Entergy

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PNP 2016-055

October 25, 2016

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

SUBJECT: Response to Generic Letter 2016-01, *Monitoring of Neutron Absorbing Materials in Spent Fuel Pools*

Palisades Nuclear Plant
Docket 50-255
Renewed Facility Operating License No. DPR-20

REFERENCES:

1. NRC letter to Entergy Nuclear Operations, Inc., *NRC Generic Letter 2016-01: "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools,"* dated April 7, 2016 (ADAMS Accession Number ML16097A169)
2. NRC letter to Entergy Nuclear Operations, Inc., *Palisades Nuclear Plant - Issuance of Amendment Regarding Replacement of Spent Fuel Pool Region I Storage Racks RE: (TAC No. ME8074)*, dated February 28, 2013 (ADAMS Accession Number ML13056A514)
3. NRC letter to Entergy Nuclear Operations, Inc., *Palisades Nuclear Plant– Issuance of Amendment Re: Spent Fuel Pool Region I Criticality (Tac No. ME5419)*, dated January 27, 2012 (ADAMS Package Accession Number ML11362A471)
4. NRC letter to Entergy Nuclear Operations, Inc., *Palisades Plant- Issuance of Amendment Re: Spent Fuel Pool Region I Storage Requirements (TAC No. ME0161)*, dated February 6, 2009 (ADAMS Accession Number ML090160238)
5. NRC letter to Nuclear Management Company, LLC., P*alisades - Issuance of Amendment to Change Enrichment Limits in the Fuel Pool,* dated February 26, 2002 (ADAMS Package Accession Number ML020600121)

Dear Sir or Madam:

On April 7, 2016, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2016-01 (Reference 1) to all nuclear power reactor licensees, except those that have permanently ceased operation with all power reactor fuel removed from on-site spent fuel pool (SFP) storage. The GL requested, in accordance with 10 CFR 50.54(f), specific information or references to previously docketed information, pertaining to the reliance on neutron-absorbing materials in the SFP. A written response containing this information is required to be submitted

to the NRC within 210 days of the date of GL 2016-01.

The purpose of this letter is to provide a response to GL 2016-01 for Entergy Nuclear Operations, Inc. (ENO) Palisades Nuclear Plant (PNP). PNP's SFP storage facility is divided into two areas: a main pool and a north tilt pit. Each of these areas is further divided into two regions: Region I and Region II. As such, Region I is inclusive of the Region I main pool area and the Region I north tilt pit area. Likewise, Region II is inclusive of the Region II main pool area and the Region II north tilt pit area. See Attachment 2 for a pictorial representation of the SFP areas and regions. The PNP SFP Region II main pool and north tilt pit areas have been determined to be response Category 1, the Region 1 north tilt pit area has been determined to be response Category 1, and the Region 1 main pool area has been determined to be response Category 4, in accordance with Reference 1.

The PNP SFP Region II GL response Category 1 determination was based on the analysis of record (AOR) which does not credit neutron-absorbing material other than soluble boron. Credit for the neutron-absorbing material present in the SFP storage racks (Boraflex™) was removed by the approved PNP license amendment 207 (Reference 5).

The PNP SFP Region I north tilt pit area GL response Category I determination was based on the AOR not crediting a neutron-absorbing material other than soluble boron. Credit for the neutron-absorbing material present in the SFP storage racks (Carborundum™) was removed by approved PNP license amendment 236 (Reference 4), which allowed credit for spent fuel radioactive decay by approved PNP license amendment 246 (Reference 3).

The PNP SFP Region I main pool area GL response Category 4 determination was based on the AOR crediting neutron-absorbing material other than soluble boron. Credit for the neutron-absorbing material (Metamic™) present in the SFP storage racks was approved by PNP license amendment 250 (Reference 2). The amendment request included a neutron absorbing material degradation monitoring program, which the NRC found acceptable, but it was not incorporated into PNP technical specifications or as a license condition in the PNP renewed facility operating license. As a response Category 4 licensee, information on the neutron absorber material, criticality AOR, and neutron absorber monitoring program is requested depending on the type of neutron-absorbing material present and credited in the SFP. PNP SFP Region I main pool area credits Metamic™ and therefore ENO is required to provide the information requested in areas (1) and (2) of Appendix A to GL 2016-01. Attachment 1 contains responses to the requested information.

If you have any questions regarding this submittal, please contact Jim Miksa at (269) 764-2945.

<u>Summary of Commitments</u>

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

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 25, 2016.

Sincerely,

CFA/jpm

Attachments: 1. Entergy Nuclear Operations, Inc., Palisades Nuclear Plant, Response to Requested Information for Generic Letter 2016-01

2. Entergy Nuclear Operations, Inc., Palisades Nuclear Plant Spent Fuel Pool Storage Arrangement

cc: Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC

ATTACHMENT 1

Letter PNP 2016-055

Entergy Nuclear Operations, Inc.

Palisades Nuclear Plant

Response to Requested Information

for

Generic Letter 2016-01

15 pages follow

A. Background

On April 7, 2016, the U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2016-01, *Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools*, (Reference 1). The following information provides the Entergy Nuclear Operations, Inc. (ENO) response to GL 2016-01 for the Palisades Nuclear Plant (PNP) Spent Fuel Pool (SFP) Region I main pool area. The response is limited to this area and to information requests (ARI) (1) and (2) in accordance with GL 2016-01 Appendix A for neutron-absorbing material type Metamic™. This response has been developed based on a search of plant records, including docketed information.

B. Category 4 Response - GL 2016-01, Appendix A

NRC ARI 1) a)

Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:

a) manufacturers, dates of manufacture, and dates of material installation in the SFP;

ENO Response ARI 1) a)

Manufacturer:	At PNP, the only neutron-absorbing material credited in the SFP nuclear criticality safety (NCS) analysis of record is Metamic™. Metamic™ is manufactured by Holtec International, Nanotec Metals Division.
Date of manufacture:	The Metamic™ panels used in the spent fuel pool racks at PNP were taken from Metamic™ lots created between 2005 and 2011. The racks were welded in 2012.
Date of material installation:	The Metamic™ racks were installed in the PNP SFP Region I main pool area in 2013.

NRC ARI 1) b) i)

Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:

b) neutron-absorbing material specifications, such as:

i) materials of construction, including the certified content of the neutron absorbing component expressed as weight percent;

ENO Response ARI 1) b) i)

The neutron-absorbing material, Metamic™, is a fully-dense, discontinuously-reinforced, metal matrix composite material. It consists of high-purity Type 6061 aluminum (Al 6061) alloy matrix

reinforced with Type 1 American Society for Testing and Materials (ASTM) C 750 isotopically-graded boron carbide (B_4C).

Metamic™ is characterized by extremely fine aluminum (325 mesh or smaller) powder and B_4C powder. Typically, the average B_4C particle size is between 10 and 40 microns. The high performance and reliability of Metamic™ derives from the fineness of the B_4C particle size and uniformity of its distribution, which is solidified into a metal matrix composite structure by the powder metallurgy process. This yields excellent homogeneity and a porosity-free material.

The certified content of the neutron absorbing component of Metamic™ is provided in areal density instead of weight percent. The PNP SFP has a minimum certified areal density of 0.02944 gm B^{10}/cm^2.

Additionally, the Metamic™ composite material is held in place by a sheath of stainless steel, as discussed in NRC ARI 1) d) below.

NRC ARI 1) b) ii)

b) neutron-absorbing material specifications, such as:

ii) minimum certified, minimum as-built, maximum as-built, and nominal as-built areal density of the neutron-absorbing component; and

ENO Response ARI 1) b) ii)

The neutron absorbing component of Metamic™ in the PNP SFP has a minimum certified areal density of 0.02944 gm B^{10}/cm^2.

The Metamic™ certificates of compliance documented the certified as-built neutron-absorbing component values in weight percent (Wt. %) B_4C loading versus areal density. The certified B_4C loading for all PNP SFP Metamic™ racks are:

Minimum as-built B_4C loading:	29 Wt. % B_4C
Maximum as-built B_4C loading:	33 Wt. % B_4C
Nominal as-built B_4C loading:	31 Wt. % B_4C

A review of each panel's certificate of compliance indicates that the actual as-built B_4C loading is significantly above the certified minimum 29 Wt. % because all panels, except for relatively few which are approximately 32 Wt. %, have a B_4C loading greater than 32 Wt. %.

NRC ARI 1) b) iii)

b) neutron-absorbing material specifications, such as:

iii) material characteristics, including porosity, density and dimensions;

ENO Response ARI 1) b) iii)

Metamic™ is a metal matrix composite consisting of a matrix of Type 6061 aluminum reinforced with ASTM C-750 B_4C. Metamic™ is characterized by extremely fine aluminum (325 mesh or smaller) powder and B_4C powder.

Typically, the average B_4C particle size is between 10 and 40 microns. The high performance and reliability of Metamic™ derives from the fineness of the B_4C particle size and uniformity of its distribution, which is solidified into a metal matrix composite structure by the powder metallurgy process. This yields excellent homogeneity and a porosity-free material.

The nominal density of Metamic™ in the PNP SFP is interpolated, from Reference 2, Section 2.1, *Composition of Metamic™*, using a nominal as-built loading of 31 Wt. % B_4C, is 2.642 gm/cm^3.

The nominal dimensions of the Metamic™ absorber panels installed in PNP's SFP are 0.106 inches x 6-7/8 inches x 134 inches

NRC ARI 1) c)

Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:

c) qualification testing approach for compatibility with the SFP environment and results from the testing;

ENO Response ARI 1) c)

Metamic™ is a fully-dense, discontinuously-reinforced, metal matrix composite material. It consists of high-purity Type 6061 aluminum (Al 6061) alloy matrix reinforced with Type 1 ASTM C-750 isotopically-graded B_4C. To ensure its satisfactory performance in the environments that exist in spent fuel pools, Metamic™ has been subjected to many tests that simulate the conditions to which the material will be exposed in actual service.

Metamic™ has been subjected to the following tests:

- short term (48 hour) elevated temperature (900°F) testing;
- long term elevated temperature (750°F) testing for times in excess of one year;
- accelerated corrosion testing (195°F) for times in excess of one year;
- accelerated radiation testing at exposures up to 1.5×10^{11} rads gamma;

- mechanical properties testing at temperatures up to 900°F; and
- neutron transmission testing of coupons before and after corrosion testing.

The accelerated corrosion testing of Metamic™ was carried out in two media: deionized water to simulate BWR pool conditions, and deionized water containing 2500 ppm boron as boric acid to simulate PWR pool conditions. Mill finish and anodized coupons containing 15 Wt. % and 31 Wt. % B_4C were placed in each simulated pool environment. The tests showed the deionized water was a harsher environment for Metamic™ than it was for the borated water.

Neutron transmission tests were carried out on archive coupons and on coupon samples before those samples were placed in 1) 200°F deionized water and 2) 200°F deionized water containing 2500 ppm boron as boric acid. Intermediate transmission tests have been completed on the archive coupons and the coupons that had been exposed to the 200°F water environments. The tests show uniformity of absorption across the samples, as well as consistency in absorption between the archive coupons and the coupons exposed to the pool environments.

Testing has proved Metamic™ to be an excellent, desirable material for use as the neutron absorber in high-density fuel storage applications. When impurities deposited during the fabrication process have been cleaned from its surfaces, either by glass-beading of mill-finish material or by the cleaning that precedes anodizing, Metamic™ is highly resistant to corrosion when exposed to the environments present in fuel storage pools. It is not subject to deformation or deterioration under environments far more hostile than those in fuel storage pools, and it remains an extremely consistent and effective neutron absorber.

To qualify Metamic™ panels for wet and dry storage applications, four types of measurements were employed. These included:

- chemical analysis
- neutron attenuation
- thickness measurements
- density measurements

The results of these measurements indicated that Metamic™ panels are fully acceptable for use as a neutron absorber in storage applications.

NRC ARI 1) d) i)

Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:

d) configuration in the SFP, such as:

i) method of integrating neutron-absorbing material into racks (e.g., inserts, welded in place, spot welded in place, rodlets); and

ENO Response ARI 1) d) i)

Each Metamic™ rack storage location in the PNP SFP is called a "box." Metamic™ panels are held snugly to the box surface inside a die-formed stainless steel sheathing. The flanges of the sheathing are attached to the box using stitch welds and spot welds.

NRC ARI 1) d) ii)

d) configuration in the SFP, such as:

ii) sheathing and degree of physical exposure of neutron absorbing materials to the spent fuel pool environment;

ENO Response ARI 1) d) ii)

Metamic™ panels are held snugly inside a die-formed stainless steel sheathing. The sheathings are vented; therefore the Metamic™ panels are exposed to the SFP environment.

NRC ARI 1) e) i)

Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:

e) current condition of the credited neutron-absorbing material in the SFP, such as:

i) estimated current minimum areal density;

ENO Response ARI 1) e) i)

There is no evidence of loss of boron areal density based on the analysis of the first coupon. Therefore it is apparent that the minimum installed weight percent of B_4C has remained unchanged and the minimum certified areal density of 0.02944 gm B^{10}/cm^2 continues to be met.

NRC ARI 1) e) ii)

e) current condition of the credited neutron-absorbing material in the SFP, such as:

ii) current credited areal density of the neutron-absorbing material in the NCS AOR; and

ENO Response ARI 1) e) ii)

The current credited areal density of the neutron-absorbing material (Metamic™) in the PNP SFP NCS AOR is 0.02944 gm B^{10}/cm^2.

NRC ARI 1) e) iii)

e) current condition of the credited neutron-absorbing material in the SFP, such as:

iii) recorded degradation and deformations of the neutron-absorbing material in the SFP (e.g., blisters, swelling, gaps, cracks, loss of material, loss of neutron-attenuation capability).

ENO Response ARI 1) e) iii)

The first PNP Metamic™ coupon removed from the SFP was analyzed per the coupon surveillance program. The analysis determined that there was no loss in specific gravity or boron areal density, no evidence of pitting or any other corrosion, and a loss of 2.30 grams of mass, or 1.54% Wt.

The PNP coupon surveillance program states that the loss of weight serves "a supporting role and should be examined for early indications of the potential onset of Metamic™ degradation that would suggest a need for further attention and possibly a change in measurement schedule." PNP's next coupon is scheduled for removal in 2018 and, based on the above analysis, does not warrant a schedule change.

NRC ARI 2) a)

Describe the surveillance or monitoring program used to confirm that the credited neutron-absorbing material is performing its safety function, including the frequency, limitations, and accuracy of the methodologies used.

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

ENO Response ARI 2) a)

The Metamic™ surveillance program at PNP consists of a coupon surveillance program. The coupons were taken from the same lots of material used in construction of the racks. They are to be surrounded by the hottest freshly discharged fuel for at least the first four offloads following installation in order to ensure they experience higher than average gamma, neutron irradiation, and water temperatures. The coupons thus will be able to detect aging/degradation mechanisms that the in-service materials experience.

NRC ARI 2) a) i)

Describe the surveillance or monitoring program used to confirm that the credited neutron-absorbing material is performing its safety function, including the frequency, limitations, and accuracy of the methodologies used.

a) *Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:*

i) *approach used to determine frequency, calculations and sample size;*

ENO Response ARI 2) a) i)

The coupon test frequency is 3 to 9 years (see response ARI 2) b) ii) (4)), and sample size is one coupon per test interval with a total of 10 coupons initially placed on the coupon tree. These intervals and sample sizes were based on operating experience with Metamic™ and were not based on an analytic determination. The total coupon sample size is consistent with the recommendation of the provider of the Metamic™ spent fuel racks and the proposed and accepted surveillance program found in the safety evaluation (SE) to PNP renewed facility operating license (RFOL) (Reference 3). This is also similar to other Metamic™ and Boral surveillance programs at other sites. The total coupon sample size of 10 coupons is considered to be sufficient to allow for adequate monitoring of the condition of the neutron absorber material in the SFP racks throughout the operating life of the racks in the SFP. Based on accelerated test programs and operating experience, Metamic™ is considered a suitable material for reactivity control. Ongoing programs at various spent fuel pools have not identified cases in which a loss of neutron absorbing capability has occurred.

The frequency of Metamic™ inspection and testing activities is consistent with the guidance in NUREG-1801, *Generic Aging Lessons Learned (GALL) Report*, Section XI.M40, which states that the frequency is "not to exceed 10 years." PNP's coupon surveillance schedule is provided in the response to ARI 2 b) ii) (4), was accepted by the NRC in PNP RFOL amendment 250 (Reference 3), and is consistent with the staff guidance. In the SE for amendment 250, the NRC found that it had reasonable assurance that the proposed testing frequency would identify any material property changes and is in line with what the staff has approved for other plants using Metamic™.

NRC ARI 2) a) ii)

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

ii) parameters to be inspected and data collected;

ENO Response ARI 2) a) ii)

As described in PNP RFOL Amendment 250 (Reference 3), measurements of the following parameters are performed:

- visual observation and photography
- neutron attenuation
- dimensional measurements (length, width, and thickness)
- weight and specific gravity

The NRC found that it had reasonable assurance that the proposed testing methods would identify any material property changes and is in line with what the staff has approved for other plants using Metamic™.

NRC ARI 2) a) iii)

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

iii) acceptance criteria of the program and how they ensure that the material's structure and safety function are maintained within the assumptions of the NCS AOR;

ENO Response ARI 2) a) iii)

The purpose of the surveillance program is to characterize certain properties of the Metamic™ with the objective of providing data necessary to assess the capability of the Metamic™ panels in the racks to continue to perform their intended function. The surveillance program is not designed to confirm the safety function of the in-service material, but it is capable of detecting the onset of any significant degradation with ample time to take such corrective actions as may be necessary.

For the measurements performed on the Metamic™ coupons, it is important to consider the neutron attenuation measurements (to verify the continued presence of boron) and thickness so

as to monitor any potential swelling. The acceptance criteria of the PNP monitoring program and are as follows:

- A decrease of no more than 5% Boron-10 content, as determined by neutron attenuation, is acceptable. This is equivalent to a requirement for no loss in boron within the accuracy of the measurement.
- An increase in thickness at any point should not exceed 10% of the initial thickness at that point.

Changes in excess of either of these criteria require further investigation or an engineering evaluation. This may include early retrieval and measurement of one or more of the remaining coupons. Where it is determined that the deviation is actually occurring, an engineering evaluation will be performed to identify further testing or any corrective action as may be necessary.

NRC ARI 2) a) iv)

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

iv) monitoring and trending of the surveillance or monitoring program data; and

ENO Response ARI 2) a) iv)

ENO's monitoring and trending of surveillance program data is implemented through PNP site procedure EM-04-58, *Spent Fuel Pool Metamic™ Coupon Surveillance Program*. Surveillance coupons removed from PNP's SFP are sent to a vendor for testing and analysis. Vendor test results are recorded for future trending, compared to acceptance criteria by PNP engineers and, if certain values are outside acceptance criteria, then further evaluation is performed, under the corrective action program, to determine if additional actions are required.

To date, ENO has only removed one test coupon (in November of 2015). Coupon testing and analysis results from the removed coupon were received in June of 2016. As more coupons are removed from the SFP for testing, trending of the results will be possible. The following information is summarized from the vendor surveillance report:

A. Coupon 1 (Year 2016)

Results

Testing consisted of one Metamic™ coupon. The coupon was in good overall condition. Visual inspection of the coupon demonstrated no significant oxide layer and no pitting was visible. There was no significant deterioration or degradation noted.

The Boron-10 areal density of the coupon was measured via neutron attenuation testing conducted at five locations on the coupon. The average areal density from five test locations of the coupons was 0.0336 gm B^{10}/cm^2, which is an extremely slight increase of above the pre-exposure areal density of 0.0335 gm B^{10}/cm^2, resulting in a 0.30% change. All of the individual measurements were greater or equal to the pre-irradiation measurement; therefore, the coupon passed the B^{10} areal density acceptance criterion of less than a 5% decrease. In addition, the measurements are above the assumed value in the NCS AOR (i.e., 0.02944 gm B^{10}/cm^2).

The dimensional measurements of the coupon showed no significant change in length, width, or thickness. No measurement exceeded a ±4.41% change; therefore, the coupon passed the acceptance criterion of less than a 10% change in thickness.

Conclusive Statement

In conclusion, the recent coupon surveillance test determined that the coupon remained intact through the surveillance period, with no apparent areas of missing Metamic™, and excellent coupon performance.

NRC ARI 2) a) v)

a) Provide the technical basis for the surveillance or monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

v) industry standards used.

ENO Response ARI 2) a) v)

PNP RFOL Amendment 250 (Reference 3) does not reference specific industry standards pertaining directly to the coupon surveillance program. The testing frequency is concurrent with the guidance provided in NUREG-1801, Section XI.M40, in that testing should not occur beyond a ten-year timeframe. In addition, the parameters monitored (see ARI 2) a) ii)) and the acceptance criteria (see ARI 2) a) iii)) provide reasonable assurance that property changes would be identified. Further, the NRC SE for Amendment 250 stated:

"Given the relatively slow nature of material degradation seen in other neutron absorbing materials used in the SFP, favorable results from industry testing concerning the performance of Metamic™ in a SFP environment, and no operational experience concerning the degradation of the Metamic™ currently in use as a neutron absorbing material in other SFPs, the staff has reasonable assurance that the licensee's surveillance program will allow enough time for the licensee to take corrective actions prior to any degradation challenging the minimum areal density of the Metamic™ panels. Therefore, the staff finds that licensee's proposed surveillance program acceptable."

NRC ARI 2) b) i)

b) For the following monitoring methods, include these additional discussion items.

i) If there is visual inspection of in-service material:

(1) describe the visual inspection performed on each sample; and

(2) describe the scope of the inspection (i.e., number of panels or inspection points per inspection period).

ENO Response ARI 2) b) i)

ENO's PNP SFP Metamic™ coupon surveillance program does not include a visual inspection of in-service material.

NRC ARI 2) b) ii) (1)

b) For the following monitoring methods, include these additional discussion items.

ii) If there is a coupon monitoring program:

(1) provide a description and technical basis for how the coupons are representative of the material in the racks. Include in the discussion, the material radiation exposure levels, SFP environment conditions, exposure to the SFP water, location of the coupons, configuration of the coupons (e.g., jacketing or sheathing, venting bolted on, glued on, or free in the jacket, water flow past the material, bends, shapes, galvanic considerations, and stress-relaxation considerations), and dimensions of the coupons;

ENO Response ARI 2) b) ii) (1)

The PNP SFP Metamic™ surveillance program includes 10 Metamic™ test coupons that were taken from the same lots of material that were used for construction of the racks. They are

mounted on a coupon tree, placed in a designated cell in Region I, and surrounded by spent fuel. The coupons are approximately 6 inches x 8 inches x 0.106 inches.

The coupons are positioned axially within the central eight feet (approximate) of the active fuel zone where the gamma flux is expected to be reasonably uniform. The coupons are mounted on the tree by way of threaded rods and hang freely in the water. They are exposed to the flow, boric acid, and galvanic effects of the SFP. The coupons are not sheathed.

To ensure that the coupons have experienced a slightly higher radiation dose than the panels in the racks, the coupon tree will be surrounded by freshly discharged fuel assemblies after each of the first four offloads following installation. At the time of the first fuel offload, the four storage cells surrounding the tree were loaded with fresh, discharged fuel assemblies. These four assemblies were replaced during the second refueling outage with freshly discharged fuel. For at least the next two refueling outages, this practice will continue, resulting in the coupons being continuously exposed to freshly discharged assemblies. The tree will remain in its original cell.

NRC ARI 2) b) ii) (2)

b) For the following monitoring methods, include these additional discussion items.

ii) If there is a coupon monitoring program:

(2) provide the dates of coupon installation for each set of coupons;

ENO Response ARI 2) b) ii) (2)

The PNP SFP coupons were all installed on February 20, 2014 as a single set of ten coupons.

NRC ARI 2) b) ii) (3)

b) For the following monitoring methods, include these additional discussion items.

ii) If there is a coupon monitoring program:

(3) if the coupons are returned to the SFP for further evaluation, provide the technical justification of why the reinserted coupons would remain representative of the materials in the rack; and

ENO Response ARI 2) b) ii) (3)

ENO's PNP current SFP Metamic™ coupon surveillance program does not include direction to return coupons into the SFP. Additionally, PNP does not plan to return coupons into the SFP since PNP has nine remaining coupons in the SFP available for removal and analysis.

NRC ARI 2) b) ii) (4)

b) For the following monitoring methods, include these additional discussion items.

ii) If there is a coupon monitoring program:

(4) provide the number of coupons remaining to be tested and whether there are enough coupons for testing for the life of the SFP. Also provide the schedule for coupon removal and testing.

ENO Response ARI 2) b) ii) (4)

There are 9 coupons remaining to be tested. The last coupon is scheduled for testing in 2073, which takes the coupon program 42 years beyond the current renewed operating license of the plant. The current schedule for coupon removal is at 2, 5, 9, 13, 19, 26, 35, 44, 52, and 60 years of service life starting from the installation of the storage racks. Note that the coupon removal scheduled at 2 years has been completed.

NRC ARI 2) b) iii)

b) For the following monitoring methods, include these additional discussion items.

iii) If RACKLIFE is used:

(1) note the version of RACKLIFE being used (e.g., 1.10, 2.1);

(2) note the frequency at which the RACKLIFE code is run;

(3) describe the confirmatory testing (e.g., in-situ testing) being performed and how the results confirm that RACKLIFE is conservative or representative with respect to neutron attenuation; and

(4) provide the current minimum RACKLIFE predicted areal density of the neutron-absorbing material in the SFP. Discuss how this areal density is calculated in RACKLIFE. Include in the discussion whether the areal densities calculated in RACKLIFE are based on the actual as-manufactured areal density of each panel, the nominal areal density of all of the panels, the minimum certified areal density, the minimum as-manufactured areal density, or the areal density credited by the NCS AOR. Also discuss the use of the escape coefficient and the total silica rate of Boraflex™ degradation in the SFP.

ENO Response ARI 2) b) iii)

This ARI is not applicable to PNP because RACKLIFE is not used at PNP as a monitoring method.

NRC ARI 2) b) iv)

b) For the following monitoring methods, include these additional discussion items.

iv) If in-situ testing with a neutron source and detector is used (e.g., BADGER testing, blackness testing):

(1) describe the method and criteria for choosing panels to be tested and include whether the most susceptible panels are chosen to be tested. Provide the statistical sampling plan that accounts for both sampling and measurement error and consideration of potential correlation in sample results. State whether it is statistically significant enough that the result can be extrapolated to the state of the entire pool;

(2) state if the results of the in-situ testing are trended and whether there is repeat panel testing from campaign to campaign;

(3) describe the sources of uncertainties when using the in-situ testing device and how they are incorporated in the testing results. Include the uncertainties outlined in the technical letter report titled "Initial Assessment of Uncertainties Associated with BADGER Methodology," September 30, 2012 (Agency wide Access and Management Systems Accession No. ML12254A064). Discuss the effect of rack cell deformation and detector or head misalignment, such as tilt, twist, offset, or other misalignments of the heads and how they are managed and accounted for in the analysis; and

(4) describe the calibration of the in-situ testing device, including the following:

(a) describe how the materials used in the calibration standard compare to the SFP rack materials and how any differences are accounted for in the calibration and results;

(b) describe how potential material changes in the SFP rack materials caused by degradation or aging are accounted for in the calibration and results; and

(c) if the calibration includes the in-situ measurement of an SFP rack "reference panel", explain the following:

(i) the methodology for selecting the reference panel(s) and how the reference panels are verified to meet the requirements;

(ii) whether all surveillance campaigns use the same reference panel(s); and

(iii) if the same reference panels are not used for each measurement surveillance, describe how the use of different reference panels affects the ability to make comparisons from one campaign to the next.

ENO Response ARI 2) b) iv)

This ARI is not applicable to PNP because In-situ testing is not used at PNP as a monitoring method.

References:

1. NRC letter to Entergy Nuclear Operations, Inc., *NRC Generic Letter 2016-01: "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools,"* dated April 7, 2016 (ADAMS Accession Number ML16097A169)

2. NRC letter to Entergy Operations, Inc., *Arkansas Nuclear One, Units 1 and 2 – Review of Holtec Report RE: Use of Metamic™ in Fuel Pool Applications (TAC Nos. MB5862 and MB5863)*, dated June 17, 2003 (ADAMS Accession Number ML031681432)

3. NRC letter to Entergy Nuclear Operations, Inc., *Palisades Nuclear Plant - Issuance of Amendment Regarding Replacement of Spent Fuel Pool Region I Storage Racks RE: (TAC No. ME8074)*, dated February 28, 2013 (ADAMS Accession Number ML13056A514)

ATTACHMENT 2

Letter PNP 2016-055

Entergy Nuclear Operations, Inc.

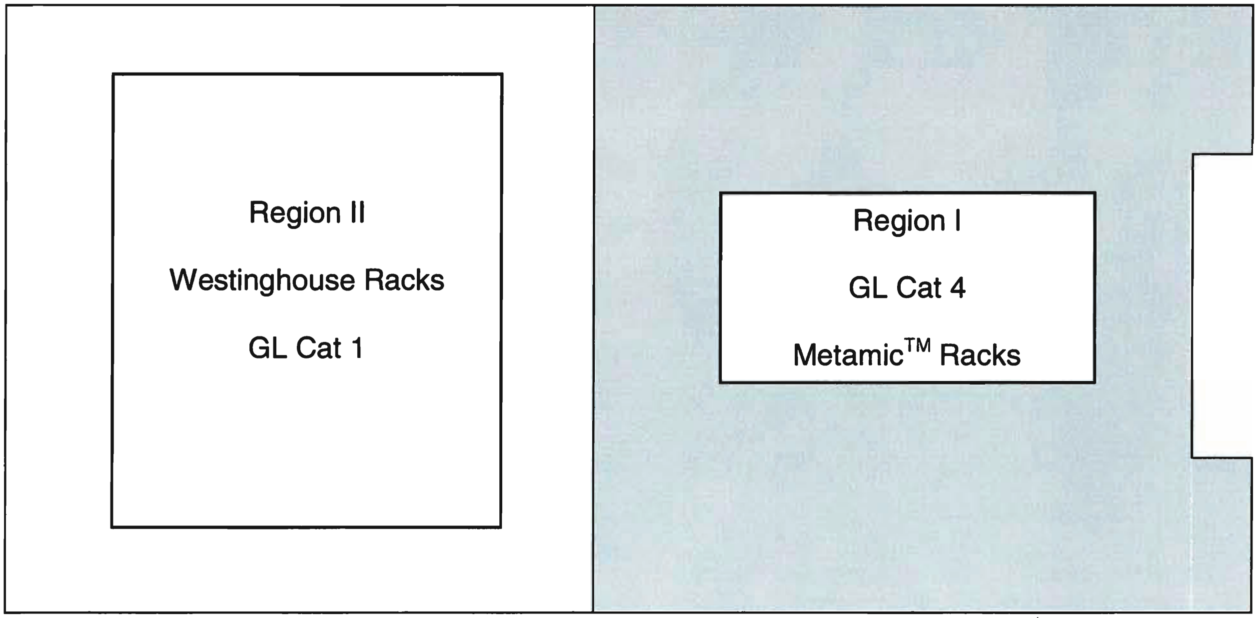
Palisades Nuclear Plant

Spent Fuel Pool

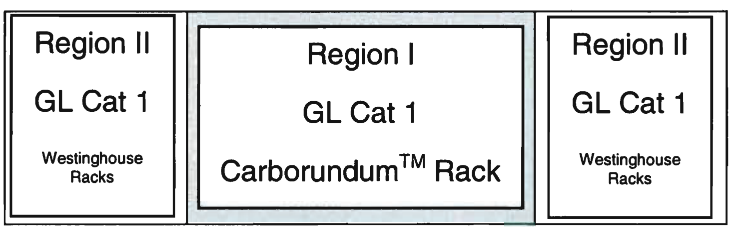
Storage Arrangement

1 page follows

Main Pool



North Tilt Pit



Acronyms

GL Cat 1 - Generic Letter 2016-01 Response Category 1

GL Cat 4 - Generic Letter 2016-01 Response Category 4