FENOC™
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
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724-682-4862

December 21, 2015

L-15-337

10 CFR 2.202

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-001

SUBJECT:
Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Completion of Required Action by NRC Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (TAC No. MF0842) and NRC Order EA-12-051, Reliable Spent Fuel Pool Instrumentation (TAC No. MF0800)

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, and Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, to FirstEnergy Nuclear Operating Company (FENOC). These Orders were effective immediately and directed FENOC to: (1) develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event for Beaver Valley Power Station, Unit No. 2 (BVPS-2) as outlined in Attachment 2 of Order EA-12-049; and (2) have a reliable indication of the water level in associated spent fuel storage pools for BVPS-2 as outlined in Attachment 2 of Order EA-12-051.

This letter, along with its attachments, provides the notification required by Section IV.C.3 of each Order that full compliance with the requirements described in Attachment 2 of each Order has been achieved for BVPS-2.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at 330-315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 21, 2015.

Respectfully submitted,

Timothy F. Steed

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Attachments:
1. Compliance with Order EA-12-049
2. NRC Requests for Information (Order EA-12-049)
3. Compliance with Order EA-12-051
4. NRC Requests for Information (Order EA-12-051)

cc: Director, Office of Nuclear Reactor Regulation (NRR)
NRC Region I Administrator
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP (w/o Attachments)
Site BRP/DEP Representative (w/o Attachments)

INTRODUCTION

FirstEnergy Nuclear Operating Company (FENOC) developed an Overall Integrated Plan (OIP) for Beaver Valley Power Station, Unit Nos. 1 and 2 (BVPS-1, BVPS-2) (Reference 1) documenting the diverse and flexible strategies (FLEX), in response to Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Reference 2). The information provided herein documents full compliance for BVPS-2 with Reference 2.

OPEN ITEM RESOLUTION

FENOC has provided a response for the following items and considers them to be complete for BVPS-2. A summary of the response to each of the items is provided in Attachment 2 of this letter.

Interim Staff Evaluation (ISE) Open Items – All BVPS-2 ISE open items have been closed

ISE Confirmatory Items – Complete pending Nuclear Regulatory Commission (NRC) closure

Licensee Identified Open Items – None

Audit Questions/Audit Report Open Items – Complete pending NRC closure

Safety Evaluation (SE) Review Open Items – Complete pending NRC closure

MILESTONE SCHEDULE – ITEMS COMPLETE

BVPS-2 Milestone	Completion Date
Submit FLEX Integrated Implementation Plan	February-2013
6 Month NRC Status Updates	August-2015
Update 1	August-2013
Update 2	February-2014
Update 3	August-2014
Update 4	February-2015
Update 5	August-2015
Complete FLEX Strategy Review	March-2013
Validation	October-2015
Walk-throughs or Demonstrations-Unit 2	October-2015
Complete Staffing Analysis	November-2014
Submit NEI 12-01 Phase 1 Staffing Study	April-2013
Submit NEI 12-01 Phase 2 Staffing Study	November-2014
Complete Plant Modifications	October-2015
Target plant modifications	April-2013
Unit 2 Modifications complete	October-2015
Complete 2R17 outage modifications	May-2014
Complete on-line modifications	September-2015
Complete 2R18 outage modifications	October-2015
FLEX Storage Complete	October-2015
Complete Building Design	March-2015
Commence Construction	March-2015
Complete Construction	October-2015
River (UHS) Access Complete	October-2014
Fence & Gate Modification Design	February-2014
New Fence & Gate Construction	August-2014
Security Barrier Pipe Penetrations Design	March-2014
Security Barrier Pipe Penetration Construction	October-2014
On-site FLEX Equipment	October-2015
Confirm FLEX Equipment Requirements	November-2013
FLEX Equipment Ordered	April-2015
FLEX Equipment Delivered-Unit 2	October-2015
Off-site FLEX Equipment	October-2015
*Develop Strategies with RRC**	June-2015
Phase 3 Site Access Strategies in Place	June-2015
Complete Near Site Staging Location (as needed)	October-2015
Procedures Complete	October-2015
PWROG issues NSSS-specific guidelines	June-2013
Issue Beaver Valley Unit 2 FLEX Support Guideline (FSG)	October-2015
Issue Maintenance Procedures	October-2015
Training	October-2015
Develop Training Plan	December-2014
Implement Unit 2 Training	October-2015
Submit Completion Report	December-2015

* Regional Response Center (RRC) is now called National SAFER Response Center (NSRC)

ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

The elements identified below for BVPS-2, as well as the OIP (Reference 1), the Initial Status Report (Reference 3), and the Six-Month Status Reports (References 4, 5, 6, 7 and 8), demonstrate compliance with Order EA-12-049.

STRATEGIES – COMPLETE

BVPS-2 strategies are in compliance with Order EA-12-049. There are no strategy related Open Items, Confirmatory Items, or Audit Questions/Audit Report Open Items.

MODIFICATIONS – COMPLETE

The modifications required to support the FLEX strategies for BVPS-2 have been fully implemented in accordance with the station design control process.

EQUIPMENT – PROCURED AND MAINTENANCE AND TESTING – COMPLETE

The equipment required to implement the FLEX strategies for BVPS-2 has been procured in accordance with Nuclear Energy Institute (NEI) 12-06 (Reference 9), Section 11.1 and 11.2, received at BVPS-2, initially tested/performance verified as identified in NEI 12-06, Section 11.5, and is available for use.

Maintenance and testing will be conducted through the use of the BVPS-2 Preventative Maintenance program such that equipment reliability is achieved.

PROTECTED STORAGE – COMPLETE

The storage facilities required to implement the FLEX strategies for BVPS-2 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for BVPS-2 is stored in its protected configuration.

PROCEDURES – COMPLETE

FLEX Support Guidelines (FSGs) for BVPS-2 have been developed and integrated with existing procedures. The FSGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

TRAINING – COMPLETE

Training for BVPS-2 has been completed in accordance with an accepted training process as recommended in NEI 12-06, Section 11.6.

STAFFING – COMPLETE

The staffing study for BVPS-2 has been completed in response to Recommendation 9.3 of the March 12, 2012 NRC request, "Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," (Reference 10), as documented in letters dated April 29, 2013 (Reference 11) and December 5, 2014 (Reference 12).

NATIONAL SAFER RESPONSE CENTERS – COMPLETE

FENOC has established a contract with Pooled Equipment Inventory Company (PEICo) and has joined the Strategic Alliance for FLEX Emergency Response (SAFER) Team Equipment Committee for off-site facility coordination. It has been confirmed that PEICo is ready to support BVPS-2 with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site specific SAFER Response Plan.

VALIDATION – COMPLETE

FENOC has completed performance of validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for FLEX strategies are feasible and may be executed within the constraints identified in the OIP for Order EA-12-049.

FLEX PROGRAM DOCUMENT – ESTABLISHED

The BVPS-2 FLEX Program Document has been developed in accordance with the requirements of NEI 12-06.

REFERENCES

1. FirstEnergy Nuclear Operating Company's (FENOC'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), dated February 27, 2013.

2. Nuclear Regulatory Commission (NRC) Order Number EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012.

3. FirstEnergy Nuclear Operating Company's (FENOC's) Initial Status Report 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), dated October 26, 2012.

4. FirstEnergy Nuclear Operating Company's (FENOC's) First Six-Month Status Report 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-12-051) (TAC Nos. MF0841, MF0842, MF0961, and MF0962), dated August 26, 2013.

5. FirstEnergy Nuclear Operating Company's (FENOC's) Second Six-Month Status Report 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) and Relief/Relaxation Request (TAC Nos. MF0841, MF0842, MF0961, and MF0962), dated February 27, 2014.

6. FirstEnergy Nuclear Operating Company's (FENOC's) Third Six-Month Status Report 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) (TAC Nos. MF0841, MF0842, MF0961, and MF0962), dated August 28, 2014.

7. FirstEnergy Nuclear Operating Company's (FENOC's) Fourth Six-Month Status Report 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) (TAC Nos. MF0841, MF0842, MF0961, and MF0962), dated February 26, 2015.

8. FirstEnergy Nuclear Operating Company's (FENOC's) Fifth Six-Month Status Report 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) (TAC Nos. MF0841, MF0842, and MF0961), dated August 27, 2015.

9. Nuclear Energy Institute (NEI) 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, Revision 0, dated August 2012.

10. NRC Letter, Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012.

11. Response to NRC Letter, Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated April 29, 2013.

12. Response to NRC Letter, Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated December 5, 2014.

INTERIM STAFF EVALUATION (ISE) OPEN ITEMS (OI)

OI 3.2.1.8.A

Verify resolution of the generic concern associated with the modeling of the timing and uniformity of the mixing of a liquid boric acid solution injected into the RCS [reactor coolant system] under natural circulation conditions potentially involving two-phase flow.

Response:

The response to this item was provided by FirstEnergy Nuclear Operating Company (FENOC) letter dated February 27, 2014.

As a result of discussion with the Nuclear Regulatory Commission (NRC) staff during the site audit conducted in July 2015, FENOC revised the RCS cooldown and depressurization mitigating strategy. In the NRC audit report issued by letter dated November 2, 2015, the NRC staff indicated that the licensee input needed for OI 3.2.1.8.A was to submit the revised FLEX mitigating strategy to rely on a limited secondary depressurization to control RCS pressure in a range sufficient to avoid undesired accumulator injection. A summary of the revised strategy is provided in Item SE 16-E below.

AUDIT QUESTIONS (AQ)/AUDIT REPORT OPEN ITEMS

AQ 1-B

In NEI [Nuclear Energy Institute] 12-06, Section 5.3.2, Consideration 5, states: "A means to move the equipment should be provided that is also reasonably protected from the event."

The licensee's plan for deployment of FLEX equipment does not provide reasonable assurance that the plan will comply with NEI 12-06 Section 5.3.2, Consideration 5, for deployment of FLEX equipment because the means to move the equipment that is also reasonably protected from the event is not identified. Although FENOC has listed debris removal equipment and pickup trucks that would be used for the FLEX strategies, they have not described how this equipment would be reasonably protected from the event.

The licensee is requested to provide details regarding how this equipment would be reasonably protected from the event to demonstrate conformance to NEI 12-06, Section 5.3.1, Consideration 5.

Response:

The storage for debris removal equipment and equipment needed to deploy FLEX equipment meet the same requirements for FLEX portable equipment storage. Debris removal equipment and trucks are stored in the same storage facility as the FLEX portable equipment. The FLEX Phase 2 equipment and material that are available to implement the FLEX strategies are included in the FLEX Equipment and Material document that was made available for NRC review.

In addition to the FLEX Equipment and Material document, a FLEX equipment storage building layout and list of FLEX storage for Beaver Valley Power Station, Unit No. 2 (BVPS-2) compliance were made available for NRC review.

AQ 30-B

In NEI 12-06, Section 11.5, provides that "mitigation equipment should be initially tested or other reasonable means used to verify performance conforms to the limiting requirements."

By using load shedding, it appears that the licensee is expecting the batteries to be available for more than 20 hours after the ELAP [extended loss of ac (alternating current) power] event. The licensee is requested to address the following with regard to the load shedding of the dc [direct current] bus in order to conserve battery capacity: Provide the following: a) A dc load profile with the required loads for the mitigation strategies to maintain core cooling, containment, and spent fuel pool cooling; b) A detailed discussion on the loads that will be shed from the dc bus, the equipment location (or location where the required action needs to be taken), and the required operator actions necessary and the time to complete each action. In your response, explain which functions are lost as a result of shedding each load and discuss any impact on defense-in-depth strategies and redundancy.

Response:

a) The DC load profiles for BVPS-2 are shown below:

Battery	(0-1) min	(1-180) min	>180 min
BAT-2-1	287A	206A	89A
BAT-2-2	243A	163A	79A
BAT-2-3	81A	81A	50A
BAT-2-4	101A	101A	47A

Battery	(0-1) min	(1-90) min	(90-180) min	>180 min
BAT-2-5	985A	771A	557A	50A

The following DC sizing calculations were made available to the NRC for review:

Calculation 10080-DEC-3578, *FLEX Battery BAT*2-1 Coping Analysis*
Calculation 10080-DEC-3579, *FLEX Battery BAT*2-2 Coping Analysis*
Calculation 10080-DEC-3580, *FLEX Battery BAT*2-3 Coping Analysis*
Calculation 10080-DEC-3581, *FLEX Battery BAT*2-4 Coping Analysis*
Calculation 10080-DEC-3582, *FLEX Battery BAT-2-5 Coping Analysis*

b) The DC Load Shed Operator Action Summary provided below contains the timelines and plant locations where operator actions are performed. The BVPS-2 actions are completed in 1 hour and 11 minutes (validated) from event initiation. Battery coping calculations assume that load shed is complete within 3 hours of event initiation. There is significant margin available.

DC Load Shed Operator Action Summary

Guidance for shedding non-required DC loads during site blackout is provided in procedure 2OM-53E.1.FSA-11, *DC/UPS ELAP Load Shed*. Actions for this load shed were validated in Validation Plan BV-FLEX-02-13 for Load Shed. Operators must access and turn off breakers in the following four areas with the validated times indicated:

Control Room:	31 minutes
Emergency Switchgear:	16 minutes
2-5 Essential Bus:	18 minutes
Rod Control Building:	6 minutes

All areas that must be accessed are in safety-related structures.

Due to redundancy between trains, no key parameter indications or functionality is lost as a result of DC load shed on BVPS-2.

AQ 34-B

Operator Actions: Attachment 1A, SOE [sequence of events] Timeline on pages 81-84 of the OIP lists the operator actions and associated completion times to mitigate the consequences of ELAP.

The licensee is requested to discuss how the plant specific guidance, mitigation strategies and the associated administrative controls and training program will be developed and implemented to assure that the required operator actions are consistent with that assumed in the ELAP analysis and can be reasonably achieved within the required completion times.

Response:

Verification and validation of the mitigating strategies has been conducted in accordance with the industry guidance developed by NEI and are documented in NORM-LP-7101, *Beaver Valley Power Station FLEX Verification and Validation Report*, which was made available for NRC review.

Training was developed using the Systematic Approach to Training (SAT).

AQ 38-B

Load reduction to conserve dc power: Provide a summary of the sizing calculation for the FLEX turbine generators to show that they can supply the loads assumed in phases 2 and 3.

Response:

The electrical loads to be powered from FLEX generators during Phases 2 and 3 were tabulated and summed (see below). For conservatism and simplicity, loads associated with battery chargers, uninterruptible power supplies, and lighting transformers were determined based on the maximum rating of the equipment rather than the anticipated demand. Motor loads were determined based on the rated full load current. For each phase, the total load was confirmed to be less than the rating of the proposed generator. Given that the generators are being sized to accommodate plants with higher loading requirements, the BVPS-2 needs are met with a high degree of margin.

Calculation 10080-DEC-3586, *FLEX Electrical Load and Voltage Evaluation*, has been approved. The calculation demonstrates that the FLEX generators and the associated electrical distribution equipment are adequately rated to support FLEX strategies. Additionally, the calculation provides recommended operating limits for the FLEX generators that ensure adequate voltage is supplied to plant equipment.

Calculation 10080-DEC-3586, Revision 0, was made available for NRC review.

FLEX DG Load Tabulation

Unit 2 Train A						
Phase 2						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2HVC-FN241A	Control room filtered air intake fan	5HP	6.5	MCC-2-E9-2A	A	Nameplate full load current
2HVZ-FN216A	Battery room exhaust fan	7.5HP	9.5	MCC-2-E13-4A	A	Nameplate full load current
2HVC-FN265A	Control building exhaust fan	20HP	25.5	MCC-2-E03-8C	A	Nameplate full load current
2HVC-FN266A	Control building supply fan	20HP	25.5	MCC-2-E03-8D	A	Nameplate full load current
BAT-CHG2-1	Battery Charger	100A	31	MCC-2-E05-1E	A	31A corresponds to the maximum input current. This current is expected when initially charging a depleted battery.
BAT-CHG2-3	Battery Charger	100A	31	MCC-2-E05-2A	A	31A corresponds to the maximum input current. This

						current is expected when initially charging a depleted battery.
UPS-VITBS2-1	Uninterruptible power supply	20kVA	22.6	MCC-2-E05-12A	A	Current estimated based on 50% loading. The actual loading is expected to be less.
UPS-VITBS2-3	Uninterruptible power supply	15kVA	18	MCC-2-E05-1D	A	Current estimated based on 50% loading. The actual loading is expected to be less.
	RCS injection pump	15HP	18.1		N/A	To be powered directly from FLEX generator. Current estimated.
		Total Current	187.7			
		Total KVA	**156.1**			The total load is less than the rating of the proposed Phase 2 generator.
Phase 3 – 4kV						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2RHS-P21A	Residual heat removal pump	300HP	36.2	4KVS-2AE-2E4	A	Nameplate full load current
2CCP-P21A	Primary component cooling pump	400HP	48	4KVS-2AE-2E5	A	Nameplate full load current
2CCP-P21C	Primary component cooling pump	400HP	48	4KVS-2AE-2E3	A	Swing motor - can be powered from either train. Nameplate full load current
		Total Current	132.2			
		Total KVA	**952.5**			
Phase 3 – 480						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2FNC-P21A	Spent fuel pool cooling pump	25HP	32.5	MCC-2-E03-8A	A	Nameplate full load current
2HVR-FN201A	Containment air recirculation fan	300HP	331	480VUS-2-8-11C	A	Nameplate full load current
2HVR-FN201C	Containment air recirculation fan	300HP	335	480VUS-2-8-11B	A	Swing motor - can be powered from either train. Nameplate full load current
		Total Current	698.5			
		Total KVA	**580.7**			
	Total KVA (All Phases)	**1689.3**				The total load is less than the rating of the proposed Phase 3 generator.

Unit 2 Train B						
Phase 2						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2HVC-FN241B	Control room filtered air intake fan	5HP	6.5	MCC-2-E10-2A	B	Nameplate full load current
2HVZ-FN216B	Battery room exhaust fan	7.5HP	9.5	MCC-2-E14-4D	B	Nameplate full load current
2HVC-FN265B	Control building exhaust fan	20HP	25.5	MCC-2-E04-8C	B	Nameplate full load current
2HVC-FN266B	Control building supply fan	20HP	25.5	MCC-2-E04-8D	B	Nameplate full load current
BAT-CHG2-2	Battery Charger	100A	31	MCC-2-E06-1C	B	31A corresponds to the maximum input current. This current is expected when initially charging a depleted battery.
BAT-CHG2-4	Battery Charger	100A	31	MCC-2-E06-2A	B	31A corresponds to the maximum input current. This current is expected when initially charging a depleted battery.
UPS-VITBS2-2	Uninterruptible power supply	20kVA	22.6	MCC-2-E06-10A	B	Current estimated based on 50% loading. The actual loading

						is expected to be less.
UPS-VITBS2-4	Uninterruptible power supply	15kVA	18	MCC-2-E06-1D	B	Current estimated based on 50% loading. The actual loading is expected to be less.
	RCS injection pump	15HP	18.1		N/A	To be powered directly from FLEX generator. Current estimated.
		Total Current	187.7			
		Total KVA	**156.1**			The total load is less than the rating of the proposed Phase 2 generator.
Phase 3 – 4kV						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2RHS-P21B	Residual heat removal pump	300HP	36.2	4KVS-2DF-2F4	B	Nameplate full load current
2CCP-P21B	Primary component cooling pump	400HP	48	4KVS-2DF-2F5	B	Nameplate full load current
2CCP-P21C	Primary component cooling pump	400HP	48	4KVS-2DF-2F3	B	Swing motor - can be powered from either train. Nameplate full load current
		Total Current	132.2			
		Total KVA	**952.5**			
Phase 3 – 480						
Functional Location	Description	Rating	Current (A)	Power Source	Train	Notes
2FNC-P21B	Spent fuel pool cooling pump	25HP	32.5	MCC-2-E04-8A	B	Nameplate full load current
2HVR-FN201B	Containment air recirculation fan	300HP	349	480VUS-2-9-11C	B	Nameplate full load current
2HVR-FN201C	Containment air recirculation fan	300HP	335	480VUS-2-9-11B	B	Swing motor - can be powered from either train. Nameplate full load current.
		Total Current	716.5			
		Total KVA	**595.7**			
	Total KVA (All Phases)	**1704.3**				The total load is less than the rating of the proposed Phase 3 generator.

AQ 40-B

On page 31 of 172 under "Mobile Boration Unit", the OIP states that "A mobile boration unit will be received from the RRC [Regional Response Center] to provide demineralized makeup to the PPDWST [Primary Plant Demineralized Water Storage Tank]." The rest of the terminology in this section indicates that the boration unit will be used to provide makeup to the Refueling Water Storage Tank [RWST]. Please clarify the use of the boration unit in this section.

Response:

This was a typographical error resulting from a cut and paste. It should read RWST versus PPDWST.

This item was left open to review the use of the RWST during Phase 3. From Condition Report (CR) 2015-09938, Beaver Valley Power Station FLEX Phase 3 strategies are based on maintaining the secondary heat sink indefinitely. However, contingencies for transitioning to residual heat removal for long term core cooling will also be included as part of the Phase 3 procedure 2OM-53E.1.FSG-14, *Phase 3 – Indefinite Coping On The Secondary Heat Sink*. An outline of the procedure and attachments is attached to the CR. Corrective Action (CA) 2015-09938-001 was initiated to track completion of 2OM-53E.1-FSG-14. FSG-14 provides guidance for Phase 3 strategies, including the use of the RWST.

The completed procedure, 2OM-53E.1.FSG-14, was made effective on October 12, 2015. The procedure was also made available for NRC review.

AQ 43-B

The submittal does not address a method of isolating accumulators to prevent nitrogen injection into the RCS [reactor coolant system]. Please discuss the analytical methodology (e.g., see Attachment 1 to PA-PSC-0965) and key assumptions (e.g., containment temperature / heat transfer to accumulator) for assessing the potential for nitrogen injection. Please further identify instrumentation operators would rely upon to ensure that nitrogen injection will not occur.

Response:

Let down and reactor coolant pump (RCP) seal injection are isolated by procedure 2OM-53A.1.ECA-0.0, *Loss of All AC Power*, early in the event, prior to load shedding. Additionally, the valves isolating let down fail closed on loss of power. The safety injection (SI) accumulators are isolated in accordance with 2OM-53E.1.FSG-10, *Passive RCS Management*.

<u>SAFETY EVALUATION (SE) REVIEW OPEN ITEMS</u>

SE 12-E

The licensee needs to confirm that the temperature and pressures within containment, other areas within the plant (i.e., electrical switchgear rooms), and Atmospheric Dump Valve rooms will not exceed the qualification of electrical equipment that is being relied upon as part of their FLEX strategies. The licensee needs to ensure that the qualification of the required electrical equipment remains bounding for the entire duration of the event (i.e., indefinitely).

Response:

During an ELAP event, plant ventilation systems will not be available. If the plant environment were to become adverse, this could hinder a person from completing an action, restrict access to a plant area, challenge equipment functionality, or have a similar negative effect.

CR 2015-09890 tracked ELAP loss of ventilation analyses or documenting evaluations of why actions are not necessary. Refer to the Engineering Evaluation Report (EER) information below for details.

Based on CR 2015-09890, EER 600987403, BVPS-1/BVPS-2 control room ELAP loss of ventilation assessment, was performed. An Excel spreadsheet showing a 24-hour plot of the temperature of the BVPS-1 control room, BVPS-2 control room, BVPS-1 computer room, BVPS-2 computer room, and BVPS-2 ventilation equipment room as a function of time following an ELAP resulted in the following.

Location	Maximum Temperature	At Time
BVPS-1 Control Room	108°F	1 hour
BVPS-2 Control Room	95°F	24 hours
BVPS-1 Computer Room	108°F	1 hour
BVPS-2 Computer Room	91°F	24 hours
BVPS-2 Ventilation Equipment Room	93°F	24 hours

These results are below the equipment qualification (EQ) temperature limit of 120°F, and equipment in the control room will not be challenged by this bulk air temperature of less than 115°F.

Additionally, an Excel spreadsheet was also created showing a 6-hour plot of the wet-bulb globe temperature (WBGT) calculated using the highest node temperature at each time step. This resulted in the maximum control building WBGT of 96°F at 1 hour.

Comparing the WBGT data to the WBGT-based stay times from Table 12.6 of Beaver Valley procedure ES-M-012, Revision 5, *Environmental Conditions for Equipment Qualification Requirements*, (assuming low metabolism working conditions performed in work clothes) it was found that the control room environment is acceptable for the first 6 hours of this event. After 6 hours, additional manpower would become available.

Based on CR 2015-09890, EER 600987427 was created to perform a loss of ventilation assessment of the BVPS-2 battery rooms and switchgear areas due to an ELAP event. This included the environmental effect on equipment and the environmental conditions for performing operator actions. An Excel spreadsheet showing a 24-hour plot of the temperature of the BVPS-2 emergency switchgear and battery rooms 2-1 through 2-4 as a function of time following an ELAP resulted in the following.

Location	Maximum Temperature	Time after ELAP
Emergency Switchgear	111.1°F	1 hour
Battery Room 2-1	115.4°F	12 hours
Battery Room 2-2	104.8°F	1 hour
Battery Room 2-3	115.6°F	12 hours
Battery Room 2-4	104.7°F	1 hour

These results indicate that battery rooms will remain under 125°F, where battery functionality is supported, while the emergency switchgear remains at a low enough temperature to support operator actions.

Based on CR 2015-09890, EER 600987428, BVPS-2 fuel building ELAP loss of ventilation assessment, was performed. An Excel spreadsheet showing a 24-hour plot of the temperature of the BVPS-2 fuel building nodes as a function of time following an ELAP resulted in the following.

Case*	Node Fuel Building	Maximum Temperature	Time
1	Lower	83.5°F	4.58 hours
1	Middle	84.2°F	4.58 hours
1	Upper	84.6°F	4.58 hours
2	Lower	86.9°F	24 hours
2	Middle	86.2°F	24 hours
2	Upper	89.9°F	24 hours

*Case 1: Following full core offload (4 days after shutdown)
Case 2: Following a 1/3 core offload (150 days after shutdown)

It is noted that a 1/3 core offload 150 days after shutdown is not a conservative case. However, the difference is spent fuel pool (SFP) heating of the fuel building is insignificant until SFP boiling. As seen in BVPS-1 calculation DMC-1669, Revision 1 through Addendum 7, *Time to RCS Boiling Calculation for Pre-Outage Shutdown Defense in Depth Report*, SFP boiling for a 60 assembly discharge (25 days after shutdown with an initial SFP temperature of 100°F) has been shown not to occur until after 30 hours, so there should not be a significant difference for the fuel building's 24-hour heat-up temperature profile.

Per NUREG-0700, Revision 2, *Human-System Interface Design Review Guidelines*, a WBGT of 91°F can be used for a 60 minute stay time in work clothes for moderate working conditions. This results in a corresponding dry-bulb temperature of 91.28°F. Case 1 remains below this temperature for 4.58 hours while Case 2 does not exceed this temperature during the modeled 24 hours. As such, the environment is suitable within the respective duration for both cases.

Based on CR 2015-09890, EER 600987429, BVPS-2 main steam valve area ELAP loss of ventilation assessment, was performed. The steady-state indoor dry-bulb temperature was found to be 123°F, while the indoor WBGT was calculated to be 102°F, with a relative humidity (RH) of 34 percent and a dew point temperature of 86°F. This environment is suitable for required operator actions.

Based on CR 2015-09890, EER 600987430, BVPS-2 safeguards building (for example, auxiliary feedwater pump and throttle valve areas) ELAP loss of ventilation assessment, was performed. The results are that the environmental effects on equipment and the environmental conditions for performing operator actions were adequately considered. Because the maximum temperature that would be reached in the first 24 hours is less than 120°F, the equipment would not be challenged. With actions to establish forced ventilation in the area, the operator actions involved with equipment (for example, pump, turbine, trip throttle valve, or auxiliary feedwater throttle valves) would be able to be accomplished by maintaining the area temperature to less than 110°F.

CR 2015-09941 documented remaining items in the area of alternate ventilation strategies for habitability that were to be completed prior to FLEX implementation and compliance with NRC Order EA-12-049. The results of CA 2015-09941-001 address the items related to BVPS-2.

CR 2015-09942 documented remaining items in the area of habitability that were to be completed prior to FLEX implementation and compliance with NRC Order EA-12-049. The results of CA 2015-09942-001 address the items related to BVPS-2.

The following documents were made available for NRC review:

- CR 2015-09890, FLEX Audit – Loss of Ventilation Analyses
- CR 2015-09941, FLEX Audit – Timeline for Alternate Ventilation
- CA 2015-09941-001, BVPS-2 Actions for Alternate Ventilation Strategies
- CR 2015-09942, FLEX Audit – Verify Human Factors Related to the Habitability of Areas where Operators will Control RCS Pressure and Temperature during an ELAP
- CA 2015-09942-001, BVPS-2 Actions for Habitability
- EER 600987427, BVPS-2 Battery Rooms and Switchgear Areas ELAP Loss of Ventilation Assessment
- EER 600987403, BVPS-1/BVPS-2 Control Room ELAP Loss of Ventilation Assessment
- EER 600987428, BVPS-2 Fuel Building ELAP Loss of Ventilation Assessment
- EER 600987429, BVPS-2 Main Steam Valve Area ELAP Loss of Ventilation Assessment
- EER 600979830, BVPS-2 Safeguards Building ELAP Loss of Ventilation Assessment

SE 16-E

Following discussion with the NRC staff during the audit, the licensee intends to revise its mitigating strategy to rely on a limited secondary depressurization to control RCS pressure in a range sufficient to avoid undesired accumulator injection. This aspect of the revised strategy would be similar in concept to the recommended strategy in the existing generic analysis performed for the Pressurized Water Reactor Owners Group in WCAP-17601-P. Once revisions to its FLEX procedures are completed, the licensee should (1) summarize the specifics of its revised FLEX procedures related to RCS cooldown, depressurization, and level / inventory maintenance, (2) provide a revised sequence of events that is consistent with the revised strategy, and (3) confirm

that the RCS conditions for the revised strategy are consistent with the temperature and pressure history assumed in the SHIELD white paper.

Response:

1. Following is a summary of the Beaver Valley Power Station RCS cooldown and depressurization strategy. The hours referenced are based on time after the event.

   Only safety-related systems and equipment and the FLEX equipment is credited for the RCS cooldown and depressurization strategy. Immediately following the event, RCS temperature is controlled on the main steam safeties. The turbine driven auxiliary feed water pump (TDAFWP) starts automatically to maintain steam generator (SG) water levels. At about one hour, operators take manual control of the auxiliary feed water (AFW) throttle valves to prevent overfill of the SGs. No other actions are required in the first 6 hours. Low leakage RCP seals limit loss of RCS inventory and the pressurizer still has indicated level with the RCS subcooled.

   After 6 hours, additional personnel are available to assist with the FLEX responses. The following three activities related to RCS cooldown and depressurization are started at this time:

   a. Commence deployment of the FLEX 480 volts alternating current (VAC) generator. This is the power source for the motor operated valves that isolate the safety injection (SI) accumulators and the FLEX RCS boration pump.

   b. Commence deployment of the FLEX boration pump. Borating during cooldown ensures adequate shut down margin. RCS volume from the cooldown provides the space in the RCS for the boration.

   c. Deploy and connect the jumper between motor control centers E5 and E6. This is required to ensure that all three SI accumulators can be isolated.

   SI accumulators are isolated from the RCS by 14 hours, and the RCS cooldown and depressurization is commenced. By 14 hours and 40 minutes, RCS temperature is less than 520°F and boration can commence. When the RCS volume shrinks out of the pressurizer, RCS pressure rapidly goes to saturation. By 20 hours, the initial RCS cooldown is complete (425°F on BVPS-1 and 445°F on BVPS-2). These target temperatures were chosen to permit continued operation of the TDAFWP. The FLEX alternate AFW pump deployment is complete by 14 hours, so it is available to maintain SG levels, if required. RCS boration is completed by 22 hours and 40 minutes, which meets the goal of completing RCS cooldown, depressurization and boration by 24 hours. This leaves the plant in a condition where there are two methods of maintaining SG level, the TDAFWP and the FLEX alternate AFW pump.

   After 24 hours, the plant transitions to Phase 3 coping. The decision for further RCS cooldown and depressurization will be based on actual conditions and available plant equipment.

2. The Beaver Valley Power Station FLEX Timeline, Revision 4, was transmitted to the NRC by FENOC letter dated August 27, 2015 (ADAMS Accession No. ML15239A290). The timeline has been amended as follows:

[The following table, based on an Overall Integrated Plan/Final Integrated Plan, Table 1A, provides the reviewer with a rapid reference for determining validation levels with respect to the event timeline.]

Annotated Sequence of Events Timeline

BVPS TIMELINE

Action Item	Elapsed Time (Hr:Min)	Action	Time constraint Y/N Level of Validation (A, B, C, N/A)	Remarks/Applicability
	0	Event Starts	N/A	Plant @ 100% power
1	0	Commence station blackout coping actions per ECA-0.0	N	
2	0:04	Recall Operators	N	All shift personnel report to Control Room
3	0:15	Monitor Control Room Temperature	N	Prior to 104 deg F, Control Room doors are opened for ventilation.
4	U1 – 0:21 U2 – 0:24	Troubleshoot EDGs	N	Assumed Durations: Unit 1 – 12 min (EOP Att 2E) Unit 2 – 15 min (EOP Att A-1.5)
5	**0:30**	**Declare ELAP**	**Y** **(A)**	**Required by 1 hour** **Assumption used in Battery Coping Calculations**
6	0:35	Isolate RCP Seals	N	Requires RP coverage
7	**Unit 1 0:40** **Unit 2 0:45**	**Preserve 1 train of Batteries**	**Y** **(A)**	**Required by 2 hours** **Assumption used in Battery Coping Calculations**

8	1:00	Commence Initial Damage Assessment	N	Determine priorities and available equipment/connection points
9	**1:03**	**Initiate ventilation for AFW Room Habitability (U1 only) & Control AFW Flow Locally (AFW Throttle Valves)**	**Y** **(A)**	**Required by 1 hour 12 minutes** **Prevent S/G overfill** **(AFW Throttle Valves located in AFW Room where temperature can reach 125 deg F without ventilation (Unit 1 only, N/A for U2).**
10	1:05	Contact SAFER	N	SAFER will have equipment on site within 24 hours of notification. BVPS requires purified water by 72 hours
11	1:20	Vent H2 from MUG	N	1OM-35.4.J / 2OM-35.4.I
12	**1:25**	**Secure Air Side Seal Oil Pump (Unit 2 only)**	**Y** **(A)**	**Required by 1 hour 30 minutes** **Assumption used in 2-5 Battery Calculation**
13	**1:40**	**Complete Load Shed**	**Y** **(A)**	**Required by 3 hours** **Assumption used in Battery Coping Calculations**
14	2:00	Complete Initial Damage Assessment	N	Determine priorities and available equipment/connection points
15	2:20	Commence actions for Debris Removal & to deploy FLEX PPDWST Make Up Pumps & Hoses	N	Earliest start time based on operator availability. Validated time must be less than 4 hours 40 minutes.
16	2:25	Commence actions to Open SFP Doors for Ventilation	N	Start time based on Phase 2 Staffing Study Tabletop

17	**3:15**	**Open SFP Doors for Ventilation**	**Y** **(B)**	***Required by 13 hours** **Provide heat release path prior to boiling (based on SFP starting temp of 140 deg F)**
18	6:00	Commence actions to deploy FLEX 480VAC Generators & Cables	N	Earliest start time based on personnel & tow equipment availability (4 hours allowed for completion)
19	6:00	Commence actions to deploy FLEX RCS Boration Pumps & Hoses	N	Earliest start time based on personnel beyond minimum staffing required (4 hours allowed for completion)
20	6:00	Commence actions to deploy FLEX Control Room Portable Ventilation & Lighting	N	Earliest start time based on personnel beyond minimum staffing required (2 hours allowed for completion)
21	6:00	Commence actions to install jumpers between safety related MCCs	N	Earliest start time based on personnel beyond minimum staffing required (4 hours allowed for completion)
22	**7:00**	**Start Make Up to the PPDWST**	**Y** **(A)**	**Required by 9 hours** **Based on PPDWST minimum volume & nominal DHR**
23	7:00	Commence actions to deploy and set up Hoses in SFP Building	N	Earliest start time based on deployment equipment limitations (2 hours allowed for completion)
24	8:00	Portable Lighting & Ventilation available for Control Room	N	
25	**9:00**	**SFP hoses deployed in SFP Building**	**Y** **(B)**	****Required by 13 hours** **Boiling in SFP Building (U1 – 13.02; U2 – 13.61; assuming normal heat load & starting temperature of 140 deg F)**

26	**10:00**	**FLEX 480VAC Generator deployed for Battery Charging / RCS Boration; Start Charging Battery**	**Y (B)**	**Required by 14 hours based on need to start boration** **Required by 21.2 hours for battery charging per battery coping calculations**
27	**10:00**	**FLEX RCS Boration Pump deployed to support RCS boration**	**Y (B)**	**Required by 14 hours based on need to start RCS boration**
28	**10:00**	**Jumpers installed between safety related MCCs**	**Y (B)**	**Required by 12 hours to support SI Accumulators isolation**
29	10:00	Commence actions to deploy FLEX Alternate AFW Pumps & hoses	N	Earliest start time based on deployment equipment limitations (2 hours allowed for completion)
30	10:00	Commence actions to isolate SI Accumulators	N	Earliest start time based on need for FLEX 480VAC Generator deployed and MCC jumpers installed
31	10:35	Start Control Room U1 Air Recirculation Fan, U2 Supply & Exhaust Fan	N	Provides air circulation in the Control Room using power from the FLEX 480VAC Generator
32	**14:00**	**SI Accumulators isolated**	**Y (B)**	**Required by 15 hours to support RCS cool down below 520 deg F Thot** **RCS cool down shrinkage is required for BAST injection**
33	14:00	FLEX Alternate AFW Pump deployed to support RCS Cool Down & Depressurization	N	Change from TDAFWP to Alternate AFW Pump when S/G pressure no longer supports TDAFWP operation.

34	14:00	Commence RCS Cool Down to 425 deg F Thot (Unit 1) 445 deg F Thot (Unit 2) & RCS Boration	N	RCS boration, cool down & depressurization commences when FLEX portable equipment is staged & operators available for local control of ASDVs. Target Temperature Basis: U1-prevent SI accum N2 injection; U2 – TDAFWP critical speed steam pressure (Note: if SI accumulators are isolated, limit does not apply)
35	14:00	Commence deployment of FLEX SFP Make Up Pumps & Hoses	N	Earliest start time based on deployment equipment limitations (2 hours allowed for completion)
36	14:30	Commence FLEX Portable Equipment Refueling	N	Based on 250 gph use for the 480VAC generators & 5 gph use for PPDWST Make Up Pumps
37	**14:40**	**Complete Cool Down to 520 deg F Thot / Commence Boration**	**Y**	**Required by 15 hours to establish RCS pressure (<1500 psig) & volume for boration**
38	**16:00**	**FLEX SFP Make Up Pumps & Hoses deployed**	**Y** **(C)**	**Required by 71 hours** **Prevent SFP level decrease below 15 ft above top of fuel assemblies**
39	20:00	Complete RCS Cool Down to 425 deg F Thot (Unit 1), 445 deg F Thot (Unit 2)	N	6 hours allotted for controlled cool down on natural circulation
40	**22:40**	**Complete RCS Boration**	**Y** **(B)**	**Required by 23 hours** **6,105 gal of high concentration boric acid from the Boric Acid Storage Tanks injected into the RCS at 12 gpm to maintain sub-criticality Allows 1 hour for mixing to achieve required concentration by 24 hours**

41	25:00	Commence set up of Water Purification Units from NSRC	N	First equipment from NSRC begins to arrive on site 24 hours following notification
42	30:00	Determine timing for Cool Down & Depressurization of RCS to Mode 4 Conditions	N	Minimize RCS inventory loss & energy input into containment
43	36:00	Change to RWST for Boration / Make Up	N	BAST inventory is expended by 41 hours
44	**48:00**	**Provide Purified Water to the S/Gs to maintain Secondary Heat Sink**	**Y (C)**	**Required by 72 hours** **Satisfactory S/G heat exchange capability can be maintained until 72 hours. Requires water purification units from the NSRC.**
45	72:00	Provide ability to make up to Borated Water Source (RWST)	N	Borated water used to borate RCS / make to RCS or SFP inventory needs to be replenished. Requires mobile boration units from the NSRC.

*Actual historical times to boiling immediately following refueling outages have always been greater than 24 hours

AFW = Auxiliary Feed Water
ASDV = Atmospheric Steam Dump Valve
BAST = Boric Acid Storage Tank
DHR = Decay Heat Removal
EDG = Emergency Diesel Generator
EOP = Emergency Operating Procedure
F = Faranheit
gph = gallons per hour
gpm = gallons per minute
MCC = Motor Control Center
MUG = Main Unit Generator
PPDWST = Primary Plant Demineralized Water Storage Tank
psig = pounds per square inch
RCP = Reactor Coolant Pump
RCS = Reactor Coolant System
RP = Radiation Protection
RWST = Refueling Water Storage Tank
SFP = Spent Fuel Pool
S/G = Steam Generator
SI = Safety Injection
TDAFWP = Turbine Driven Auxiliary Feed Water Pump
Thot = RCS Hot Leg Temperature

3. The RCS conditions for the revised strategy, described above, are consistent with the temperature and pressure history assumed in Westinghouse report TR-FSE-14-1-P, Revision 1. For example, Section 7.1.5, Figure 7.1-2, and Table 7.2-3 show how the test temperature exceeded 550°F, and the test pressure was initiated and maintained at 2250 pounds per square inch absolute (psia) for the first 24 hours and then stepped down to 1650 psia by 72 hours. This bounds the Beaver Valley Power Station strategy where the RCS maximum steady-state temperature will be less than 550°F and, in order to borate the RCS, the RCS pressure will be reduced to less than 1500 pounds per square inch gauge (psig), with boration being completed within the first 24 hours.

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 1), to FirstEnergy Nuclear Operating Company (FENOC). This Order was effective immediately and directed FENOC to have a reliable indication of the water level in associated spent fuel storage pools for the Beaver Valley Power Station, Unit No. 2 (BVPS-2) as outlined in Attachment 2 of the Order. The Order required compliance prior to plant startup from the second refueling outage following submittal of the overall integrated plan (OIP), or by December 31, 2016, whichever comes first. The compliance date for BVPS-2 was October 24, 2015. The NRC staff requested that the compliance report be submitted within 60 days of the compliance date. The information provided herein documents full compliance for BVPS-2 in response to the Order.

COMPLIANCE

FENOC has installed two independent full scale level monitors on the spent fuel pool (SFP) at BVPS-2 in response to Reference 1. This SFP instrumentation was supplied and qualified by Westinghouse, LLC (Westinghouse). BVPS-2 discharges irradiated fuel to a single spent fuel storage pool. With the exception of limited time periods for maintenance or non-refueling operations, administrative controls maintain gates in the open position between the following pools: spent fuel pool, fuel transfer canal, and cask loading pit. Thus, these pools are normally inter-connected and at the same water level when the water level in the spent fuel pool is greater than 1 foot above the top of stored fuel seated in the storage racks. These pools are treated as one SFP with regard to Reference 1.

FENOC submitted the Beaver Valley Power Station OIP by letter dated February 27, 2013 (Reference 2). By letter dated November 19, 2013 (Reference 3), the NRC provided its interim staff evaluation and requested additional information necessary for completion of the review. The information requested by the NRC is included in Attachment 4 of this submittal.

Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance and status reports at six-month intervals following submittal of the OIP. FENOC provided the initial status report for BVPS-2 by letter dated October 26, 2012 (Reference 4). The first, second, third, fourth, and fifth six-month status reports for BVPS-2 were provided by letters dated August 26, 2013, February 27, 2014, August 28, 2014, February 26, 2015, and August 18, 2015, respectively (References 5, 6, 7, 8, and 9).

Compliance with Order EA-12-051 was achieved using the guidance in Nuclear Energy Institute (NEI) document NEI 12-02, Revision 1 (Reference 10), which has been endorsed by the NRC (Reference 11) with exceptions and clarifications. A summary of the compliance elements is provided below

Identification of Levels of Required Monitoring

FENOC has identified the three required levels for monitoring SFP level in compliance with Reference 1. These levels have been integrated into the site processes for monitoring SFP level during beyond-design-basis external events (BDBEEs) and responding to loss of SFP inventory.

Instrumentation Design Features

FENOC has installed SFP instrumentation consisting of permanently mounted, fixed primary and backup instrument channels at BVPS-2. This SFP instrumentation was supplied and qualified by Westinghouse. The design of the SFP instrumentation system complies with the requirements specified in Reference 1 and Reference 10. The SFP instrumentation has been installed in accordance with the site design control process.

The instruments have been arranged to provide reasonable protection against missiles (airborne objects). Each channel consists of a level sensor, an electronics unit, and an indicator. The sensors are mounted on the opposite ends of the SFP as close to the adjacent corners as possible to minimize the possibility of a single event or missile damaging both channels. The sensor arrangement also limits interference with existing equipment in or around the SFP. This design does not pose a potential hazard to personnel working around the pool or on the SFP level instrumentation itself.

The instruments have been mounted to retain design configuration during and following the maximum expected ground motion considered in the design of the SFP structure. 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 designed accuracy following a power interruption and are designed to allow for routine testing and calibration.

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

Program Features

The Systematic Approach to Training was utilized to develop and implement training. Training has been provided for applicable personnel in the use of, and provision of alternate power to, primary and backup instrument channels.

Procedures for the testing, calibration, and use of the primary and backup SFP instrument channels have been established and integrated with existing procedures.

Preventive maintenance tasks have also been established and scheduled to ensure the instruments are maintained at their design accuracy.

REFERENCES

1. Nuclear Regulatory Commission (NRC) Order Number EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, dated March 12, 2012.

2. FirstEnergy Nuclear Operating Company's (FENOC's) Overall Integrated Plan in Response to March 12, 2012 Commission Order Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051), dated February 27, 2013.

3. NRC Letter, Beaver Valley Power Station, 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, dated November 19, 2013.

4. FirstEnergy Nuclear Operating Company's (FENOC's) 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 26, 2012.

5. FirstEnergy Nuclear Operating Company's (FENOC's) First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0799, MF0800, MF0960, and MF0802), dated August 26, 2013.

6. FirstEnergy Nuclear Operating Company's (FENOC's) Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0799, MF0800, MF0960, and MF0802), dated February 27, 2014.

7. FirstEnergy Nuclear Operating Company's (FENOC's) Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0799, MF0800, MF0960, and MF0802), dated August 28, 2014.

8. FirstEnergy Nuclear Operating Company's (FENOC's) Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0799, MF0800, MF0960, and MF0802), dated February 26, 2015.

9. FirstEnergy Nuclear Operating Company's (FENOC's) Fifth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard

to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) (TAC Nos. MF0800, and MF0960), dated August 18, 2015.

10. NEI Document, 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.

11. NRC Japan Lessons-Learned Project Directorate Interim Staff Guidance, JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, dated August 29, 2012.

By letter dated November 19, 2013, the Nuclear Regulatory Commission (NRC) issued an interim staff evaluation (ISE) and request for additional information (RAI) regarding the Beaver Valley Power Station, Units 1 and 2 (BVPS-1, BVPS-2) overall integrated plan for implementation of NRC Order EA-12-051, Reliable Spent Fuel Pool Instrumentation. Subsequently, by letter dated March 26, 2014, the NRC staff transitioned to an audit-based review process that allowed the use of the licensee's ePortal to provide responses to the RAIs to support the staff's review process. FirstEnergy Nuclear Operating Company (FENOC) utilized the ePortal to provide the majority of RAI responses for BVPS-2. The compliance date for BVPS-2 was October 24, 2015. The ISE RAIs are provided below as they pertain to BVPS-2. The responses to the following RAIs were previously provided to the NRC via the FENOC ePortal: RAI-4(b) schematic, RAI-5, RAI-7, RAI-8, RAI-10(b), RAI-11, RAI-12, RAI-13, RAI-14, and RAI-15. RAI responses to RAI-2, RAI-3, RAI-4(a), RAI-4(b), RAI-4(c), RAI-5, RAI-7, RAI-9(a), RAI-11, RAI-12(b), RAI-12(d), RAI-13, RAI-14, and RAI-15 have been amended. The responses are provided in the tense that was applicable when presented on the ePortal, and therefore may not reflect the final completed status. The NRC staff question is presented in bold type, followed by the FENOC response. Following the RAI responses is a copy of the bridging document that was previously provided to the NRC via the FENOC ePortal.

RAI-1:

Please specify for Level 1 how the identified location represents the higher of the two points described in the NEI [Nuclear Energy Institute] 12-02 guidance for this level.

Response:

The response to this RAI was provided by FENOC letter dated February 27, 2014.

RAI-2:

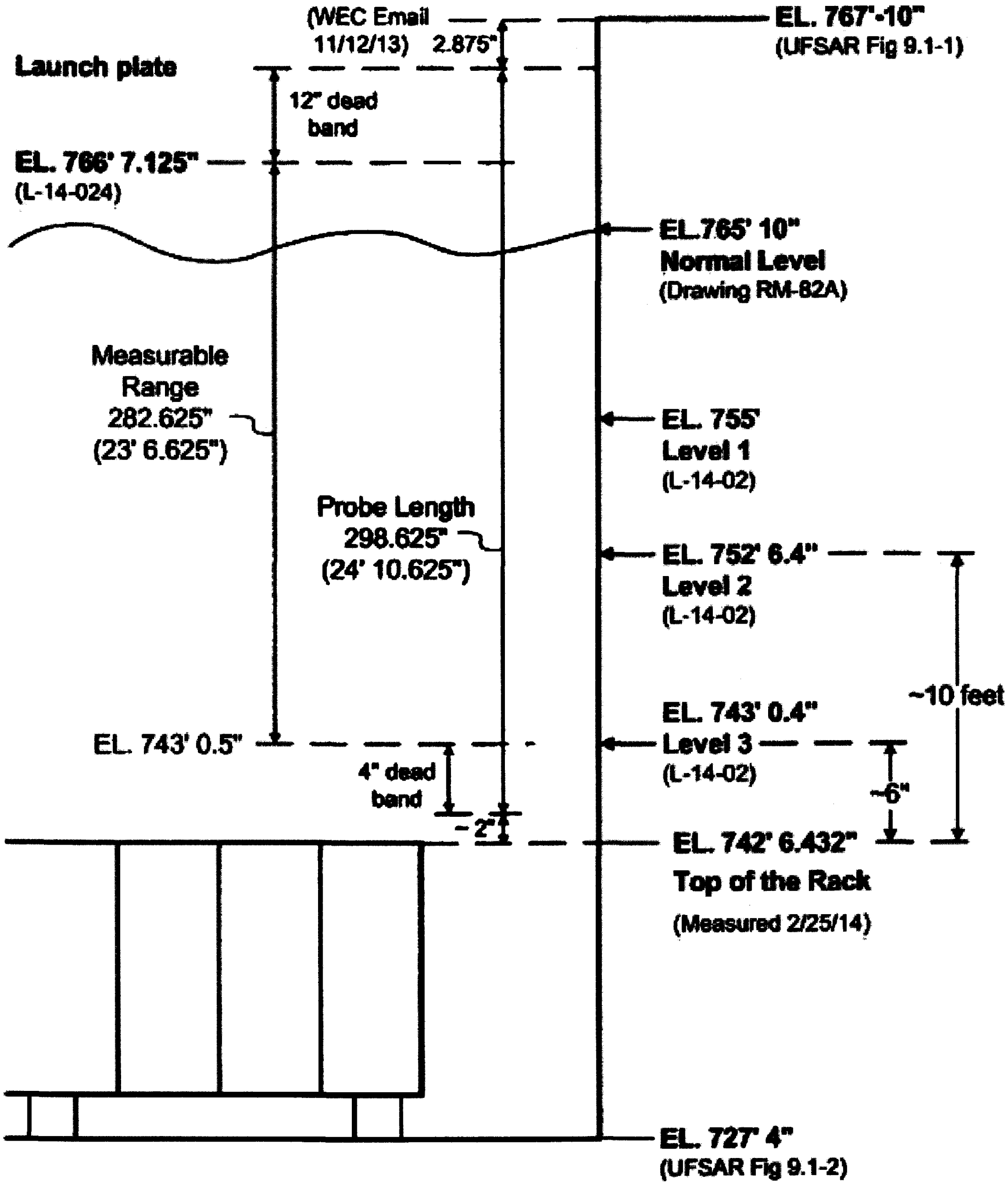
Please provide a clearly labeled sketch depicting the elevation view of the proposed typical mounting arrangement for the portions of the instrument channel consisting of permanent measurement channel equipment (e.g., fixed level sensors and/or stilling wells, and mounting brackets). Indicate on this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

(This information was previously requested as RAI-1b in the NRC letter dated June 25, 2013.)

Response:

By letter dated February 27, 2014, FENOC provided a sketch depicting the requested datum values. Subsequently, more refined measurements were obtained for the top of fuel rack and bottom of measurement range. An updated sketch is provided below.

BVPS Unit 2 Critical Level Elevations and Measurement Range



RAI-3:

Please provide a clearly labeled sketch or marked-up plant drawing of the plan view of the SFP [spent fuel pool] area, depicting the SFP inside dimensions, the planned locations/placement of the primary and back-up SFP level sensor, and the proposed routing of the cables that will extend from these sensors toward the location of the read-out/display device.

(This information was previously requested as RAI-2 in the NRC letter dated June 25, 2013.)

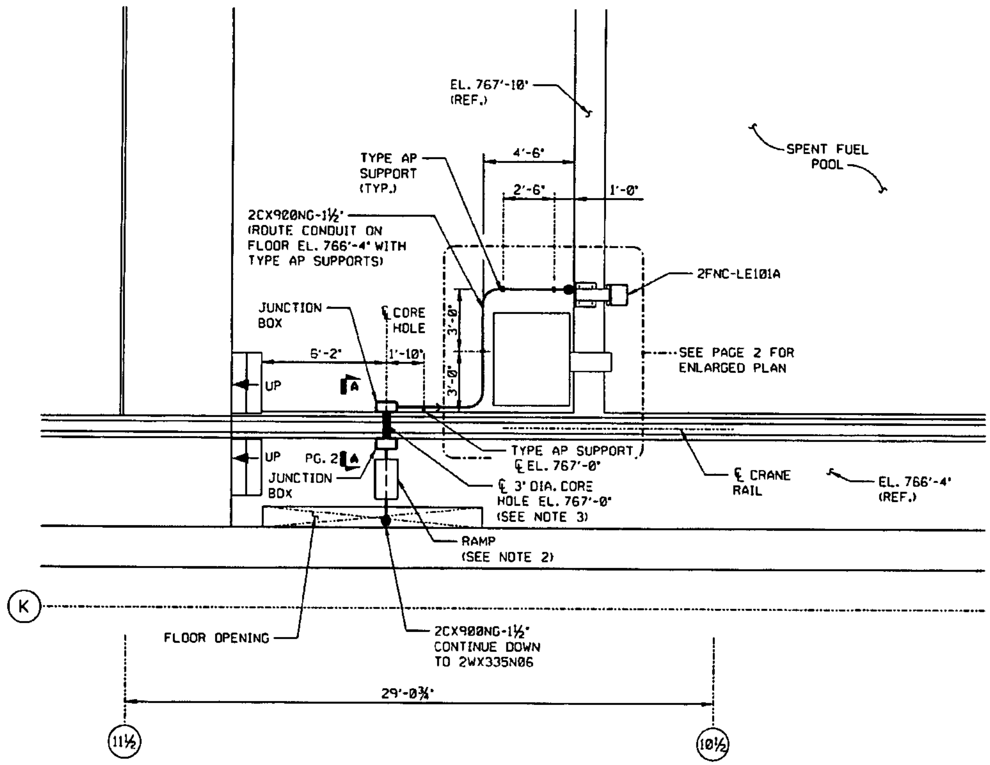
Response:

The response to this RAI was provided by FENOC letter dated February 27, 2014. Subsequently, by FENOC letter dated February 26, 2015, the design for BVPS-2 progressed from conceptual design to final design. As a result, some of the locations of the instrumentation and conduit routing were changed. Updated sketches are provided below, depicting general configuration. Previous versions of these sketches were made available to the NRC staff for review.

The electronics enclosure units (transmitters) are located in an area removed from the SFP environment, which would be accessible in the event of a beyond-design-basis external event (BDBEE) that would restrict access to the SFP. The enclosures for the two instrument channels are separated to minimize the possibility of a single event damaging both channels. The primary level indicating transmitter 2FNC-LIT101A is located on the north wall of the BVPS-2 relay room auxiliary building, general area elevation (El.) 755’ 6”. The backup level indicating transmitter 2FNC-LIT101B is located on the north wall of the BVPS-2 relay room auxiliary building, general area El. 755’ 6”. The level transmitters located in the auxiliary building have a local display, although the credited display units will be located in the main control room (MCR). Cabling for each channel is run in separate conduits and cable trays to the control room indicators.

The primary electronics enclosure 2FNC-PNL101A (control room digital indication) is located on the south wall of the control room, El. 735’ 6”. The backup electronics enclosure 2FNC-PNL101B is located on the south wall of the computer room in the control room, El. 735’ 6”.

Sketches for BVPS-2 Primary SFP Instrumentation



PLAN VIEW
UNIT 2 FUEL BUILDING

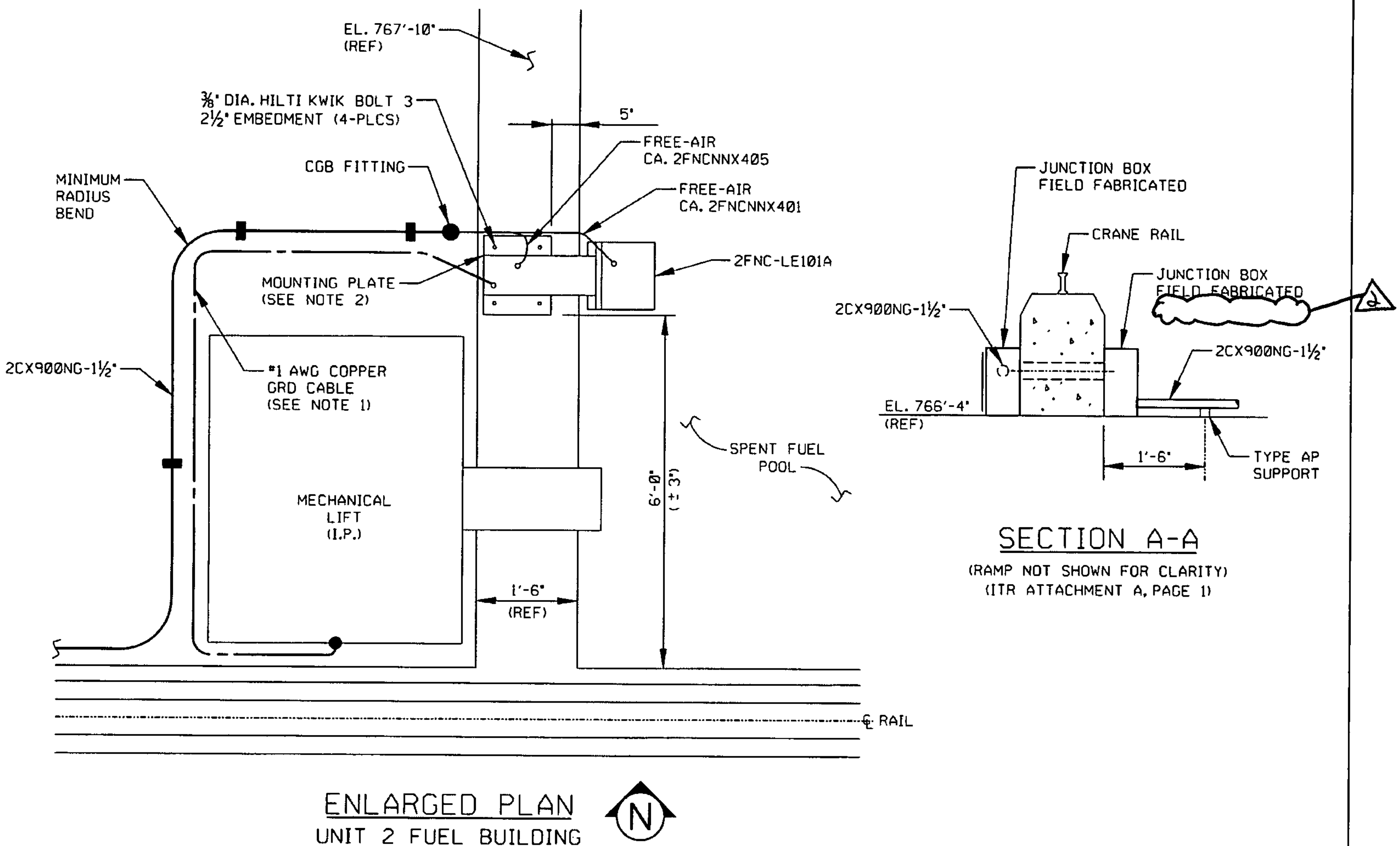
NOTES:

1. SUPPORT TYPES AND LOCATIONS FOR CONDUIT AND JUNCTION BOXES SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.
2. FIELD FABRICATE AND ANCHOR A RAMP TO THE FLOOR IN WALKWAY TO PROVIDE PROTECTION FOR CONDUIT AND TO AVOID A TRIPPING HAZARD AS REQUIRED. SEE ATTACHMENT D.
3. CORE HOLE LOCATION IN CRANE RAIL PEDESTAL MAY BE ALTERED TO AVOID FIELD OBSTRUCTIONS.

REFERENCE:

CONDUIT PLAN, FUEL DECONT BUILDINGS SH 2	RE-50B
FUEL & DECONTAMINATION BLDG. PLANS EL. 768-4" & BELOW	RC-38B

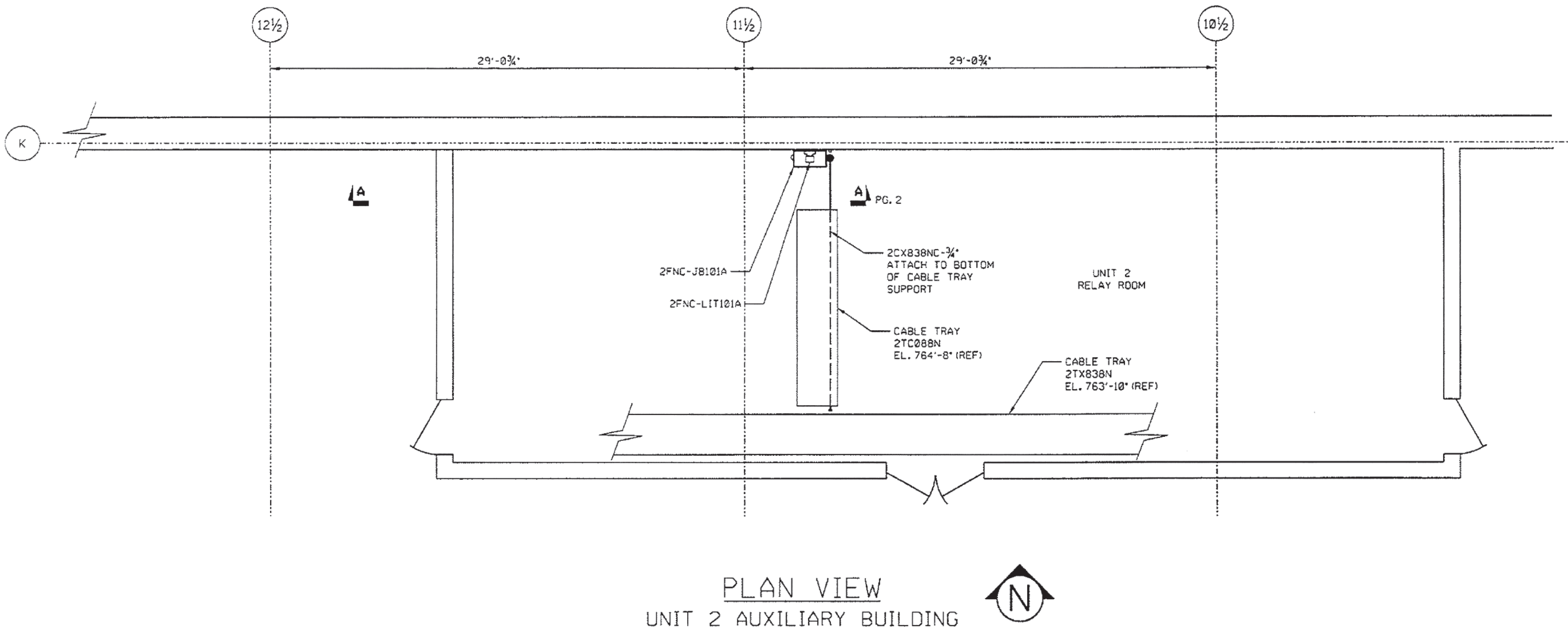
ECP 13-0562-001
ITR ATTACHMENT A
PAGE 1 OF 2
REV 2



NOTES:

1. GROUND NEW EQUIPMENT TO NEAREST STATION GROUND PER 1/2-PIPS-E15.3.
2. SEE WESTINGHOUSE DWG. 1006693 FOR LEVEL SENSOR MOUNTING BRACKET.

ECP 13-0562-001
ITR ATTACHMENT A
PAGE 2 OF 2
REV 2



PLAN VIEW
UNIT 2 AUXILIARY BUILDING
EL. 755'-6"

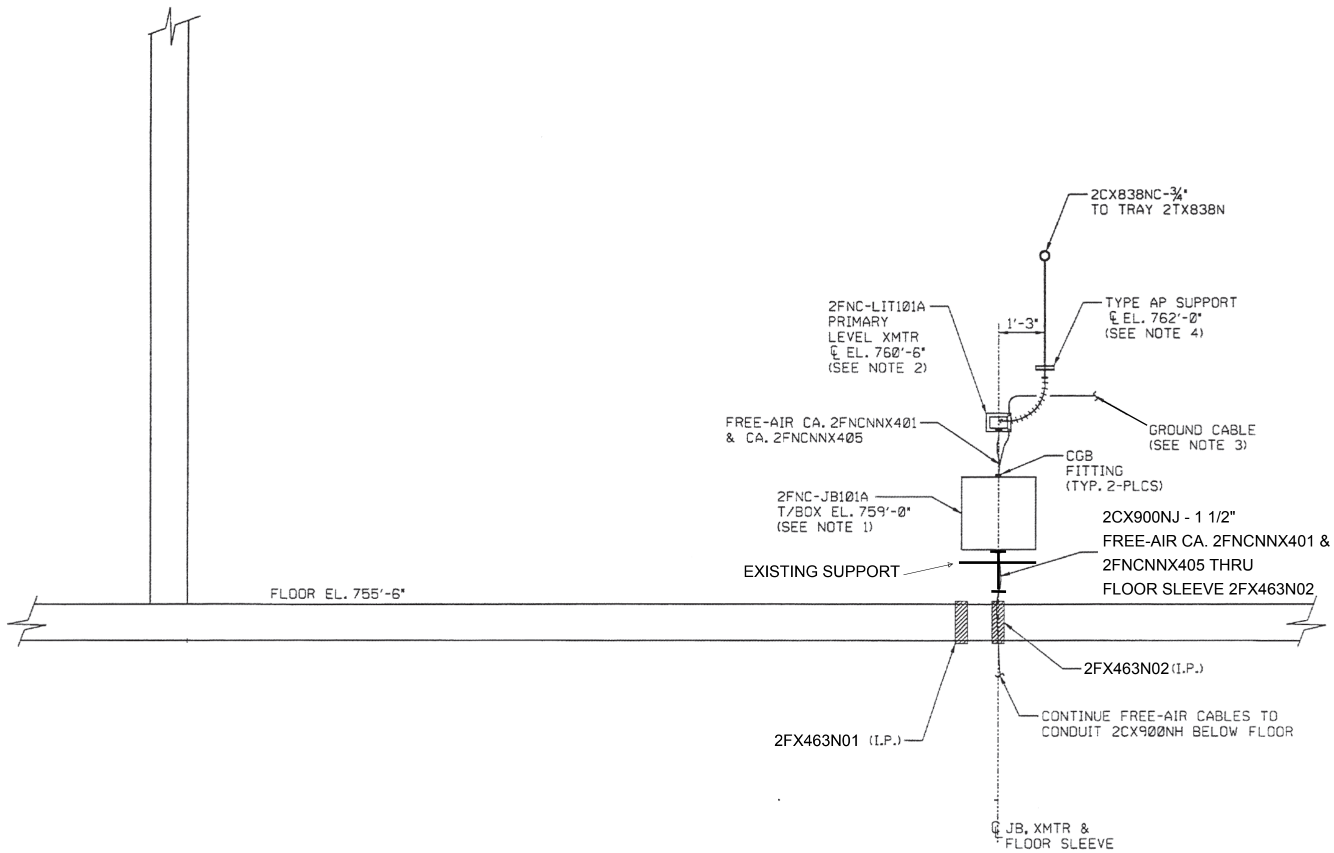
NOTES:

1. SUPPORT TYPES AND LOCATIONS FOR CONDUIT SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.

REFERENCE:

CABLE TRAY ARRANGEMENT, CABLE TUNNEL AUXILIARY BLDG. SH.1	RE-34F
CONDUIT PLAN, INSTR AUXILIARY BUILDING EL. 755'-6"	RE-57L

ECP 13-0562-001
ITR ATTACHMENT B
PAGE 1 OF 4
REV 2



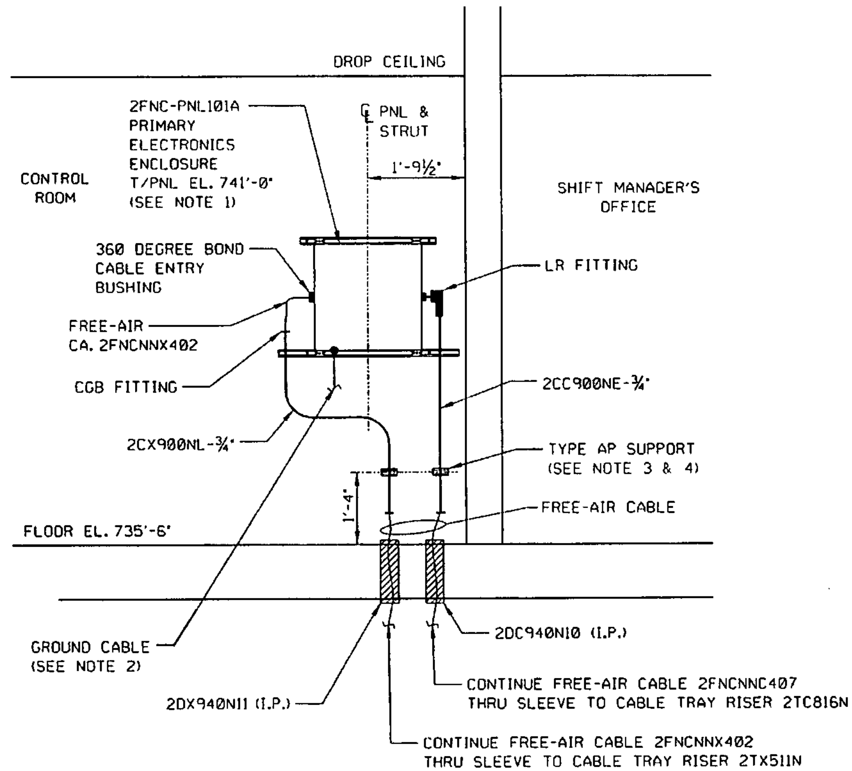
ELEVATION VIEW

UNIT 2 RELAY ROOM
AUXILIARY BUILDING
EL. 755'-6"
(LOOKING NORTH)

NOTES:

1. FOR JUNCTION BOX MOUNTING SEE PAGE 3.
2. FOR TRANSMITTER MOUNTING SEE PAGE 4.
3. GROUND NEW EQUIPMENT TO NEAREST STATION GROUND PER 1/2-PIPS-E15.3.
4. SUPPORT TYPES AND LOCATIONS FOR CONDUIT SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.

ECP 13-562-001
ITR ATTACHMENT B
PAGE 2 OF 4
REV 2



ELEVATION VIEW

CONTROL ROOM
EL. 735'-6"
(LOOKING SOUTH)

NOTES:

1. FOR PANEL MOUNTING SEE PAGE 2.

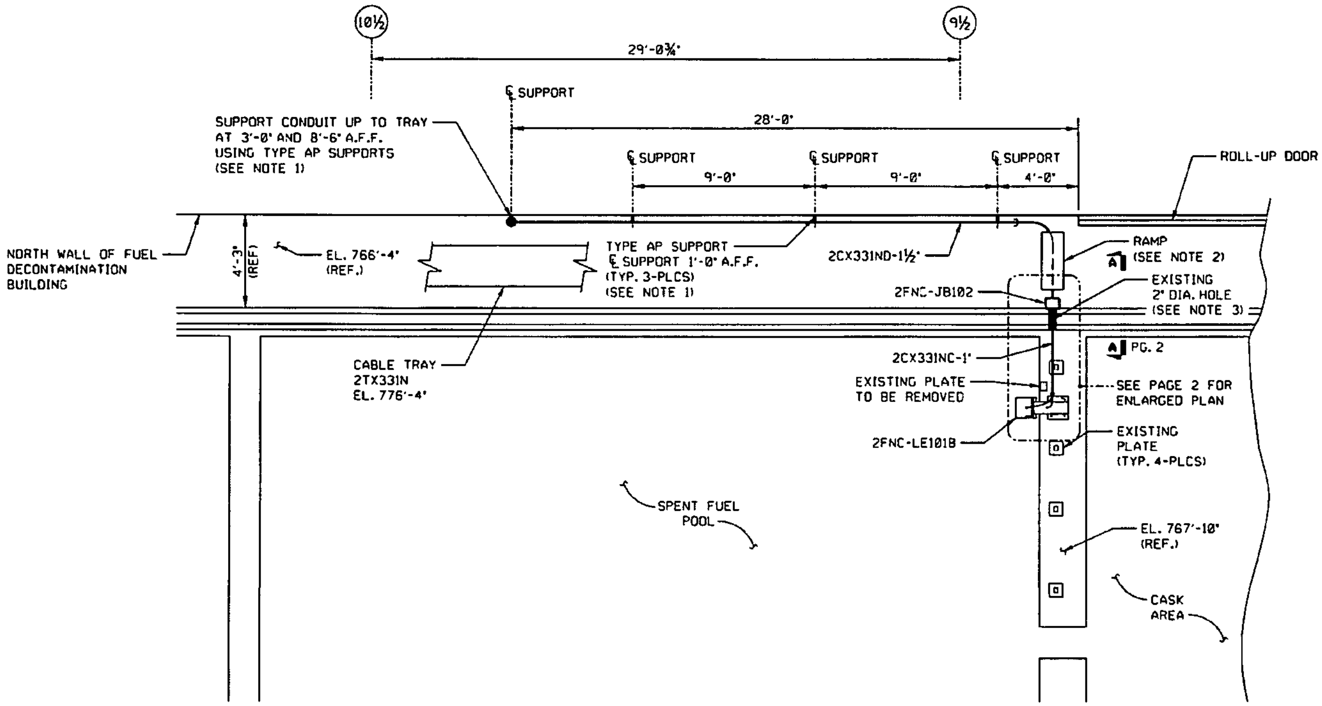
2. GROUND NEW EQUIPMENT TO NEAREST STATION GROUND PER 1/2-PIPS-E15.3.

3. SUPPORT TYPES AND LOCATIONS FOR CONDUIT SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.

4. ADD GROUNDING BUSHING AT END OF CONDUIT 2CC900NE AND ROUTE #12 GROUND CONDUCTOR THRU SLEEVE TO CABLE TRAY RISER 2TC816N AND ATTACHED.

ECP 13-0562-001
ITR ATTACHMENT C
PAGE 1 OF 2
REV 2

Sketches for BVPS-2 Backup SFP Instrumentation



PLAN VIEW

UNIT 2 FUEL BUILDING

N

NOTES:

1. SUPPORT TYPES AND LOCATIONS FOR CONDUIT AND JUNCTION BOXES SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.
2. FIELD FABRICATE AND ANCHOR A RAMP TO THE FLOOR IN WALKWAY TO PROVIDE PROTECTION FOR CONDUIT AND TO AVOID A TRIPPING HAZARD AS REQUIRED. SEE ATTACHMENT D. (1)
3. EXISTING 2" DIA. CORE HOLE LOCATED IN GROUT BELOW CRANE RAIL.

REFERENCE:

CONDUIT PLAN, FUEL DECONT BUILDINGS SH 2	RE-50B
FUEL & DECONTAMINATION BLDG. PLANS EL. 768-4" & BELOW	RC-38B
RAILWALKER DESIGN & DETAILS EL. 767'-10" FUEL BLDG.	RC-38M

ECP 13-0562-002
ITR ATTACHMENT A
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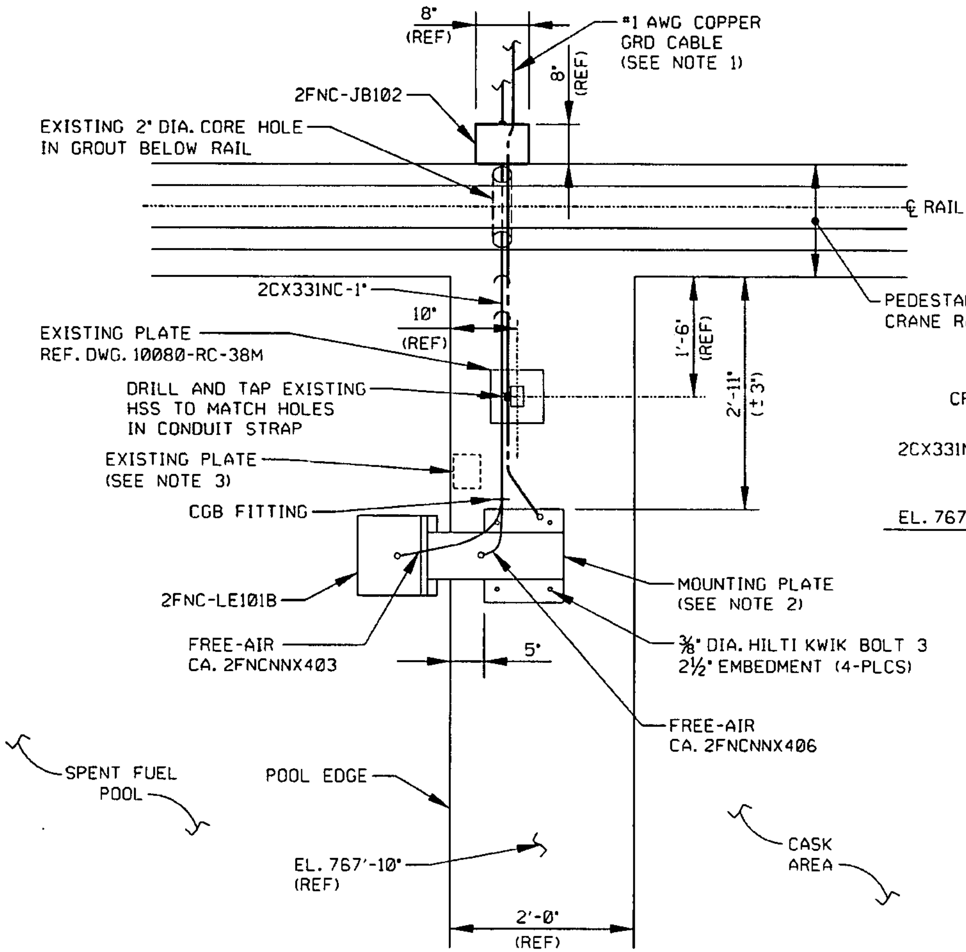
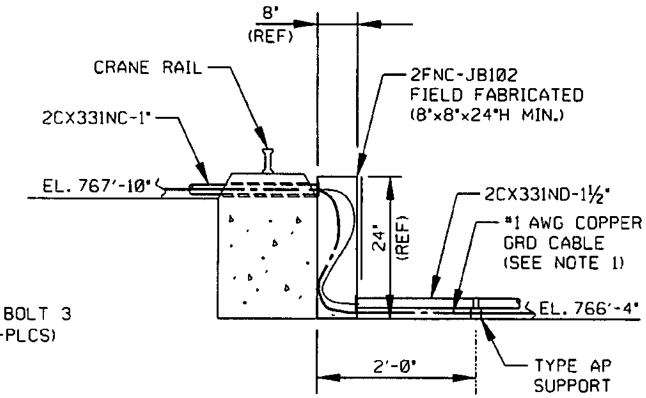
REV 1



ENLARGED PLAN
UNIT 2 FUEL BUILDING



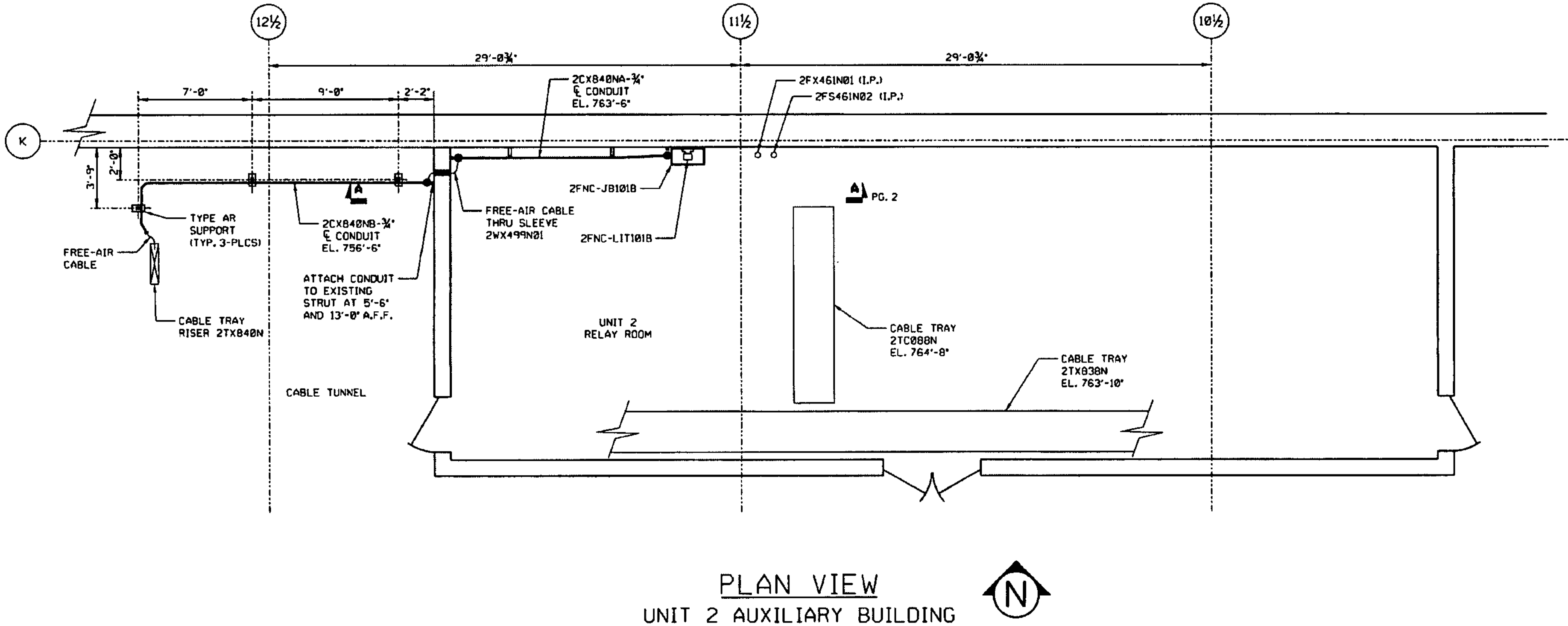
SECTION A-A
(RAMP NOT SHOWN FOR CLARITY)
(ITR ATTACHMENT A, PAGE 1)

NOTES:

1. GROUND NEW EQUIPMENT TO NEAREST STATION GROUND PER 1/2-PIPS-E15.3.
2. SEE WESTINGHOUSE DWG. 1006693 FOR LEVEL SENSOR MOUNTING BRACKET.
3. REMOVE EXISTING PLATE USED FOR POOL MEASUREMENT.

N

ECP 13-0562-002
ITR ATTACHMENT A
PAGE 2 OF 2
REV 1



PLAN VIEW
UNIT 2 AUXILIARY BUILDING
EL. 755'-6"

NOTES:

1. SUPPORT TYPES AND LOCATIONS FOR CONDUIT SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.

REFERENCE:

CABLE TRAY ARRANGEMENT, CABLE TUNNEL AUXILIARY BLDG. SH.1	RE-34F
CONDUIT PLAN, INSTR AUXILIARY BUILDING EL. 755'-6"	RE-57L

ECP 13-0562-002
ITR ATTACHMENT B
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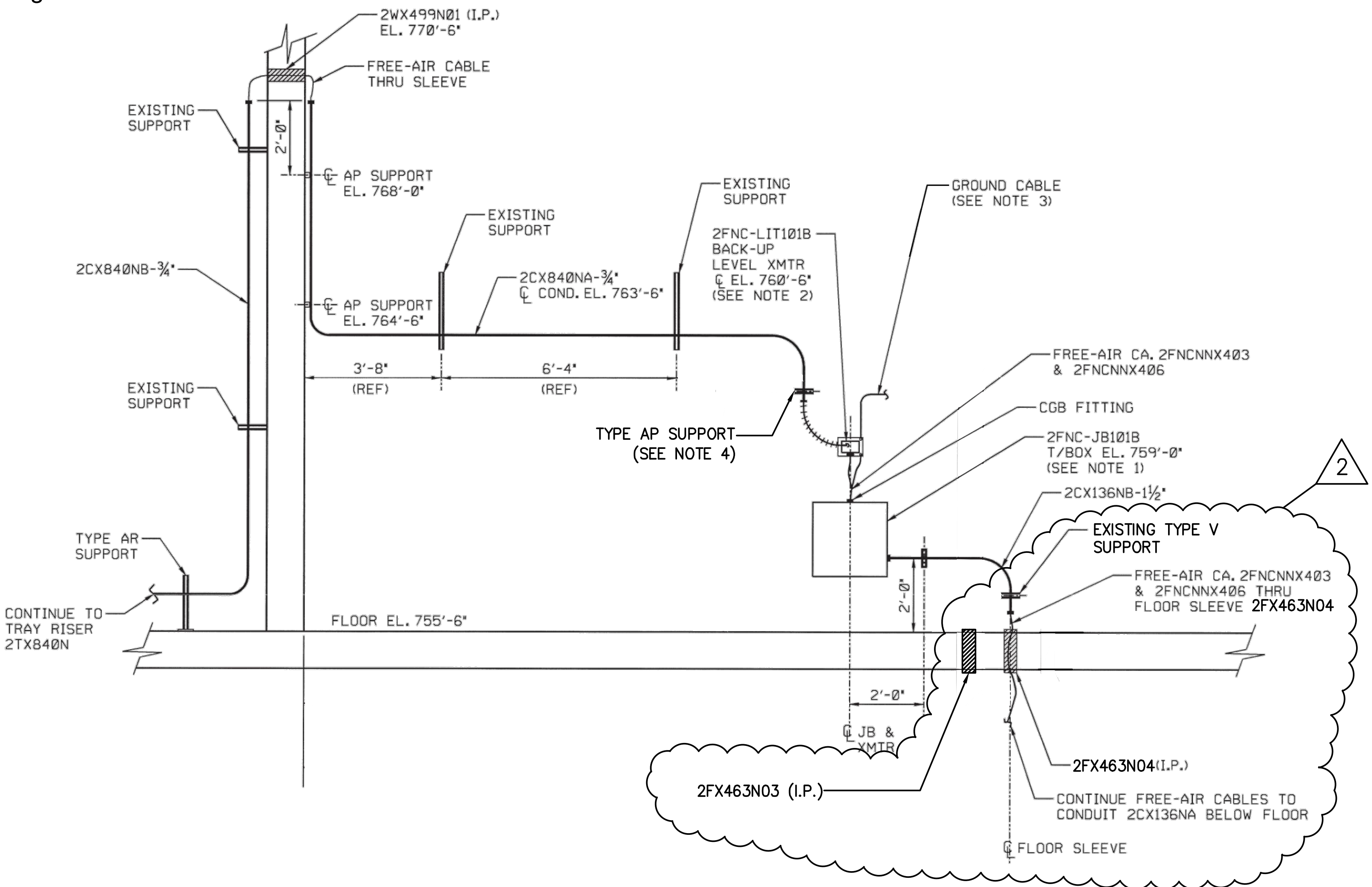
REV 1



SECTION A-A

UNIT 2 RELAY ROOM
AUXILIARY BUILDING
EL. 755'-6"
(LOOKING NORTH)

NOTES:

1. FOR JUNCTION BOX MOUNTING SEE PAGE 3.
2. FOR TRANSMITTER MOUNTING SEE PAGE 4.
3. GROUND NEW EQUIPMENT TO NEAREST STATION GROUND PER 1/2-PIPS-E15.3.
4. SUPPORT TYPES AND LOCATIONS FOR CONDUIT SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.

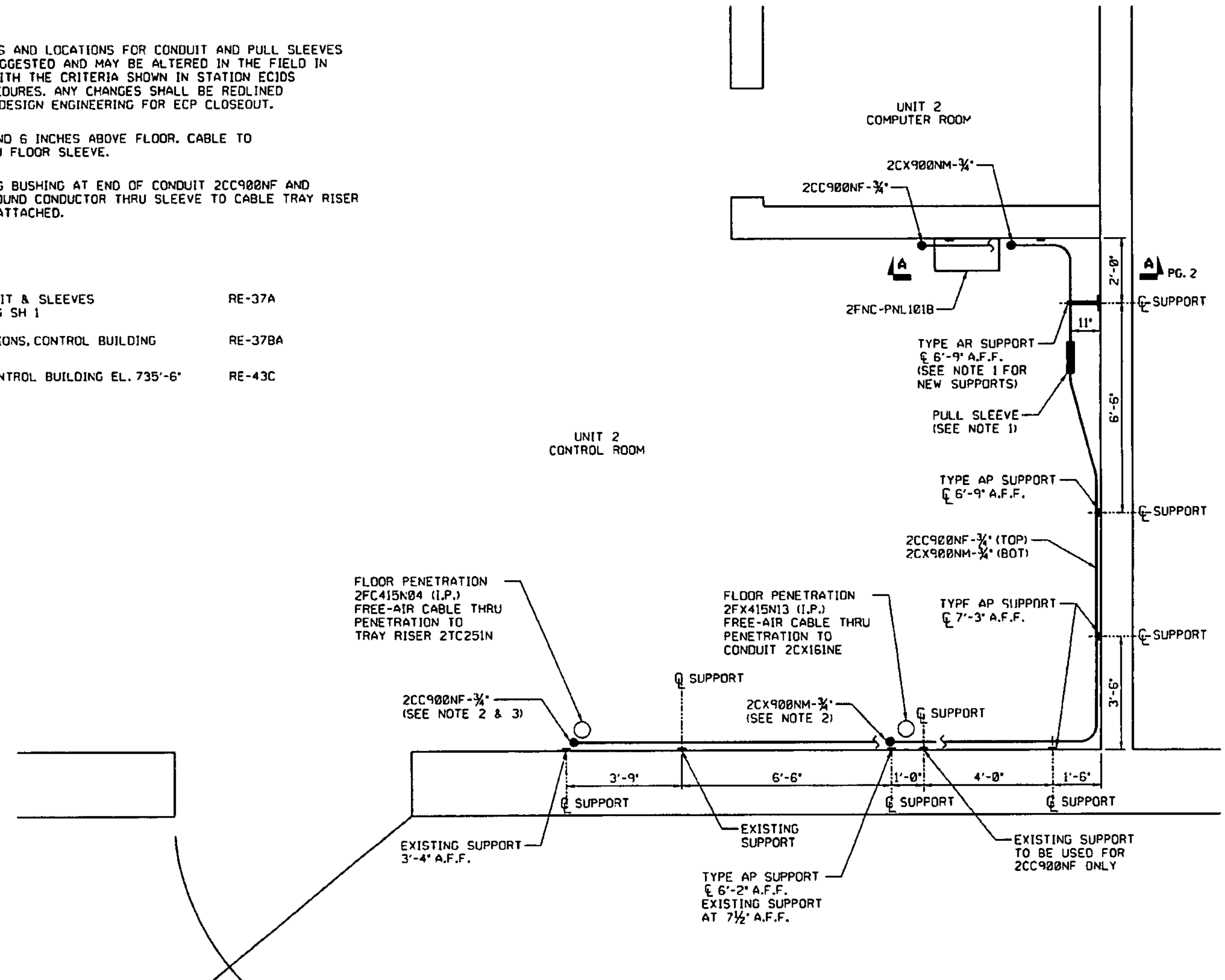
ECP 13-0562-002
ATTACHMENT B
PAGE 2 OF 4
REV 2

NOTES:

1. SUPPORT TYPES AND LOCATIONS FOR CONDUIT AND PULL SLEEVES SHOWN ARE SUGGESTED AND MAY BE ALTERED IN THE FIELD IN ACCORDANCE WITH THE CRITERIA SHOWN IN STATION ECIDS AND PIP PROCEDURES. ANY CHANGES SHALL BE REDLINED AND SENT TO DESIGN ENGINEERING FOR ECP CLOSEOUT.
2. CONDUIT TO END 6 INCHES ABOVE FLOOR. CABLE TO FREE-AIR THRU FLOOR SLEEVE.
3. ADD GROUNDING BUSHING AT END OF CONDUIT 2CC900NF AND ROUTE #12 GROUND CONDUCTOR THRU SLEEVE TO CABLE TRAY RISER 2TC251N AND ATTACHED.

REFERENCE:

CONCEALED CONDUIT & SLEEVES CONTROL BUILDING SH 1	RE-37A
SLEEVE DESIGNATIONS, CONTROL BUILDING	RE-37BA
CONDUIT PLAN, CONTROL BUILDING EL. 735'-6"	RE-43C



PLAN VIEW
UNIT 2 CONTROL ROOM
EL. 735'-6"

N

ECP 13-0562-002
ITR ATTACHMENT C
PAGE 1 OF 3
REV 2

RAI-4:

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.

(This information was previously requested as RAI-3 in the NRC letter dated June 25, 2013.)

Response:

The response to part (a) of this RAI was provided by FENOC letter dated February 27, 2014. Part (a) has subsequently been amended as follows:

(a) The mounting bracket for the sensing probe will be designed according to the plant design basis, inclusive of loads from a Safe Shutdown Earthquake (SSE). Loads that will be considered in the evaluation of the bracket and its mounting are: 1) Static loads, inclusive of the dead weight of the mounting bracket in addition to the weight of the level sensing instruments, and cabling; and 2) Dynamic loads, including the seismic load due to excitation of the dead weight of the system in addition to the hydrodynamic effects resulting from the excitation of the SFP water. A response spectra analysis will be performed for the seismic evaluation of the mounting bracket using a Finite Element Analysis (FEA) software and using floor response spectrum at the operating deck elevation (that is, mounting floor elevation). Damping values will be according to SSE and consistent with the design basis of the station. The material properties that will be used for the bracket and its mounting will take into consideration the environmental conditions in the SFP area following an event. Hydrodynamic effects on the mounting bracket will be evaluated using TID-7024 (Nuclear Reactors and Earthquakes, dated 1963). Plant acceptance criteria and applicable codes will be used for the design of the bracket and its anchorage.

Westinghouse, LLC (Westinghouse) was responsible for designing the instrumentation and mounting, including the base plate, to Beaver Valley Power Station design criteria as part of CN-PEUS-13-25, *Seismic Analysis of the SFP Mounting Bracket at Davis-Besse and Beaver Valley Nuclear Stations*. Calculation DSC-0348, *Spent Fuel Pool Level Instrumentation Mounting Anchor Qualification*, qualifies the expansion anchors used to mount the poolside bracket and demonstrates that 3/8 inch Hilti Kwik-Bolt 3 expansion anchor with a minimum 2.5 inch embedment will be subjected to a maximum considered 280 pound-force (lbf) tension and 98 lbf shear. The minimum allowable tension is 1475 lbf and the minimum allowable shear is 1230 lbf. The resultant interaction ratio is less than 1.0, which is acceptable.

Addendum 1 to calculation DSC-0348 demonstrates that the additional load on the anchors due to sloshing results in a maximum considered tension of 1151.87 lbf. The minimum allowable tension is 1475 lbf. The interaction ratio is less than 1.0 and is, therefore, acceptable.

Calculation DSC-0349, *Spent Fuel Pool Level Instrumentation Equipment Mounting*, qualifies the mounting of the transmitter and electronics enclosure. The pull-out load for the spring nuts is 474.656 lbf and the slip load is 241.982 lbf. The allowable pull-out load is 1000 lbf and the allowable slip load is 800 lbf. The uniform load on the Unistrut supports is 623.811 lbf and the axial load is 407.802 lbf. The allowable uniform load is 1130 lbf and the allowable axial load is 3050 lbf. The tension per anchor for the primary enclosure is 453.256 lbf and the shear is 310.281 lbf. The tension per anchor for the backup enclosure is 594.956 lbf and the shear is 336.256 lbf. The nominal tension for both channels is 1730 lbf and the nominal shear is 1230 lbf. The tension for the transmitter bracket anchors is 274.022 lbf and the shear is 54.663 lbf. The nominal allowable tension is 1730 lbf and the nominal allowable shear is 1230 lbf. The resulting interaction ratio is less than 1.0 for all items.

With the exception of providing a schematic, a response to part (b) of this RAI was provided by FENOC letter dated February 27, 2014. Part (b) has subsequently been amended as follows:

(b) The bracket will be attached to the pool deck using installed anchors that will be designed according to the plant existing specification for design of concrete anchors. This is the only support for this instrument. The pedestal will be adjusted to the height of the poolside curb to ensure the SFP bracket extends over the pool horizontally level. The probe attaches to the bracket’s support plate via a 1½ inch NPT (National Pipe Thread Taper) threaded connection. Non-movable connections of parts will be welded.

The requested schematic contains vendor proprietary information. Westinghouse drawing 1006693, Revision 1, provides details of the mechanical and electrical connections for the mounting of the level sensor in the Fuel Handling Building. The drawing was made available to the NRC staff for review.

The response to part (c) of this RAI was provided by FENOC letter dated February 27, 2014. Part (c) has subsequently been amended as follows:

(c) The attachment of the seismically qualified bracket to the pool deck will be through permanently installed anchors. With permanently installed anchors, the bracket pedestal will be secured to the poolside deck with adequate washers and bolts.

The following results of the response spectra analysis are contained in Westinghouse calculation CN-PEUS-13-25, Revision 1, *Seismic Analysis of the SFP Mounting Bracket at Davis-Besse and Beaver Valley Nuclear Stations*. The GTSTRUDL model and output considers self-weight, dead load of the instrumentation, hydrodynamic loads due to seismic effects, and seismic load on the bracket. All members passed code check with interaction ratios below the allowable limit using the applicable requirements per American Institute of Steel Construction (AISC) 7th Edition. Considering all of the loads and load combinations, all members of the bracket are acceptable. All welds and bolts are acceptable when compared to their applicable allowable values. This calculation, which contains vendor proprietary information, was made available for NRC review.

RAI-5:

For RAI 4(a) above, 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:

The results of the analysis and the parameters used are contained in Westinghouse calculation CN-PEUS-13-25, Revision 1. The results are obtained from the GTSTRUDL model and are in accordance with site design requirements and AISC 7th Edition. Considering all of the applicable loads and load combinations, all members of the bracket are acceptable. All welds and bolts are acceptable when compared to their applicable allowable values. The results of the analysis represent all the applied loads and load combinations that were applied. The GTSTRUDL model and output considers self-weight, dead load of the instrumentation, hydrodynamic effects of the SFP water, and seismic load on the bracket. All members passed code check with interaction ratios below the allowable limit using the applicable requirements per AISC 7th Edition. Considering all of the loads and load combinations, all members of the bracket are acceptable. All welds and bolts are acceptable when compared to their applicable values. This calculation, which contains vendor proprietary information, was made available for NRC review.

Calculations are DSC-0348, *Spent Fuel Pool Level Instrumentation Mounting Anchor Qualification*, and DSC-0349, *Spent Fuel Pool Level Instrumentation Equipment Mounting*. The vendor manual is 2507.210-000-008; Qualification Reports; and Drawings. These documents demonstrate that the design for the mounting of electronic components and conduits was completed in accordance with the endorsed guidance in Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 344-2004, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*. Additional detail was provided in the amended response to RAI-4 above.

Because Beaver Valley Power Station and Davis-Besse Nuclear Power Station (DBNPS) share a bracket design and because DBNPS has a larger pool, the sloshing analysis performed in CN-PEUS-13-25 is bounded by DBNPS. The wave height due to sloshing is 2.574 feet maximum. This value is documented in CN-PEUS-13-25, Section 4.5.2.3, and is based on TID-7024. This 2.574 feet value is bounded by the 5-foot value considered in the generic qualitative analysis performed for the level sensing probe documented in LTR-SEE-II-13-47. The BVPS-2 specific distance from the nominal water level to the bracket is approximately 21 inches, which is greater than the 12 inches used in the generic analysis performed by Westinghouse (LTR-SEE-II-13-47).

RAI-6:

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:

The response to this RAI was provided by FENOC letter dated February 27, 2014. Additional detail related to this response was provided in the amended response to RAI-4 above.

RAI-7:

Please provide the following:

(a) A description of the specific method or combination of methods that will be applied to demonstrate the reliability of the permanently installed equipment under BDB [beyond-design-basis] 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 (i) the level sensor mounted in the SFP area, and (ii) any control boxes, electronics,

or read-out and re-transmitting devices that will be employed to convey 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.

(This information was previously requested as RAI-4 in the NRC letter dated June 25, 2013.)

Response:

The NRC staff audited the Westinghouse SFP instrumentation design verification analyses and performance test results in support of its review of Tennessee Valley Authority's (TVA's) overall integrated plan for the Watts Bar Nuclear Plant (WBN) facility (ADAMS Accession No. ML14211A346) for compliance to EA-12-051. The NRC staff found the SFP instrumentation design and qualification process reasonable.

Westinghouse methodologies for demonstrating the reliability of the installed SFP level instrumentation system are described in Westinghouse report EQ-QR-269, Revision 1, *Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation System*, and Westinghouse report EQ-QR-264, Revision 0, *Equipment Qualification Abbreviated Summary Report for the Spent Fuel Pool Instrumentation System*. These reports, which contain vendor proprietary information, were made available for NRC review.

(a) Environmental qualification testing was performed in accordance with Institute of Electrical and Electronics Engineers, Inc. (IEEE) Std. 323-2003, and electromagnetic compatibility (EMC) qualification testing was performed in accordance with the technical requirements of Regulatory Guide 1.180.

    Temperature and Humidity – Thermal aging and steam testing were performed on the coaxial cables and couplers using a thermal aging oven at a temperature of 212°F for the calculated age duration of 311 hours plus 10 percent margin, or 343 hours, and at 219°F for 206.5 hours plus a 10 percent margin, or 228 hours. The coaxial cables and couplers were coiled and set on separate racks in the thermal oven. The coupler was required to be threaded into the non-preconditioned end of the cable and aged as one assembly. Steam testing was performed in accordance with IEEE Std. 323-2003. The test specimen was exposed to 212°F (+/-1.8°F), 100 percent saturated (+0, -2 percent) for a duration including 10 percent margin of 185 hours. In addition, the connectors were splash tested to determine the appropriate torque level and sealing.

    The expected temperature of the BVPS-2 SFP area in BDB conditions is 212°F due to boiling water. This matches the design temperature of 212°F. The expected humidity is 100 percent. This matches the design humidity of 100 percent.

The components outside of the SFP area are required to operate reliably per "mild environment conditions" that occur during normal plant operation, including any abnormal operating occurrence. An abnormal operating occurrence would be a loss of heating, ventilating, and air conditioning (HVAC) in the installed equipment location. For equipment located in a mild environment, seismic is the only postulated consequential event. No BDB conditions were defined for mild-environment equipment.

The expected temperature of the transmitter location during abnormal operation is 120°F (calculation 12241-B-2A, *Primary Auxiliary Building and Waste Handling Building Air Conditioning Loads and Air Flow Rates*). This is below the design temperature of 140°F. The expected humidity of the transmitter location is 90 percent. This is within the design range of 0 – 95 percent.

It is required that the operators be able to access the electronics enclosures located in the main control room in the event of a BDBEE. The temperature and humidity levels in this area will remain mild during a BDBEE. Therefore, the area conditions are considered habitable by the operator.

The expected temperature of the electronics enclosure location during abnormal operation is 120°F (calculation 12241-B-8A, *Control Building Air Conditioning Loads Air Flow Rates*). This is below the design temperature of 140°F. The expected humidity is 50 percent. This is within the design range of 0 – 95 percent.

Radiation – The coaxial cable and coupler underwent radiation aging in accordance with IEEE Std. 323-2003 for service in post-accident radiation conditions. Test specimens were required to be exposed to a minimum of 11 Mrad of Co^{60} gamma rays at a dose rate minimum of 0.2 – 0.5 Mrad/hour.

The bounding dose for location of the transmitters was determined to be 987.6 rad [Engineering Change Package (ECP) 13-0562-000], which is less than the 1000 rad design limit. The bounding dose for the level sensors was determined to be 2.67 Mrad (calculation 10080-UR(B)-512, *Radiation Levels Following Spent Fuel Pool Drain Down and Environmental Dose to NEI 12-02 SFP Level Instrumentation*), which is less than the 10 Mrad design limit. The bounding dose for the location of the electronics enclosures was determined to be 300 rad (ECP 13-0562-000), which is less than the 1000 rad design limit.

EMC – Susceptibility, emissions and harmonics testing was performed and the guidance and limits provided in Regulatory Guide 1.180 were used. Continuous monitoring was performed to monitor the performance during the application of EMC susceptibility testing. Performance Criterion for this system is determined to be Criterion B.

A radio exclusion zone will be established around the equipment in the SFP. The transmitter and electronics enclosure locations are already established exclusion zones. There are no motors in the vicinity of the equipment that could interfere with the operation of the equipment.

(b) Seismic qualification testing was performed in accordance with IEEE Std. 344-2004, which is endorsed by NRC Regulatory Guide 1.100, Revision 3, and IEEE Std. 323-2003. The electronics enclosure was mounted to the test fixture with four 3/8-inch Grade 5 bolts, lock washers, flat washers, and nuts torqued snug tight. The sensor head unit mounting bracket was mounted to the fixture with four 3/8-inch Grade 5 bolts, lock washers, and flat washers torqued snug tight. The sensor head unit was mounted to the sensor head unit mounting bracket with two 1/4 inch-20 bolts and lock washers torqued to 75 in-lbs. The coaxial coupler was torqued hand tight. The launch plate was mounted to the fixture with four 5/16-inch Grade 5 bolts and lock washers torqued snug tight. The sensor head unit mounting bracket was mounted to the coupler using the integral threads in the probe and a lock washer to snug tight. Terminal block attachments within the rear of the sensor head unit were torqued to 8 in-lbs.

Seismic testing was performed on a 4x4-foot independent triaxial test table using random, multi-frequency acceleration time history inputs. Accelerometers were mounted on the test table and equipment under test. The table drive signal was applied separately and simultaneously in both the horizontal and vertical directions for a duration of 30 seconds with a minimum of 20 seconds of strong motion. The response from the table and the response accelerometers were analyzed at 5 percent critical dampening for each operating basis earthquake (OBE) and safe shutdown earthquake (SSE) test and were plotted at one twelfth octave intervals over the frequency range of 1 to 100 Hz.

Seismic testing of the instrumentation was performed in accordance with IEEE 344-2004. The required response spectra (RRS) included a 10 percent margin recommended by IEEE 323-2003. Seismic testing was performed to the defined SSE and hard rock high frequency (HRHF) spectra. The OBE RRS at 5 percent critical damping was at least 70 percent of the respective SSE seismic level. At a minimum, five successful OBE level tests were required, followed by two successful SSE level tests and one successful HRHF level test. In addition, static pull tests were performed on the Radial connectors (straight and 90 degree) to address seismic qualification of the connectors.

(c) The equipment under test (EUT) was powered on during OBE seismic test runs, but was not electrically monitored during the test runs. Functional testing was performed before and after the five successful OBE test runs. The system maintained accuracy after five successful OBE level tests and no loss of power was noted during the test runs. The EUT was powered on during all SSE and HRHF seismic test runs, but was not electrically monitored during the test runs. Functional testing was also performed before and after each successful SSE and HRHF test run. The system maintained accuracy after all SSE and HRHF level tests and no loss of power was noted during the test runs.

During the SSE 2, the alternating current (AC) power was removed from the system approximately 15 seconds into the run. This operation was performed to ensure that the uninterruptible power supply (UPS) was able to switch from line power to battery power during a seismic event. The system performed without issue. The EUT met all of the required performance and acceptance criteria and maintained structural integrity during all acceptable OBE test runs, acceptable SSE test runs, and the acceptable HRHF test run to the RRS. Acceptable functionality of the EUT was confirmed upon completion of seismic testing. The post-test inspection performed upon completion of all seismic tests revealed no major structural issues or damage to the EUT.

RAI-8:

For RAI 7 above, please provide the results from the selected methods, tests and analyses used to demonstrate the qualification and reliability of the installed equipment in accordance with the Order requirements.

Response:

The NRC staff audited the Westinghouse SFP instrumentation design verification analyses and performance test results in support of its review of TVA's overall integrated plan for the WBN facility (ADAMS Accession No. ML14211A346) for compliance to EA-12-051. The NRC staff found the SFP instrumentation design and qualification process reasonable.

Westinghouse test results for the SFP level instrumentation system are described in Westinghouse report EQ-QR-269, Revision 1, *Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation System* and Westinghouse report EQ-QR-264, Revision 0, *Equipment Qualification Abbreviated Summary Report for the Spent Fuel Pool Instrumentation System*. These reports, which contain vendor proprietary information, were made available for NRC review.

Temperature and Humidity – Thermal aging was performed within the required temperature parameters and for the required duration and a post-thermal aging functional test was successfully performed. During steam testing, functional tests were performed, which verified that the test equipment was functioning within the required accuracy, as well as confirmed that the enclosure display correctly identified the simulated pool level. Acceptable functional test results were obtained during functional testing. Post-test baseline testing was conducted upon completion of environmental testing with successful functional results.

Westinghouse concluded that the probe, coaxial cable, 90 degree and straight connector, and stainless steel coupler are able to perform in abnormal conditions in the SFP area for up to seven days. In addition, Westinghouse tests demonstrated that the level sensor electronics with the coupler and the coaxial cable attached performs accurately when the probe, coupler, and coaxial cable are exposed to a temperature range of 10 to 100°C (50-212°F) and up to 100 percent relative humidity (RH).

Regarding components outside the SFP area, Westinghouse concluded the aggregate of the environmental verification activities for the SFP instrumentation demonstrate that the instrumentation operates reliably in accordance with the service environmental requirements specified for both the harsh and outside SFP area conditions. The level sensor electronics housing was also verified to meet IP67 rating per EPSILON 08 TEST 2373, which will prevent water ingress and withstand 100 percent humidity.

In addition, Westinghouse completed their 10-year aging test. The purpose of the testing was to extend the existing qualified life from 15 months to 10 years. The system with the 90 degree connector passed the test and is now qualified to a 10-year life. The BVPS design uses the 90 degree connector.

Shock and Vibration – Seismic testing consisted of five successful OBE tests, two successful SSE tests, and one successful HRHF test. During the second successful SSE level test (281 SSE 2), AC power was cut off to the SFP instrumentation system to ensure that the UPS would reliably switch during a seismic event. No equipment failures were noted as a result of the seismic test runs. Westinghouse performed functional testing of the equipment before and after each SSE and HRHF runs, and the equipment maintained its functionality. In addition, Westinghouse inspected the equipment after the seismic testing and no damage was found. Westinghouse concluded that the system met all requirements, maintaining structural integrity during and after all OBEs, SSEs and HRHF tests.

Radiation – The coaxial signal cable and coupler were subjected to thermal and radiation aging prior to seismic testing. Two sets of identical specimens were aged, and the components performed to the limits of 2.5 years for thermal aging and 10 MRad + 10 percent margin for radiation aging. The coaxial cable and coupler were visually inspected after radiation resting. It was identified that a lock washer was missing from the probe attachment point of the coupler. Westinghouse noted that the absence of this lock washer had no effect on the thermal or radiation aging performed, and that the inspection did not reveal any noticeable degradation. A baseline functional test was performed and did not show any change in performance as a result of the radiation aging performed.

EMC – The system met all of the identified performance requirements before, during and after each EMC susceptibility test and demonstrated compliant emission levels. No modifications or deviations were required to achieve compliance during EMC testing.

RAI-9:

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 pacticable.

(b) Further information describing the design and installation of each level measurement system, consisting of level sensor electronics, cabling, and read-out devices. Please address how independence of these components of the primary and back-up channels is achieved through the application of independent power sources, physical and spatial separation, independence of signals sent to the location(s) of the readout devices, and the independence of the displays.

(This information was previously requested as RAI-5 in the NRC letter dated June 25, 2013.)

Response:

The response to this RAI was provided by FENOC letter dated February 27, 2014. Subsequently, by FENOC letter dated February 26, 2015, the design for BVPS-2 progressed from conceptual design to final design. As a result, some of the locations of the instrumentation and conduit routing were changed. An amended response to part (a) for BVPS-2 is hereby provided.

(a) Within the BVPS-2 SFP area, the brackets are located on the west deck of the southwest corner (primary sensor) and east deck of the northeast corner (back-up sensor) of the SFP El. 767' 10", as permanent plant structures allow. Placing the brackets and probes in the corners allows for natural protection from a single event or missile from disabling both systems. The cabling within the SFP area is routed in separate hard-pipe conduit. Site safety related separation requirements will be followed.

RAI-10:

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.

(This information was previously requested as RAI-6 in the NRC letter dated June 25, 2013. However, based on feedback from the licensees, it was revised as above.)

Response:

The response to part (a) of this RAI was provided by FENOC letter dated February 27, 2014.

(b) The back-up battery is designed to last a minimum of 72 hours. The vendor's calculation has determined that the battery will last from a full charge for greater than 100 hours per Section 5.2.1 of Westinghouse calculation WNA-CN-00300-GEN, Revision 0, *Spent Fuel Pool Instrumentation System Power Consumption*.

RAI-11:

Please provide the following:

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

(b) A description of the methodology 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.

(This information was previously requested as RAI-7 in the NRC letter dated June 25, 2013.)

Response:

(a) The design accuracy is 3 inches or less for both normal and BDB conditions. Westinghouse calculation WNA-CN-00301-GEN provides the channel accuracy of a wired system with a standard measurement span of 296 inches. The calculated accuracy of the standard system is 0.54 percent of span or 1.60 inches. The cable probe length for BVPS-2 is 282.625 inches, which is less than the assumed value of WNA-CN-00301-GEN; therefore, the calculated accuracy of 0.54 percent of span or 1.60 inches is bounding for BVPS-2 and within the design range.

(b) A periodic calibration verification will be performed within 60 days of a refueling outage considering normal testing scheduling allowances (for example, 25 percent). Calibration verification will not be required to be performed more than once per 12 months. These calibration requirements are consistent with the guidance provided in Nuclear Energy Institute (NEI) 12-02, Section 4.3. Per Westinghouse procedures, should the calibration verification indicate that the instrument is out of tolerance by more than the designed 3-inch tolerance, a recalibration will be performed.

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 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 calibration tests and functional checks will be performed, and the frequency at which they will be conducted. Discuss how these surveillances will be incorporated into the plant surveillance program.

(d) A description of 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.

(This information was previously requested as RAI-8 in the NRC letter dated June 25, 2013.)

Response:

(a) A periodic calibration verification will be performed in-situ to verify that the transmitter is in calibration using a calibration verification tool provided by the manufacturer and in accordance with the plant procedures and manufacturer's recommendations (Reference RAI 14 response for more detail). Should the calibration verification indicate that the transmitter is out of calibration, a full-range calibration adjustment will be completed using a calibration test kit. The portable test kit is composed of a replicate probe, coupler and launch plate equivalent to those installed, a replicate coaxial cable of the same electrical length as installed in the pool, a bracket to hold the weight end of the probe cable, simulated pool liner, and a moveable metal target. To perform the calibration, the installed SFP instrumentation system coaxial cable is disconnected from the sensor and the replicate test kit coaxial cable is connected. A metal target is used to measure several points along the length of the probe to perform the full-range calibration. The readings displayed on the output display at each point along the probe will be compared to the physical distance measured along the length of the probe cable to determine calibration acceptance. Each component in the instrument channel can be replaced (transmitter included) to restore the instrument loop to service in the event a component failure occurs.

(b) A channel check is not conducted as part of 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*, and 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-101B*, to ensure that upon completion of the calibration check or calibration that the two channels compare within acceptable limits. The SFP level indication is located in the main control room. To aid in early detection of any "off normal" readings, which could indicate that channel adjustment may be required, a daily channel check using this indication of SFP level has been added to 2OM-54.3.L5, *Surveillance Verification Log*. The channel check confirms that the two SFP level instruments are reading within 6 inches of each other to conform to the system design accuracy of ±3 inches per channel. The channel check periodicity and acceptance criteria are controlled within BVPS-2 operating procedures and periodic maintenance programs and may change based on equipment operating experience. Testing to validate instrument functionality per NEI 12-02, Section 4.3, is based on the instrument calibration periodicity as noted in response to RAI-12(c).

(c) FENOC will perform periodic calibration verifications using periodic maintenance procedures and manufacturer's guidelines. The periodic calibration verification will be performed within 60 days of a refueling outage considering normal testing scheduling allowances (for example, 25 percent). Calibration verification will not be required to be performed more than once per 12 months. These calibration requirements are consistent with the guidance provided in NEI 12-02, Section 4.3.

(d) Preventive Maintenance (PM) procedures will be in place for periodic replacement of the backup batteries based on manufacturer recommendations and for calibration verification. New PMs based on NORM-ER-3733, *FENOC FLEX Spent Fuel Pool Level Monitor*, are listed in the table contained in the response for RAI-13.

RAI-13:

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 SFP instrumentation. The licensee is requested to include a brief description of the specific technical objectives to be achieved within each procedure.

Response:

ECP 13-0562, Spent Fuel Pool Instrumentation, installs the new hardware and ensures that the appropriate procedures for testing, calibration, operation, and abnormal response issues associated with the primary and backup SFP instrumentation channels are completed. The following is a list of the procedures.

- 1/2OM-53C.4A.100.4, *Spent Fuel Pool (b.5.b)*
- 2OM-20.1.E, *Specific Instrumentation and Controls*
- 2OM-20.3.C, *Power Supply and Control Switch List*

- 2OM-20.4.AAB, *Spent Fuel Pool Level High/Low (ARP)*
- 2OM-20.4.T, *Alternate Power to SFPLI [2FNC-LI-LI101A, 101B]*
- 2OM-53A.1.ECA-0.0(ISS2), *Loss of All AC Power (EOP)*
- 2OM-53B.4.ECA-0.0(ISS2), *Loss of All Emergency 4KV AC Power Background*
- 2OM-53C.4.2.20.1, *Spent Fuel Pool Cooling Trouble (AOP)*
- 2OM-20.4.M, *Makeup to the Spent Fuel Pool Using Service Water*
- 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*
- 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101B*

The objectives of each procedural area are described below:

<u>Inspection, Calibration, and Testing</u> – Guidance on the performance of periodic visual inspections, as well as calibration and testing, to ensure that each SFP channel is operating and indicating level within its design accuracy.

- 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*
- 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101B*

<u>Preventative Maintenance</u> – Guidance on scheduling of, and performing, appropriate preventative maintenance activities necessary to maintain the instruments in a reliable condition. New PMs based on NORM-ER-3733, *FENOC FLEX Spent Fuel Pool Level Monitor*, are listed in the table below.

FLOC	Equipment	PM Type	Interval	Owner
NORM-ER-3733	Primary and Secondary Level Sensor transmitter	Calibration	1/Cycle	Maint
	Primary and Secondary Level Sensor transmitter	Inspection/Cleaning	1/Cycle	Maint
	Primary and Secondary Level Sensor transmitter	Coax Cable Resistance Check	1/Cycle	Maint
	Primary and Secondary Battery	Replacement	3Y	Maint
	Primary and Secondary Level Sensor transmitter	Replacement	6Y	Maint
	Level Sensor Probe	Replacement	7Y	Maint
	Primary and Secondary Coaxial Cable, Coupler, and Coax Connector	Replacement	10Y	Maint
	Primary and Secondary Electronics Enclosure Components	Replacement	10Y	Maint

<u>Maintenance</u> – To specify troubleshooting and repair activities necessary to address system malfunctions.

- 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*
- 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101B*

Programmatic controls – Guidance on actions to be taken if one or more channels is out of service is contained in the program document.

System Operations – To provide instructions for operation and use of the system by plant staff.

- 1/2OM-53C.4A.100.4, *Spent Fuel Pool (b.5.b)*
- 2OM-20.1.E, *Specific Instrumentation and Controls* – List of instruments
- 2OM-20.3.C, *Power Supply and Control Switch List* – List of power supplies and switch positions
- 2OM-20.4.AAB, *Spent Fuel Pool Level High/Low (ARP)* – Actions to be taken in the event of high/low water level
- 2OM-20.4.T, *Alternate Power to SFPLI [2FNC-LI-LI101A, 101B]* – Actions to provide alternate power to the SFP level indicators
- 2OM-53A.1.ECA-0.0(ISS2), *Loss of All AC Power (EOP)* – Emergency procedure for loss of all AC power
- 2OM-53B.4.ECA-0.0(ISS2), *Loss of All Emergency 4KV AC Power Background* – Emergency procedure for loss of all emergency 4KV power
- 2OM-53C.4.2.20.1, *Spent Fuel Pool Cooling Trouble (AOP)* – Abnormal operating procedure for trouble with the SFP cooling system
- 2OM-20.4.M, *Makeup to the Spent Fuel Pool Using Service Water* – Procedure for initiating makeup water to the SFP using service water

Response to inadequate levels – Action to be taken on observations of levels below normal level are addressed in:

- 2OM-20.4.AAB, *Spent Fuel Pool Level High/Low (ARP)*
- 2OM-53C.4.2.20.1, *Spent Fuel Pool Cooling Trouble (AOP)*
- 2OM-20.4.M, *Makeup to the Spent Fuel Pool Using Service Water*
- 2OM-53E.1.FSG-11, *Alternate SFP Makeup and Cooling*

RAI-14:

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 your 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) Describe how the guidance in NEI 12-02 Section 4.3, regarding compensatory actions for one or both non-functioning channels will be addressed.

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

(This information was previously requested as RAI-11 in the NRC letter dated June 25, 2013.)

Response:

(a) SFP instrumentation channel/equipment maintenance/preventative maintenance and testing program requirements to ensure design and system readiness will be established in accordance with FENOC's processes and procedures (NORM-ER-3733). The design modification process will take into consideration the vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance is performed (and available for inspection and audit).

The maintenance and testing program requirements for the SFP will be documented in maintenance program documents and be contained in the program implementation document.

The SFP level indication is located in the main control room. To aid in early detection of any "off normal" readings, which could indicate that channel adjustment may be required, a daily channel check using this indication of SFP level will be added to 2OM-54.3.L5, *Surveillance Verification Log*. The channel check confirms that the two spent fuel pool level instruments are reading within 6 inches of each other to conform to the system design accuracy ±3 inches per channel. The channel check periodicity and acceptance criteria are controlled within BVPS-2 operating procedures and periodic maintenance programs and may change based on equipment operating experience.

FENOC will perform periodic calibration verifications using periodic maintenance procedures and manufacturer's guidelines. The periodic calibration verification will be performed within 60 days of a refueling outage considering normal testing scheduling allowances (for example, 25 percent), using:

- 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*
- 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101B*

(b) Both primary and backup SFP instrumentation channels incorporate permanent installation (with no reliance on portable, post-event installation) of relatively simple and robust augmented quality equipment. Permanent installation coupled with stocking of adequate spare parts reasonably diminishes the likelihood that a single channel (and greatly diminishes the likelihood that both channels) is (are) out-of-service for an extended period of time. Planned compensatory actions for unlikely extended out-of-service events are summarized as follows:

# Channel(s) Out-of-Service	Required Restoration Action	Compensatory Action if Required Restoration Action not completed within Specified Time
1	Restore channel to functional status within 90 days (or if channel restoration not expected within 90 days, then proceed to Compensatory Action)	Immediately initiate action in accordance with Note below
2	Initiate action within 24 hours to restore one channel to functional status and restore one channel to functional status within 72 hours	Immediately initiate action in accordance with Note below

Note:
Present a report to the on-site safety review committee within the following 14 days. The report shall outline the planned alternate method of monitoring, the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status.

(c) A condition report will be initiated and addressed through FENOC's Corrective Action Program. Provisions associated with out of service (OOS) or non-functional equipment, including allowed outage times and compensatory actions, will be consistent with the guidance provided in Section 4.3 of NEI 12-02, Revision 1. If one OOS channel cannot be restored to service within 90 days, appropriate compensatory actions, including the use of alternate suitable equipment, will be taken. A daily visual inspection of the SFP level is performed by Operations. If both channels become OOS, actions would be initiated within 24 hours to restore one of the channels to operable status and to implement appropriate compensatory actions, including the use of alternate suitable equipment and/or supplemental personnel, within 72 hours.

RAI-15:

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 calibration verification involves attaching a sliding plate to the flat surface above the launch plate of the fixed bracket and placing a metal target against the probe cable above the water level. To complete this method, the water level must be a sufficient distance below the 100 percent level mark, which is nominally 12 inches below the launch plate. The differences in distances imparted by this standard can be physically determined and compared to the distance difference observed on the level display of the sensor electronics. The second portion of this calibration verification is a visual waveform check to verify proper signal operation. If the calibration verification check falls within the required calibration tolerance (±3 inches) and the waveform check meets the criteria outlined, the calibration verification is successful and the equipment may be returned to the normal operating setup. If an anomaly with the calibration is observed during this calibration verification, the electronic verification or calibration adjustment is to be followed for further investigation. This verification shall be performed on both channels (primary and backup) of the SFP instrumentation system independently. The transmitter is capable of self-diagnostics at a maximum of 15 minute intervals. Upon identification of a fault or loss of signal, the transmitter output will be driven low.

Procedures 2LCP-20-L101A, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101A*, and 2LCP-20-L101B, *Calibration of Fuel Pool Level Instrumentation Loop 2FNC-L101B*, were made available for NRC review.

#	Topic	Parameter Summary	Westinghouse Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
1	Design Specification	SFPIS Requirements derived from References 1, 2, & 3	WNA-DS-02957-GEN	Contains technical SFPIS requirements based on NRC order, NEI guidance, and the ISG listed above.	N/A	Acceptable. FENOC provided a supplemental Technical Requirements Document in the Equipment Purchase Order
2	Test Strategy	Per Requirements.	WNA-PT-00188-GEN	Strategy for performing the testing and verification of the SFPIS and pool-side bracket.	N/A	Acceptable
3	Environmental qualification for electronics enclosure with Display	50° F to 140° F, 0 to 95% RH TID ≤ 1E03 R γ normal (outside SFP area) TID ≤ 1E03 R γ abnormal (outside SFP area)	EQ-QR-269 and WNA-TR-03149-GEN for all conditions.	Results are summarized in EQ-QR-269 and WNA-TR-03149-GEN. Radiation Aging verification summarized in Section 5 of WNA-TR-03149-GEN.	Test passed conditions described.	Acceptable
4	Environmental Testing for Level Sensor components in SFP area – Saturated Steam & Radiation	50 ° F to 212° F and 100% humidity	EQ-QR-269, Rev. 1	Testing summarized in Section 5.7.	Passed	Acceptable
		1E03 R γ normal (SFP area)	WNA-TR-03149-GEN	Thermal Aging & radiation aging verification summarized in Sections 4.1 and 5 (entire system) of WNA-TR-03149-GEN.	Passed	Acceptable
		1E07 R γ BDB (SFP area)	EQ-TP-354 (procedure) Actual test report is in progress.	Additional thermal & radiation aging programs being conducted under test procedure EQ-TP-354.	Additional aging program is in progress to achieve longer life.	Acceptable
5	Environmental Testing for Level Sensor Electronics Housing –	50° F to 140° F, 0 to 95% RH	EQ-QR-269, Rev. 1	Testing summarized in Section 5.5.	Passed	Acceptable

#	Topic	Parameter Summary	Westinghouse Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
	outside SFP	100% RH	WNA-TR-03149-GEN	100% humidity addressed in Section 7.5.	Passed	
		TID ≤ 1E03 R γ normal (outside SFP area) TID ≤ 1E03 R γ abnormal (outside SFP area)	WNA-TR-03149-GEN	Radiation Aging verification summarized in Section 5.	Passed	
6	Thermal & Radiation Aging – organic components in SFP area	1E03 R γ normal (SFP area)	EQ-QR-269, Rev. 1 and WNA-TR-03149-GEN	Thermal Aging & radiation aging verification summarized in Sections 4.1 and 5 (entire system) of WNA-TR-03149-GEN.	Passed	Acceptable with the exception of the 10-year aging test failure documented per Westinghouse Letter LTR-EQ-14-149, steam test failure using the straight connector (affects Perry)
		1E07 R γ BDB (SFP area)	EQ-TP-354 (procedure) Actual test report is in progress.	Additional thermal & radiation aging programs being conducted under test procedure EQ-TP-354.	Additional aging program is in progress to achieve longer life.	
7	Basis for Dose Requirement	<u>SFP Normal Conditions:</u> 1E03 R γ TID (above pool) 1E09 R γ TID (1' above fuel rack) <u>SFP BDBE Conditions:</u> 1E07 R γ TID (above pool) < 1E07 R γ TID (1' above fuel rack)	LTR-SFPIS-13-35 and WNA-DS-02957-GEN	Explanation of Basis for Radiation Dose Requirement (includes the clarification of production equivalency of electronics enclosure used for Seismic and EMC Testing)	Passed for all conditions	Acceptable

#	Topic	Parameter Summary	Westinghouse Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
8	Seismic Qualification	Per Spectra in WNA-DS-02957-GEN	EQ-QR-269, Rev. 1	EQ-QR-269, Rev. 1 summarizes the testing performed by Westinghouse.	Passed	Acceptable
			WNA-TR-03149-GEN	WNA-TR-03149-GEN provides high level summary of the pool-side bracket analysis and optional RTD.	Passed	
			EQ-QR-269, Rev. 1	Seismic Pull test for new connectors documented in Section 4.4.	Passed	
9	Sloshing	N/A	LTR-SEE-II-13-47	Calculation to demonstrate that probe will not be sloshed out of the SFP.	Passed	Acceptable
			WNA-TR-03149-GEN	Sloshing is also addressed in Section 7.2.	Passed	
10	Spent Fuel Pool Instrumentation System Functionality Test Procedure	Acceptance Criteria for Performance during EQ testing	WNA-TP-04613-GEN	Test procedure used to demonstrate that SFPIS meet its operational and accuracy requirements during Equipment Qualification Testing programs.	See applicable EQ test.	Acceptable
11	Boron Build-Up	Per requirement in WNA-DS-02957-GEN	WNA-TR-03149-GEN	Boron build up demonstrated through Integrated Functional Test (IFT).	Passed	Acceptable
12	Pool-side Bracket Seismic Analysis	N/A	CN-PEUS-13-25, Rev. 1 (Davis Besse and Beaver Valley) CN-PEUS-13-27, Rev. 2 (Perry)	Also includes hydrodynamic forces, as appropriate.	Passed	Acceptable
13	Additional Brackets (Sensor Electronics and Electronics Enclosure)	N/A	WNA-DS-02957-GEN	Weights provided to licensees for their own evaluation.	N/A	Acceptable

#	Topic	Parameter Summary	Westinghouse Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
14	Shock & Vibration	WNA-DS-02957-GEN	WNA-TR-03149-GEN	Section 7 provides rationale and summary of RTD.	N/A	
15	Requirements Traceability Matrix	Maps Requirements to documentation / evidence that Requirement is met	WNA-VR-00408-GEN	The RTM maps the requirements of the NRC order, NEI guidance, ISG to the applicable technical requirements in the SFPIS design specification and maps the design specification requirements to the documentation demonstrating the requirement is met.	Complete	Acceptable
16	Westinghouse Factory Acceptance Test, including testing of dead-zones	IFT Functional Requirements from WNA-DS-02957-GEN	WNA-TP-04752-GEN	The Integrated Functional Test (IFT) demonstrates functionality of the full system for each customer's FAT, which includes calibration of each channel.	Pilot IFT executed/passed Beaver Valley IFT executed/passed Davis Besse IFT executed/passed Perry IFT executed/passed	Acceptable
		12" dead-zone at top of probe 4" dead-zone at bottom of probe	WNA-TP-04752-GEN	Dead-zone tests are in Section 9.6.2.	N/A	
17	Channel Accuracy	+/- 3 inches per WNA-DS-02957-GEN	WNA-CN-00301-GEN	Channel accuracy from measurement to display.	Passed	Acceptable
18	Power Consumption	3 day battery life (minimum) 0.257 Amps power consumption	WNA-CN-00300-GEN	N/A	Passed	Acceptable

#	Topic	Parameter Summary	Westinghouse Reference Document #	Additional Comment	Test or Analysis Results	Licensee Evaluation
19	Technical Manual	N/A	WNA-GO-00127-GEN	Information and instructions for Operation, Installation, use, etc. are included here.	N/A	Acceptable
20	Calibration	Routine Testing/calibration verification and Calibration method	WNA-TP-04709-GEN	Also, includes preventative maintenance actions such as those for Boron buildup and cable probe inspection.	N/A	Acceptable
21	Failure Modes and Effects Analysis (FMEA)	N/A	WNA-AR-00377-GEN	Addresses mitigations for the potential failure modes of the system.	N/A	Acceptable
22	Emissions Testing	RG 1.180 R1 test conditions	EQ-QR-269, Rev. 1	Documented in Section 5.6.	Passed	Acceptable

References:

1) ML12056A044, NRC Order EA-12-051, “ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE SPENT FUEL POOL INSTRUMENTATION,” Nuclear Regulatory Commission, March 12, 2012.

2) 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) 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) Westinghouse Proprietary Document, WNA-DS-02957-GEN, “Spent Fuel Pool Instrumentation System (SFPIS) Standard Product System Design Specification,” Revision 4 reviewed by NRC in April 2014; current revision is Revision 4.

5) Westinghouse Proprietary Document, WNA-PT-00188-GEN, “Spent Fuel Pool Instrumentation System (SFPIS) Standard Product Test Strategy,” Revision 1 reviewed by NRC in February 2014; NRC did not review in April; current revision is Revision 2.

6) Westinghouse Proprietary Document, EQ-QR-269, “Design Verification Testing Summary Report for the Spent Fuel Pool Instrumentation,” Revision 1 reviewed by NRC in April 2014; current revision is Revision 1.

7) Westinghouse Proprietary Document, WNA-TR-03149-GEN, “SFPIS Standard Product Final Summary Design Verification Report,” Revision 1 reviewed by NRC in April 2014; current revision is Revision 1.

8) Westinghouse Proprietary Document, LTR-SFPIS-13-35, "SFPIS: Basis for Dose Requirement and Clarification of Production Equivalency of Electronics Enclosure Used for Seismic Testing," Revision 0 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 1.

9) Westinghouse Proprietary Document, LTR-SEE-II-13-47, "Determination if the Proposed Spent Fuel Pool Level Instrumentation can be Sloshed out of the Spent Fuel Pool during a Seismic Event," Revision 0 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 0.

10) Westinghouse Proprietary Document, WNA-TP-04613-GEN, "Spent Fuel Pool Instrumentation System Functionality Test Procedure," Revision 5 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 5.

11) Westinghouse Proprietary Document, CN-PEUS-13-25, "Seismic Analysis of the SFP Mounting Bracket at Davis Besse and Beaver Valley Nuclear Stations," Revision 1; never reviewed by the NRC.

12) Westinghouse Proprietary Document, CN-PEUS-13-27, "Seismic Analysis of the SFP Mounting Bracket at Perry Nuclear Power Plant," Revision 2; never reviewed by the NRC.

13) Westinghouse Proprietary Document, WNA-VR-00408-GEN, "Spent Fuel Pool Instrumentation System Requirement Traceability Matrix," Revision 0 reviewed by the NRC in April 2014; current revision is Revision 1.

14) Westinghouse Proprietary Document, WNA-TP-04752-GEN, "Spent Fuel Pool Instrumentation System Standard Product Integrated Functional Test Procedure," Revision 1 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 1.

15) Westinghouse Proprietary Document, WNA-CN-00301-GEN, "Spent Fuel Pool Instrumentation System Channel Accuracy Analysis," Revision 0 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 1.

16) Westinghouse Proprietary Document, WNA-CN-00300-GEN, "Spent Fuel Pool Instrumentation System Power Consumption Calculation," Revision 0 reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 1.

17) Westinghouse Proprietary Document, WNA-GO-00127-GEN, "Spent Fuel Pool Instrumentation System Standard Product Technical Manual," Revision 1 reviewed by the NRC in April 2014; current revision is Revision 1.

18) Westinghouse Proprietary Document, WNA-TP-04709-GEN, "Spent Fuel Pool Instrumentation System Calibration Procedure," Revision 3 was reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 4.

19) Westinghouse Proprietary Document, WNA-AR-00377-GEN, "Spent Fuel Pool Instrumentation System Failure Modes and Effect Analysis," Revision 2 was reviewed by the NRC in February 2014; NRC did not review in April; current revision is Revision 3.