event.

Two exceptions, however, were noted and documented in the station's corrective action program; the temperature and humidity ratings of the SOLA Power Conditioner, G4100S002B, and LCR Electronics Filters, G41K601A/B SU2, were found to be below the temperature and humidity values expected during the BDB conditions. In each case, a review of the expected operating parameters during BDB conditions against the operating parameters assumed during vendor's test conditions determined that reasonable assurance exists that the components will function properly under the Fermi 2 BDB conditions. These reviews are documented in the station corrective action program.

Table 3- Summary of Temperature and Humidity Conditions

PIS	Description	Location	Equip. Max Temp/ BDB Max Temp (^{0}F)	Equip. Max Humidity/ BDB Max Humidity (%RH)
G41K187A/ G41K189A/ G41K188A/ G41K190A	MOHR Signal Processor/Power Supply/Battery	AB 4th Fl	131/ 115.4	95/68 85/68
G41K187B/ G41K189B/ G41K188B/ G41K190B	MOHR Signal Processor/ Power Supply/Battery	RB 3rd Fl	131/ 128.5	95/ 45.1 85/ 45.1
G4100S002A	SOLA Power Conditioner	AB 4th Fl	122/ 115.4	95/ 68
G4100S002B	SOLA Power Conditioner	RB 3rd Fl	122/ 128.5	95/ 45.1
G41R601A	OTEK Remote level Indicator	AB 3rd Fl	158/ 116.3	95/ 67
G41R601B	OTEK Remote Level Indicator	RB 2nd Fl	158/ 124.1	95/51
G41K601A SU2	LCR Electronics Filter	AB 43rd Fl	104/ 116.3	UKN/ 67
G41K601B SU2	LCR Electronics Filter	RB 2rd Fl	104/124.1	UKN/ 51

RAI #7
Please provide information describing the evaluation of the comparative sensor design, the shock and vibration test results, and forces and their frequency ranges and directions applied to the sensor applicable to its successful tests, demonstrating that the referenced previous testing provides an appropriate means to demonstrate reliability of the sensor under the effects of shock and vibration.

Response
Per vendor document 1-410-5 MOHR EFP-IL System Shock and Vibration Test Report, the EFP-IL system provides shock resistance appropriate for general robustness, handling, and transport per standard IEC 60068-2-27 and vibration resistance appropriate for equipment in large power plants and for general industrial use per IEC 60068-2-6. This testing meets NEI 12-02, Revision 1 (Reference 6.4 of Enclosure 1), requirements for documentation of resistance to non-seismic mechanical shock and vibration loadings expected for the nuclear power plant environment.

For shock and vibration testing, the EFP-IL and EFP-BAT-44000 enclosures were mounted on a test table described in vendor document 1-410-5. A 120 Volts AC (VAC) cable was routed to supply power for the device. A battery cable was routed through a cable strain relief block. The remaining interface cable was terminated in the cable strain relief block to simulate the required customer supplied cable strain relief. The same configuration was used for vibration testing. Any visible evidence of damage to the device or evidence of functional degradation would have constituted failure. In-test functional observations were satisfactory. At the completion of testing, final functional verification was performed. No deficiencies were identified.

RAI #8
Please provide analysis of the seismic testing results and show that the instrument performance reliability, following exposure to simulated seismic conditions representative of the environment anticipated for the SFP structures at Fermi, has been adequately demonstrated.

Response
Seismic tests were performed on three components of the SFP instrumentation system: 1) an SFP probe, 2) an SPF signal processor with battery pack, and 3) an SFP level indicator. Each of these components is installed in the one primary unit and one back-up unit.

Seismic qualification testing of the signal processor (with battery pack) and level indicator was performed in accordance with IEEE-344-2004. Seismic testing of the SFP probe was limited to a series of seismic impact tests. The tests demonstrated that, during worst-case seismic deflection of the probe, no damage would occur to either the probe or the stainless steel pool liner should the two collide. Analyses were performed by the probe manufacturer to qualify the probe for other design basis maximum seismic loads and pool-sloshing loads. Seismic qualification analyses were also in accordance with IEEE-344-2004.

SFP Probe
Probe impact test results are in Section 6.0 of vendor report 1-0410-9. In this series of tests, the lower end of a 25-foot long probe was displaced (pulled back) 41” to 55”, released, and allowed to impact a stainless steel plate located 12” from the probe’s initial position. Probe velocity on impact was 12.9 to 16.9 feet per second (fps). Other than minor burnishing of its tip, the probe suffered no mechanical or electrical damage.

The Fermi probe is 23’-3” long and located 3⅛” from the pool’s stainless steel liner. Vendor report 1-0410-9.2 contains the vendor’s analysis of the Fermi probe during a seismic event. Based on results in Section 4.1, during a seismic event, peak probe displacement and velocity will be 11/16” and 0.12 fps. Therefore, seismic displacement will not result in the probe impacting the liner; however, even if impact occurred, no mechanical or electrical damage would result.

SFP Signal Processor & Battery Pack
Report 1-0410-6 contains the results of seismic qualification tests of the SFP signal processor and battery pack. As discussed in Appendix A of the report, qualification tests demonstrate the equipment is qualified to the Fermi seismic response spectra with considerable margin.

Two series of seismic qualification tests were performed. The first series were standard IEEE-344-2004 seismic qualification tests. The two instruments were subjected to five consecutive OBEs followed by a SSE. Peak horizontal OBE and SSE acceleration values during the tests were 5.77g and 5.94g, respectively. Instrument performance was monitored during the tests and thoroughly checked at the conclusion of tests. No deficiencies in instrument performance or the condition of instrument mounting hardware were identified.

The second test series were fragility tests. The purpose of these tests, which are not required by IEEE-344, was to determine the limits of the instruments and establish their design margin. Once again, the same two instruments were subjected to five consecutive OBEs followed by one SSE. Peak horizontal OBE and SSE acceleration values during the tests were 9.9 g and 14.0 g, respectively. Instrument performance was monitored during the tests and thoroughly checked at the conclusion of the tests. Despite being tested to table limits, no deficiencies in instrument performance or the condition of instrument mounting hardware were identified.

The above series of tests demonstrated that the SFP signal processor and battery pack are seismically rugged to seismic loading beyond that of the Fermi design basis earthquakes.

SFP Level Indicator
The results of the seismic qualification tests of the SFP Level Indicator can be found in report QR 351020917-1. The indicator was subjected to testing performed in accordance with IEEE-344-2004 and excitations exceeded the provided floor response spectra (OBE/SSE for RB2 and AB3) including an amplification factor of 1.5 with at least 10% margin. Baseline functional testing consisted of electrical testing which verified the critical electrical characteristics of the indicator before and after seismic and electromagnetic interference/radio-frequency interference (EMI/RFI) testing. Several anomalies were identified during the EMI/RFI tests that were resolved by installation of an LCR Electronics Filter adjacent to the Level Indicator. This is qualified separately in report QR 351020853-1.

RAI #9
Please provide the NRC staff with the final configuration of the power supply source for each channel so the staff may conclude that the two channels are independent from a power supply assignment perspective.

Response
The 120 VAC, 1 Phase, 60 Hertz (Hz) power supply is provided to the SFPI primary and backup channel equipment. The 120 VAC power for the SFPI equipment is provided from Non-Class IE 120 VAC Instrument Control Power (ICP) Modular Power Units (MPUs) 3 and 4 via Distribution Panels H21P550 and H21P554, respectively. The instrument power distribution panels H21P550 and H21P554 are classified as non-safety, balance of plant (BOP) equipment.

The primary channel 120 VAC, instrument power distribution panel H21P550 is located on the AB fifth floor. In order to provide surge protection, harmonic filtering, and output voltage regulation, a Sola Hevi-Duty Power Conditioner is installed between the power supply panels and the SFPI equipment. The SFPI power conditioner, signal processors, and power supplies are located in the Auxiliary Building, fourth floor. The power supply cable is run in conduit and has a different routing than the backup channel power supply conduit.

The backup channel SFPI is powered from a BOP, 120 VAC, instrument power distribution panel H21P554 located in the RB, second floor. In order to provide surge protection, harmonic filtering, and output voltage regulation, a Sola Hevi-Duty Power Conditioner is installed between the power supply panels and the SFPI equipment. The SFPI power conditioner, signal processors, and power supplies are located in the RB, third floor. The power supply cable is run in conduit and has a different routing than the primary channel power supply conduit.

The distribution panels H21P550 and H21P554 receive power from MPUs that provide 120 VAC regulated power for Fermi 2 BOP instruments and are powered by 15 kiloVolt-Amperes (KVA), 480-120/240 Volt (V) transformers. The source to H21P550 (primary channel) is a 480 V primary power supply via a 15 KVA 480-120 volt transformer that is connected to a Class 1E, Division 2 Motor Control Center (MCC). The source to H21P554 (backup channel) is a 480 V primary power supply via a 15 KVA 480-120 volt transformer that is connected to a Class 1E, Division 1 MCC. The two power supply panels are independent of each other since their power sources are fed from separate independent divisional power sources.

The power supply cable is selected per DTE Specification 3071-128, EZ-04 and 05 as 3 conductor #12 (L, N, G) and is routed in conduit. A Bussman FRN-R-2 fuse is installed in each Power Supply Panel, H21P550 and H21P554, to protect the power supply cable and the Power Conditioners. The 2 ampere (amp) fuse provides protection for the #12 power supply cable from short circuiting and protects the Sola Power Conditioners.

RAI #10

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

Response

Each SFP instrumentation channel is provided with backup power with replaceable batteries for a minimum of 72 hours operation. Backup power for each channel is automatically switched "on" following the loss of the normal power source. For extended battery operation, each channel has "On Demand" operation features. An additional backup power source is provided using a FLEX Power Source, which is available within 72 hours.

Report 1-0410-7 Rev 2, "MOHR EFP-IL SFPI System Battery Life Report" analyzed the SFPI System backup battery capacity. Section 4.0 assesses the power dissipation of various EFP-IL SFPI system configurations and provides the estimated battery life using results of battery testing performed in Section 3.0. Section 4.2.1 and Table 7 show that the battery has the capability to power the EFP-IL SFPI System for at least 7 days with a 25% duty cycle (e.g., 15 samples per hour with 60 second sample duration).

Report 1-0410-7 Rev 2, Section 4.2.2 states that the EFP-RD-UPS battery backup power supply (low power version of the EFP-IL SFPI system, Section 2.1.1) can be configured to power either 4-20 milliamp (mA) instrumentation loops or external DC loads. Per Section 4.2.2.1, the EFP-RD-UPS can supply loads up to 1Watt (W) at 24 Volts Direct Current (VDC). Assuming a constant 20 mA output, the estimated battery life is 11.7 days.

RAI #11
Please provide analysis verifying the proposed instrument performance is consistent with these estimated accuracy normal and BDB values. Demonstrate that the channels will retain these accuracy performance values following a loss of power and subsequent restoration of power.

Response
The purpose of the SFPI (primary and backup) is to supply Operations with real-time SFP level indication. The SFP level instrumentation consists of permanently installed primary and backup instrument channel components. Each instrument channel consists of a probe suspended in the SFP, a signal processor, a coaxial cable, and a remote display. Each SFP instrument channel is expected to be accurate to within an estimated ±0.2% of calibrated span during normal spent fuel pool level conditions. The SFPI channels are expected to retain this estimated accuracy after being subjected to BDB conditions. The acceptance band, or "Acceptable Performance Tolerance (APT)," is defined as the acceptable parameter variation limit above or below the desired output for a given input associated with the instrument channel. The instrument channel acceptance band, which is symmetrical, is calculated using the square root of the sum of the squares (SRSS) combination of the APT for each component comprising the instrument loop. The APT of each component is equal to or greater than the reference accuracy of the device being calibrated but is not so large that it could prevent or mask detection of instrument degradation or failure.

Power interruption testing has been performed on the EFP- IL signal processor and backup battery power source. Test results indicate that no deficits were identified with respect to maintenance of reliable function, accuracy, or calibration as a result of power interruption. The results of testing provided evidence of reliable transition from the normal AC power source to the back-up battery without affecting accuracy or calibration. The results of the tests are provided in the MOHR EFP-IL SFPI System Power interruption report. The Acceptable Performance Tolerance for Fermi 2's SFPI is 5.02 inches. The EFP-IL has local indication that displays to two decimals, so the display does not factor in to the channels readability. However, the OTEK indicator's faceplate has major division every five feet (e.g. 15, 20, etc.) and minor divisions every foot. The readability of the analog indication is considered to be equal to a half of the minor division. Therefore, the channel APT was rounded to 6 inches. Even with the readability rounding, the resulting channel APT of 6 inches is equal to a half of the acceptance criteria established in NEI 12-02, Revision 1 (Reference 6.4 of Enclosure 1) for the SFP instrument channel accuracy; and therefore, is an acceptable value.

RAI #12
Please provide the following:

a) A description of the capability and provisions the proposed level sensing equipment will have to enable periodic testing and calibration, including how this capability enables the equipment to be tested in-situ.
b) A description of calibration tests and functional checks to be performed and the frequency at which they will be conducted. Discuss how these surveillances will be incorporated into the plant surveillance program.
c) A description of the preventive maintenance tasks required to be performed during normal operation, and the planned maximum surveillance interval that is necessary to ensure that the channels are fully conditioned to accurately and reliably perform their functions when needed.

Response
<u>RAI-12(a)</u>
The Signal processor (MOHR EFP-IL) system provides real-time in-situ auto-calibration of the water level and high-resolution Time Domain Reflectometry (TDR) health check of the cable and probe system attached to the instrument test port. In addition, specified system checks are performed. The LED indicator uses a two blink protocol to continuously indicate battery level, liquid level range and system diagnostic status.

The level equipment is capable of being calibration checked where it is installed with minimal test equipment. To perform the calibration check, access to the signal processor (MOHR EFP-IL) located in the AB fourth floor and the RB third floor is required. The level probe transmission cable is disconnected and the MOHR CT100 TDR cable tester is connected. The signal processor is accessed in the same location and a system check is performed. The test requires authorized access, the use of the signal processor's screen, control buttons on the signal processor, and a USB keyboard.

The calibration check for the "remote" OTEK indicators, located on the RB second floor and the MCR is performed by applying a 4-20mV signal to the device and verifying the full range of the indicator. There are two potentiometers found on the back of the unit that can be used to adjust the zero and span if necessary.

The preventative maintenance tasks (PMs) for diagnostic checks are performed in accordance with the following procedures:

- 46.635.001, Spent Fuel Pool Level Indication, Primary System, Diagnostic Checks
- 46.635.002, Spent Fuel Pool Level Indication, Backup System, Diagnostic Checks

<u>RAI-12(b)</u>
The calibration tests and checks are discussed in the response to 12(a) above. The following surveillances have been created:

- G456, G457 (6 year frequency)
  Calibration check of remote indicator from Spent Fuel Pool Level Signal Processor

- G458, G459 (2 year frequency)
  Calibration check of the Spent Fuel Pool Level Signal Processor and Level Probe
- G460, G461 (6 month frequency)
  System check/ inspection of the Spent Fuel Pool Level Signal Processor
- G463, G464 (550 day frequency, within 60 days of a refuel outage)
  System check/ inspection of the Spent Fuel Pool Level Signal Processor

Note: PMs G460, G461 and G463, G464 have the same technical requirements. The creation of two different sets of events is for scheduling purposes.

These events are in the Fermi PM process as defined by MES51, Preventive Maintenance, which will control the completion of the activities rather than the plant surveillance procedure.

RAI-12(c)
The following PM tasks have been created to ensure the channels reliably perform their function:

- G458, G459 (2 year frequency)
  Replacement of Spent Fuel Pool Level Signal Processor and Remote Indicator batteries
  Replacement of Spent Fuel Pool Level Signal Processor memory card
- G460, G461 (6 month frequency)
  Clean the Spent Fuel Pool Level Signal Processor display screen

These events are in the Fermi PM process as defined by MES51, Preventive Maintenance, which will control the completion of the activities rather than the plant surveillance procedure.

RAI #13
For the backup display location, please describe the evaluation used to validate that the backup display location can be accessed without unreasonable delay following a BOB 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) 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 backup display location remains habitable for radiological, heat and humidity, and other environmental conditions following a BOB event. Describe whether personnel are continuously stationed at the backup display or monitor the display periodically.

Response
The FLEX backup display for SFP level is located on RB second floor (RB-2). Post-ELAP environmental evaluation of this area shows this area remains below 122 ºF for 72 hours.

The FLEX SFP Injection procedure (29.FSG.12) shifts the FLEX water supply to SFP cooling (where this remote display is used to meet FLEX Phase 2 SFP cooling actions). The time for this action is approximately 5 hours and the predicted temperature at this time is 108 ºF. The 5 hour time for this action has been validated as part of Fermi's conformance with the FLEX Validation Plan promulgated by NEI.

Pathways to this location were also evaluated for temperature and show less than 110 ºF.

Transit time from the MCR to the local alternate instrument readout (G41-R601B) is estimated to be five minutes or less.

Humidity effects at the location are acceptable. The indicator is qualified to 95% RH and predicted local area humidity during a BDB event is 51%.

Radiation is not expected to be a concern as no fuel damage occurs during FLEX event. As discussed in RAI #4, the water level of the SFP at Level 1 will not impact the shielding provided by the water given that the equipment is below water level. The backup display location is on RB-2 (613 feet above sea level), which is below the water level of approximately 661 feet above sea level (Level 3). Hence, the normal operating dose rate for the area is applicable to the BDB event (0.5 mrem/hr for the general area).

Personnel are not expected to continuously man this station as changes will occur slowly based on SFP injection and expected heat load/water evaporation rate.

RAI #14
Please provide a list of the procedures addressing operation (both normal and abnormal response), calibration, test, maintenance, and inspection that will be developed for use of the SFP instrumentation. The licensee is requested to include a brief description of the specific technical objectives to be achieved within each procedure.

Response
Normal Operation:

System Operating Procedure 23.708, "Fuel Pool Cooling and Cleanup System," has been revised to incorporate the SFP level instruments. This procedure provides direction for placing the instruments in service per the electrical and instrumentation lineup sections (Attachments 2 and 3 of 23.708).

Abnormal Response:

Extreme Damage Mitigation (EDM) guidelines, 29.EDM.01, "SFP Makeup-Internal Strategy" and 29.EDM.03, "SFP Makeup-Spray-External Strategy" for SFP makeup and spray with Fire Main water (internal strategy) or EDM Truck water (external strategy) have been modified to direct the operator to monitor SFP level using the new SFP level instruments while adding water to the SFP using EDM methods.

Similarly, procedure 29.FSG.12, "FLEX SFP Injection," has been issued to include monitoring SFP level using the new SFP Level Instruments when adding water to the SFP using the FLEX water supply.

Calibration/Test/Maintenance/Inspection:

PM activities related to the SFP level instruments are described in the response to RAI #12. A system check/inspection/cleaning is performed every six months (including once within 60 days of a refueling outage). The conduct of this PM is directed by steps placed in the automatically generated work order by the work planner using a work plan template.

RAI #15

Please provide the following:

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

b) A description of the compensatory actions to be taken in the event that one or both channels are non-functioning, as described in the guidance in NEI 12-02 section 4.3.

c) A description of the planned compensatory actions in the event the non-functioning instrument channel cannot be restored to functional status within 90 days.

Response

<u>RAI-15(a)</u>

Conduct Manual MES51 defines the Preventive Maintenance (PM) program, which is used for the calibration and functional checks of the SFP level instrumentation. Specific tasks were developed and specified, with frequencies, within Maximo and Insert Key Solutions (IKS) to maintain the SFP level instrumentation. The procedure specifies that a PM Deferral Evaluation Request be submitted as soon as it is determined that a PM will not be complete by its critical date. It requires Work Management initiate a corrective action program document (Condition Assessment Resolution Document or CARD) when a required PM is not performed by its critical date. The CARD will include the reason for non-performance and rescheduled date. These actions ensure that PM schedule stability is maintained and monitored.

The Signal processor (MOHR EFP-IL) system provides real-time in-situ auto-calibration of the water level and high-resolution TDR health check of the cable and probe system attached to the instrument test port. In addition, specified system checks are performed. The LED indicator uses a two blink protocol to continuously indicate battery level, liquid level range and system diagnostic status.

The current Fermi PM program, as described in MES51, is being used to perform the required maintenance and testing of the Fuel Pool level indication equipment to ensure regular testing and calibration is performed to maintain system readiness.

PM activities have been created to maintain and check the calibration and stored errors from the equipment. They include:

G456, G457 (6 year frequency)

Calibration check of remote indicator from Spent Fuel Pool Level Signal Processor

G458, G459 (2 year frequency)

Calibration check of the Spent Fuel Pool Level Signal Processor and Level Probe

Replacement of Spent Fuel Pool Level Signal Processor and Remote Indicator batteries

Replacement of Spent Fuel Pool Level Signal Processor memory card

G460, G461 (6 month frequency)

System check/ inspection of the Spent Fuel Pool Level Signal Processor

Clean the Spent Fuel Pool Level Signal Processor display screen

The PMs for diagnostic checks are performed in accordance with the following procedures:

- 46.635.001, Spent Fuel Pool Level Indication, Primary System, Diagnostic Checks
- 46.635.002, Spent Fuel Pool Level Indication, Backup System, Diagnostic Checks

These PMs have been created based on vendor recommendations, Electric Power Research Institute (EPRI) templates, and benchmarking.

System check PMs have also been created to be completed 60 days prior to a refuel outage:

G463, G464 (550 day frequency, within 60 days of a Refuel Outage)

System check/ inspection of the Spent Fuel Pool Level Signal Processor

Clean the Spent Fuel Pool Level Signal Processor display screen

Note: PMs G463, G464 and PMs G460, G461 have the same technical requirements. The creation of two different sets of events is for scheduling purposes.

RAI-15(b)

Conduct Manual MOP25, Beyond Design Basis Event Coping Strategies Program Manual, Revision 1, Section 6.3.3.1, provides that one channel may be out of service for testing, maintenance, and/or calibration for up to 90 days provided the other channel is functional. The out-of-service component is expected to be restored under most circumstances within 45 days.

MOP25 Section 6.3.3.3 requires that if both channels become non-functioning then actions are to be initiated within 24 hours to restore one of the channels and implement compensatory actions within 72 hours. The compensatory measures include confirmation of the normal SFP control room alarms and direct observation and trending of SFP level. In addition, contingency work orders will be initiated to install a spare level indication system from stock and to install a temporary modification to provide temporary level indication.

RAI-15(c)

MOP25 Section 6.3.3.2 provides that if the channel cannot be restored within 90 days, then the availability of normal SFP control room alarms is confirmed and, during each operating shift, the remaining channel's indication is validated against observed SFP level.

RAI #16
Please provide a description of the in-situ calibration process at the SFP location that will result in the channel calibration being maintained at its design accuracy.

Response
The Signal processor (MOHR EFP-IL) system provides real-time in-situ auto-calibration of the water level and high-resolution TDR health check of the cable and probe system attached to the instrument test port. In addition, specified system checks are performed. The LED indicator uses a two blink protocol to continuously indicate battery level, liquid level range and system diagnostic status.

To perform the calibration check, access to the Signal Processor (MOHR EFP-IL) located in the AB fourth floor and the RB third floor is required. The level probe transmission cable is disconnected and the MOHR CT100 TDR cable tester is connected. The signal processor is accessed in the same location and a system check is performed. The test requires authorized access, the use of the signal processor's screen, control buttons on the signal processor and a USB keyboard.

The calibration check for the "remote" OTEK indicators, located on the Reactor Building second floor and the MCR, is performed by applying a 4-20 milliVolt (mV) signal to the device and verifying the full range of the indicator. There are two potentiometers found on the back of the unit that can be used to adjust the zero and span if necessary.

These Preventive Maintenance activities have been created based on vendor recommendations, EPRI templates, and benchmarking.

Enclosure 3 to
NRC-16-0004

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

Design Bridge Document

Design Bridge Document

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
1	Design Specification	Spent fuel pool instrumentation (SFPI) Requirements derived from References 1, 2, and 3	References 4 through 18, 20, and 21	N/A	N/A	Evaluation of the vendor information was completed under engineering design packages EDP-37088 and EDP-37034 (Ref. 45 and 46).
2	Test Strategy	Per requirements in References 1, 2, and 3	References 4, 7, 9, 10, 11, 13, 14, and 15	N/A	N/A	The equipment testing performed for the SFPI was found acceptable based on the current design requirements.
3	Environmental qualification for electronics enclosure with battery and display	65-104°F (Ref. 44)	Reference 4	N/A	14-131 °F	Acceptable, vendor testing analysis bounds licensee parameters defined in the Fermi 2 references provided in the parameter summary column. Also, see response to RAI #5 and #6 for low temperature rating of power filters and power conditioners.
		3-90% RH (Ref. 44)	Reference 4	N/A	5-95 % RH	Acceptable, vendor test / analysis bounds plant equipment licensee parameters.
		Radiation effects (Ref. 44)	N/A	N/A	N/A	Acceptable, The vendor documentation for the environmental qualification of the SFPI equipment does not contain information on the radiological dose that the SFPI electronics can withstand. This issue was addressed by locating the SFPI electronics outside the SFP area where the SFPI electronics will be exposed to the Normal and BDB environment only. In this environment, the SFPI electronics are expected to operate satisfactorily since the radiological conditions will be below 1.00x 10^3 rad TID criteria. The specific information regarding the radiological conditions in the area of the SFPI equipment location is based on the radiological assessment documented in Reference 45. The radiological dose of 1.00 x 10^3 Rad TID is the radiation threshold postulated for the COTS circuits.
4	Environmental Testing for Level Sensor components in SFP area - Submerged Portion of Probe Body	65-212°F (Ref. 1, 2, and 34)	Reference 5	Rad TID is the total 40 yr dose plus the 7 day worst case accident dose at the lowest spacer location on the Probe Body	480°F long-term for PEEK Insulators	The SFP is expected to remain at or above the minimum ambient temperature of the Auxiliary & Reactor building (65°F) as called out in the UFSAR (Ref. 34). An accident condition assumes that the spent fuel pool 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 spacers are acceptable for the application.
		Submerged component (Ref. 1 and 2)	Reference 5		PEEK Insulation capable of long term submergence	

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
		2.0 x 10^9 rad TID (Ref. 1 and 2)	Reference 5		1 × 10^{10} Rad for PEEK Insulators	The Total Integrated Dose (TID), conservatively calculated for the SFP probe, is 1.325 × 10^9 R. The equipment manufacturer, MOHR, indicates an acceptable TID for the probe at 2.0 × 10^9 Rad. Therefore, the probe is expected to remain acceptable from any TID radiation exposure with a large degree of margin.
5	Environmental Testing for Level Sensor Electronics Housing- Probe Head located Above the SFP	65-212°F (Ref. 1, 2, and 34)	Reference 5	Rad TID is the total 40 yr. dose plus the 7 day worst case accident dose at the location of the probe head	PEEK: 480°F long-term EPDM: 194°F long-term 12 day @ 311°F Sylgard 170: 392°F long-term	The SFP is expected to remain at or above the minimum ambient temperature of the Auxiliary & Reactor building (65°F) as called out in the UFSAR (Ref. 34). Maximum accident condition temperature and humidity directly above the spent fuel pool 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. 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 34 and are acceptable.
		0-100% RH (Ref. 1 and 2)	Reference 5		0-100% RH for PEEK, EPDM and Slygard 170	100% 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 39 and are acceptable.
		7.33×10^6 Rad TID (Ref. 39)	Reference 5		PEEK: 1 × 10^{10} Rad EPDM: 2 × 10^9 Rad Slygard 170: 2 × 10^8 Rad	DC-6543 (Ref. 39) defines a worst case dose rate of approximately 7.33 × 10^6 rad at 1 ft depth of water above Racks. 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 19 and are acceptable.
6	Thermal & Radiation Aging - organic components in SFP area	See items 4 & 5 above	Reference 5	N/A	See above items 4 and 5	Acceptable, vendor test / analysis bound licensee parameters, see discussion above in Items 4 and 5.
7	Basis for Dose Requirement	References 1and 2	Reference 5	N/A	Reference 39	Calculation DC-6543 (Ref. 39) based on the requirements of NEI 12-02 (Ref. 2) and EA-12-051 (Ref. 1). The calculation determines the dose rates for SFP location (RB 5) and SFP water levels for both a 7 day accident scenario and 40 year TID.
8	Seismic Qualification for level sensor level II/I	References 1 and 2	References 10, 13, 14, 20, and 21	N/A	Seismic Class I and Seismic Class II/I	Calculation DC-6557 (Ref. 40) ensures that the probes mounting is designed IAW seismic Cat. I requirements. Signal processors and battery enclosures mounting is designed IAW seismic category II/I requirements as documented in DC-0632, Vol. I DCD 1 (Ref. 38).

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
9	Sloshing	Water induced motion from seismic event does not cause equipment structural failure	References 13, 14, 20, and 21	N/A	N/A	Calculation DC-6557 (Ref. 40) ensures the probes are adequately designed for sloshing effects.
10	Spent Fuel Pool Instrumentation System Functionality Test Procedure	System must allow for routine, in situ functionality testing	References 22, 23, 24, and 25	N/A	N/A	The system features on board electrical diagnostics. Channel functional testing utilizes comparison of actual pool level to indicated level, as well as additional tests specified in References 22 and 23.
11	Boron Build-Up	Buildup cannot produce error greater than 1 ' including all other error source terms (Ref. 1 and 2)	Reference 12	N/A	N/A	Not applicable to Fermi 2 Design
12	Pool-side Brackets Seismic Analysis	Seismic Class I (Ref. 1 and 2)	References 13 and14	N/A	Seismic Class I	Calculation DC-6557 (Ref. 40) provides basic for qualification of the pool side brackets.
13	Mounting of Sensor Electronics and Batteries Enclosure	Seismic Class II/I (Ref. 1, 2, and 34)	Reference 10	N/A	Seismic Class II/I	Calculation DC-0632 Vol I DCD I (Ref. 38) ensures that electronics and batteries are mounted in accordance with the seismic category II/I requirements.

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
14	Shock & Vibration	References 1 and 2	Reference 9	N/A	N/A	Acceptable. Calculation DC-6557 Vol. I (Ref. 40) ensures that the probes are adequately designed for resistance against shock and vibration expected in the SFP. 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 machine screw connection designed with proper thread engagement and lock washers. The electronics and battery enclosures are mounted in the RB and AB. The equipment is not attached 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 category II/I and designed as rigid components inherently resistant to vibration effects. Similarly, the effects of shock on the supporting fixtures for the control room level indicator is not a credible threat; all equipment in the control room area is qualified seismically such that there are no expected impacts from adjacent objects during the design basis earthquake requirements imposed by NEI 12-02, Revision 1..
15	Requirements Traceability Matrix	Software Traceability Matrix required for software evaluation of equipment	Reference 16	N/A	N/A	The instrument software verification and validation has been completed.
16	Factory Acceptance Test	Must demonstrate full functionality of EFP-IL and SFP-1	References 41, 42, and 43	N/A	N/A	Acceptable, channel factory acceptance tests have been completed successfully (Ref. 41, 42, and 43).
17	Channel Accuracy	± 1 foot (Ref. 2)	Reference 17	Prepared additional instrument accuracy documentation	± 6.0 in. max	Evaluation of SFPI channel accuracy (Ref. 17 and 28) including expected error terms is completed.
18	Power Consumption	References 1 and 2	References 11 and 15	N/A	11.5 W (AC Battery) 8.6 W (DC Battery)	Acceptable, the instrument testing demonstrate the battery capacity is sufficient for the maximum duration required by the NRC Order (Ref. 1).

#	Topic	Parameter Summary	Vendor Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
					7 day battery life at 15 samples per hour rate	Acceptable, the instrument testing demonstrate the battery capacity is sufficient for the maximum duration required by the NRC Order (Ref. 1)
19	Technical Manual	References 1 and 2	References 23 and 24	Reference 23 Signal Processor Reference 24 Level Probe	N/A	The technical manuals have been provided by the vendor.
20	Calibration	Must allow for in-situ calibration	References 22, 23, and 24	System is calibrated using CT- 100 device and processing of scan files by vendor.	N/A	The calibration manuals have been provided by the vendor (Ref. 22, 23, 24, and 25).
21	Failure Modes and Effects Analysis (FMEA)	System provides reliable indication of fuel pool level, consistent with the requirements of References 1 and 2	References 18 and 35	N/A	SFPI system meets requirements of References 1 and 2 when installed as required	Acceptable, the FMEA adequately addressed 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.
22	Emissions Testing		References 7 and 8	N/A	EPRI TR 102323, Rev 3 (Ref. 19)	EPRI TR 102323 R3 provides testing methodology and the testing acceptance criteria for the SFPI as documented in References 7 and 8.

NRC References

1) U.S Nuclear Regulatory Commission, Order Number EA-12-051, "Issuance of Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated March 12, 2012 (ADAMS Accession No. ML12054A682)
2) Nuclear Energy Institute, NEI 12-02, Revision 1, “Industry Guidance for Compliance with NRC Order EA-12-051,” Revision 1, dated August 2012 (ADAMS Accession No. ML12240A307)
3) U.S Nuclear Regulatory Commission, Interim Staff Guidance, JLD-ISG-2012-03, “Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation,” dated August 29, 2012 (ADAMS Accession No. ML12221A339)

DTE/Vendor References

##	Document Serial Number	TITLE
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 3	MOHR EFP-IL SFPI System Proof of Concept Report
7)	1 0410 4	MOHR EFP-IL SFPI System EMC Test Report
8)	1 0410 4 S1	MOHR EFP-IL SFPI Supplemental EMC Information
9)	1 0410 5	MOHR EFP-IL SFPI System Shock and Vibration Test Report
10)	1 0410 6	MOHR EFP-IL SFPI System Seismic Test Report
11)	1 0410 7	MOHR EFP-IL SFPI System Battery Life Report
12)	1 0410 8	MOHR EFP-IL SFPI System Boric Acid Deposition Report (FIO)
13)	1 0410 9	MOHR SFP-1 Level Probe Assembly Seismic Analysis Report
14)	1 0410 9 2	MOHR SFP-1 Level Probe Assembly Seismic Analysis Report, FERMI
15)	1 0410 10	MOHR EFP-IL SFPI System Power Interruption Report
16)	1 0410 11	MOHR EFP-IL SFPI System Software Verification and Validation
17)	1 0410 15	MOHR EFP-IL SFPI System Uncertainty Analysis
18)	EVAL 194 4812 01	MOHR EFP-IL Liquid Level Measurement System Failure Modes and Effects Analysis (FMEA)
19)	EPRI TR 102323	Engineering Test Report, Number 2L0482EEPRI1 Model # SV100-115-113-000-0 Videographic Recorder
20)	NAI 1725 004	Seismic Induced Hydrodynamic Response in the CGS Spent Fuel Pool, NAI Calculation Approval and Release
21)	NAI 1791 009	Seismic Induced Hydraulic Response in the Enrico Fermi Power Plant 2, NAI Calculation Approval and Release Image
22)	VMC1-536.2	EFP-IL Signal Processor Manual
23)	VMC1-536	EFP-IL Signal Processor Technical Manual
24)	VMC1-536.1	SFP-1 Level Prove Assembly Technical Manual
25)	VMC1-532	User's Manual for EBD, LBD, LSB and SEB Indicators
26)	C1-4180	Setpoint Validation Guidelines
27)	DC-6585 Vol I	Loss of HVAC-Room Environment Analysis in Support of FLEX: RB/AB/TB Temperature Profile
28)	SFP ACCURACY EVALUATION	Fermi 2 Spent Fuel Pool Accuracy Evaluation
29)	DC-6447 Vol I	Auxiliary Power System Analysis
30)	DC-5026 Vol I	Loss of Power Impact on MPU #3
31)	DC-5027 Vol I	Loss of Power Impact on MPU #4
32)	DC-5152 Vol I	Seismic Cumulative Change Evaluation Package (SEP) for Control Room Panels H11P601, H11P602, H11P603
33)	CECO	Central Component (CECO) Database
34)	N/A	UFSAR, Sections 9.1.2.3 and 9.4.2.1
35)	FMEA 351020917 1	Failure Modes and Effects Analysis (FMEA) for OTEK LBD Digital Panel Meter
36)	IMR 2014	IMR-KHA Probe Tubing Test Reports
37)	Sola PWR Conditioner	Power Protection and Conditioning, CVS Hardwired Series-Constant Voltage Transformers
38)	DC-0632 Vol I DCD 1	Structural Evaluation of Primary and Backup Instrument Racks
39)	DC-6543 Vol I	Total Integrated Radiation Dose to Spent Fuel
40)	DC-6557 Vol I	Structural Evaluation of Spent Fuel Pool Probe Mounting Brackets
41)	EFP IL00027	Procedure 2014.01 Rev 0.5 Factory Acceptance Test Liquid Level Sensing System
42)	EFP IL00028	Procedure 2014.01 Rev 0.5 Factory Acceptance Test Liquid Level Sensing System
43)	EFP IL00029	Procedure 2014.01 Rev 0.5 Factory Acceptance Test Liquid Level Sensing System
44)	EQ0-EF2-018	Summary of Environmental Parameters Used for the Fermi 2 EQ Program
45)	37088	Install SPF Level Instrumentation to comply with NRC order EA-12-051 Guidance
46)	37034	Install Conduits & Cables through RCTR BLDG, AUX BLDG, & CNTRL RM Penetrations & Install Cutout