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RS-16-207 10 CFR 50.54(f)

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

Braidwood Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Calvert Cliffs Nuclear Power Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

Clinton Power Station, Unit 1
Facility Operating License No. NPF-62
NRC Docket No. 50-461

Dresden Nuclear Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-19 and DPR-25
NRC Docket Nos. 50-237 and 50-249

LaSalle County Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-11 and NPF-18
NRC Docket Nos. 50-373 and 50-374

Limerick Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Nine Mile Point Nuclear Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-63 and NPF-69
NRC Docket Nos. 50-220 and 50-410

Oyster Creek Nuclear Generating Station
Renewed Facility Operating License No. DPR-16
NRC Docket Nos. 50-219

Peach Bottom Atomic Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

R.E. Ginna Nuclear Power Plant
Renewed Facility Operating License No. DPR-18
NRC Docket No. 50-244

Three Mile Island Nuclear Station, Unit 1
Renewed Facility Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Response to Generic Letter 2016-01

Reference: NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

On April 7, 2016, the NRC issued Generic Letter (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," to address degradation of neutron-absorbing materials in wet storage systems for reactor fuel at power and non-power reactors.

The NRC requested a written response to be submitted in accordance with 10 CFR 50.54(f) within 210 days of the date of the Referenced GL to provide the following information:

(1) a description of 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;

(2) a description of 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;

(3) a description of the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material;

(4) a description of how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR; and

(5) a description of the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events.

Attachments 1 through 13 to this letter contain the Exelon Generation Company, LLC (EGC) responses for the nuclear power plants listed above.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Kenneth M. Nicely at (630) 657-2803.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 3rd day of November 2016.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachments:
1. Generic Letter 2016-01 Response for Braidwood Station
2. Generic Letter 2016-01 Response for Byron Station
3. Generic Letter 2016-01 Response for Calvert Cliffs Nuclear Power Plant
4. Generic Letter 2016-01 Response for Clinton Power Station
5. Generic Letter 2016-01 Response for Dresden Nuclear Power Station
6. Generic Letter 2016-01 Response for LaSalle County Station
7. Generic Letter 2016-01 Response for Limerick Generating Station
8. Generic Letter 2016-01 Response for Nine Mile Point Nuclear Station
9. Generic Letter 2016-01 Response for Oyster Creek Nuclear Generating Station
10. Generic Letter 2016-01 Response for Peach Bottom Atomic Power Station
11. Generic Letter 2016-01 Response for Quad Cities Nuclear Power Station
12. Generic Letter 2016-01 Response for R.E. Ginna Nuclear Power Plant
13. Generic Letter 2016-01 Response for Three Mile Island Nuclear Station

cc: NRC Regional Administrator – Region I
NRC Regional Administrator – Region III
Senior Resident Inspector – Braidwood Station
Senior Resident Inspector – Byron Station
Senior Resident Inspector – Calvert Cliffs Nuclear Power Plant
Senior Resident Inspector – Clinton Power Station
Senior Resident Inspector – Dresden Nuclear Power Station

Senior Resident Inspector – LaSalle County Station
Senior Resident Inspector – Limerick Generating Station
Senior Resident Inspector – Nine Mile Point Nuclear Station
Senior Resident Inspector – Oyster Creek Nuclear Generating Station
Senior Resident Inspector – Peach Bottom Atomic Power Station
Senior Resident Inspector – Quad Cities Nuclear Power Station
Senior Resident Inspector – R.E. Ginna Nuclear Power Plant
Senior Resident Inspector – Three Mile Island Nuclear Station

ATTACHMENT 1
Generic Letter 2016-01 Response for Braidwood Station

Exelon Generation Company, LLC (EGC) has determined that Braidwood Station, Units 1 and 2, are Category 3 plants, in accordance with Reference 1. In Reference 2, the NRC issued renewed Facility Operating Licenses (FOLs) for Braidwood Station, Units 1 and 2 (i.e., NPF-72 and NPF-77, respectively). These renewed FOLs include a license condition that requires completion of EGC's commitments that are described in Appendix A of NUREG-2190, "Safety Evaluation Report Related to the License Renewal of Byron Station, Units 1 and 2, and Braidwood Station Units 1 and 2." Commitment 27 in Appendix A to NUREG-2190 addresses the neutron-absorbing material monitoring program for Braidwood Station, Units 1 and 2.

This existing monitoring program is identified in NUREG-2190, Table 3.0-1, "Byron and Braidwood Aging Management Programs," and described in Section 3.0.3.1.13, "Monitoring of Neutron-Absorbing Materials Other than Boraflex." Based on this description of the Braidwood Station neutron-absorbing material monitoring program, the NRC concluded that EGC "demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation, as required by Title 10 of the 10 CFR 54.21(a)(3))." EGC affirms that no changes have been made to the neutron-absorbing material monitoring program, as described in the renewed FOLs, and the associated NRC Safety Evaluation Report.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from L. M. James (U.S. NRC) to M. P. Gallagher (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating Licenses for Braidwood Nuclear Station, Units 1 and 2 (TAC Nos. MF1879 and MF1880)," dated January 27, 2016

Exelon Generation Company, LLC (EGC) has determined that Byron Station, Units 1 and 2, are Category 3 plants, in accordance with Reference 1. In Reference 2, the NRC issued renewed Facility Operating Licenses (FOLs) for Byron Station, Units 1 and 2 (i.e., NPF-37 and NPF-66, respectively). These renewed FOLs include a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-2190, "Safety Evaluation Report Related to the License Renewal of Byron Station, Units 1 and 2, and Braidwood Station Units 1 and 2." Commitment 27 in Appendix A to NUREG-2190 addresses the neutron-absorbing material monitoring program for Byron Station, Units 1 and 2.

This existing monitoring program is identified in NUREG-2190, Table 3.0-1, "Byron and Braidwood Aging Management Programs," and described in Section 3.0.3.1.13, "Monitoring of Neutron-Absorbing Materials Other than Boraflex." Based on this description of the Byron Station neutron-absorbing material monitoring program, the NRC concluded that EGC "demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation, as required by Title 10 of the 10 CFR 54.21(a)(3))." EGC affirms that no changes have been made to the neutron-absorbing material monitoring program, as described in the renewed FOLs, and the associated NRC Safety Evaluation Report.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from J. Daily (U.S. NRC) to M. P. Gallagher (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating Licenses for Byron Nuclear Station, Units 1 and 2, (TAC Nos. MF1881 and MF1882)," dated November 19, 2015

Calvert Cliffs Nuclear Power Plant (CCNPP), Units 1 and 2, has two spent fuel pools (SFPs) that each contain a unique type of neutron-absorbing material (NAM). The Unit 1 SFP contains racks that incorporate the Carborundum NAM in the form of sheets within the rack walls. The Unit 2 SFP contains racks that were fabricated with the Boraflex NAM.

Exelon Generation Company, LLC (EGC) has determined that CCNPP Unit 1 is a Category 3 plant in accordance with Reference 1. In Reference 2, the NRC issued renewed Facility Operating Licenses (FOLs) for CCNPP, Units 1 and 2 (i.e., DPR-53 and DPR-69, respectively). These renewed FOLs include a license condition that requires completion of actions listed in Appendix E to NUREG-1705, "Safety Evaluation Report Related to the License Renewal of Calvert Cliffs Nuclear Power Plant, Units 1 and 2." Item No. 38 in Appendix E to NUREG-1705 addresses the NAM monitoring program.

This existing monitoring program is identified in NUREG-1705, Section 3.10.3.2.11, "Degradation of Neutron-Absorbing Materials." Based on this description of the NAM monitoring program, the NRC concluded that there is reasonable assurance that the effects of NAM degradation will be managed in such a way that the SFP storage racks will be capable of performing their intended function consistent with the CLB during the period of extended operation. Subsequent to issuance of the renewed FOLs, the NRC approved changes to the long-term coupon surveillance program for the Carborundum material in Reference 4.

As stated above, the Unit 2 SFP contains racks that were fabricated with the Boraflex NAM. However, the Boraflex material was found to be degrading, and its neutron-absorbing capability credit was removed from the criticality safety analysis. This change was approved by the NRC in Reference 3.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from D. L. Solorio (U.S. NRC) to C. H. Cruse (Baltimore Gas and Electric Company), "Issuance of Renewed Facility Operating Licenses, Nos. DPR-53 and DPR-69, Calvert Cliffs Nuclear Power Plant Units 1 and 2 (TAC MA3861 and MA3862)," dated March 23, 2000

3. Letter from R. V. Guzman (U.S. NRC) to G. Vanderheyden (Calvert Cliffs Nuclear Power Plant, Inc.), "Calvert Cliffs Nuclear Power Plant, Unit Nos. 2 – Amendment to Increase the Spent Fuel Pool Maximum Enrichment Limit (TAC No. MC0935)," dated January 27, 2005

4. Letter from D. V. Pickett (U.S. NRC) to J. A. Spina (Calvert Cliffs Nuclear Plant, Inc.), "Calvert Cliffs Nuclear Power Plant, Unit No. 1 – Amendment Re: Long-term Coupon Surveillance Program (TAC No. MD5509)," dated August 27, 2008

1) ***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:***

Clinton Power Station (CPS) employs three types of fuel storage racks in its three potential rack containing pools/pits. CPS can store spent fuel in the SFP, the Fuel Cask Storage Pit (FCSP), and in the Upper Containment Pool (UCP). Spent fuel racks are not typically in the FCSP, but reserve racks are maintained in a dry condition should they be needed to extend core offload capability. The UCP General Electric cast aluminum racks contain no neutron-absorbing material (NAM). In accordance with Generic Letter 2016-01, additional information regarding the UCP is not required because no NAM is credited. All SFP and FCSP fuel storage racks are high density type racks (i.e., no flux traps). The SFP contains a mix of fuel storage racks with Boral plate NAM and Metamic plate NAM (i.e., both built into stainless steel rack structures). No single rack contains more than one type of NAM. The two spent fuel racks reserved for the FCSP contain Boral NAM.

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

<u>*CPS Boral Racks*</u>

Brooks and Perkins manufactured the Boral plates for the CPS SFP racks. Nuclear Energy Services (NES) used these plates to manufacture the Boral SFP racks in 1980 to 1981, based on the contract date and the installation date. CPS installed the Boral SFP racks in June 1981. Ten of the 22 original-equipment Boral racks remain in the SFP today. CPS placed two of the 12 scrapped Boral racks in dry storage at the plant in 2007 for possible future use in the FCSP.

<u>*CPS Metamic Racks*</u>

Stage 1 SFP Capacity Expansion:

No Metamic racks were loaded into the SFP in Stage 1 of the SFP capacity expansion.

Metamic LLC manufactured the Metamic plates for the two racks installed in the CPS FCSP in Stage 1 of the SFP capacity expansion. Holtec used these plates to manufacture the two Metamic FCSP racks in Stage 1. The Metamic FCSP racks were installed by August 2005 in the FCSP.

After a reasonable search of the Boral manufacturing dates and installation dates, including docketed information, Exelon Generation Company, LLC (EGC) determined that the Boral material manufacturing and rack creation dates were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that provided the neutron absorber monitoring plan.

Stage 2 SFP Capacity Expansion:

Metamic LLC manufactured the Metamic plates for the 14 additional CPS SFP racks in Stage 2. Holtec used these plates to manufacture the Metamic SFP racks in Stage 2.

CPS completed the Metamic SFP rack installation in 2007. This rack installation included moving the two Metamic racks originally installed in the FCSP to the SFP after spending two years in the FCSP. There are 16 Metamic SFP racks in the CPS SFP at this time.

After a reasonable search of the Metamic manufacturing dates and installation dates, including docketed information, EGC determined that the Metamic material manufacturing and rack creation dates were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that provided the neutron absorber monitoring plan.

b) neutron-absorbing material specifications, such as:

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

CPS Boral Racks

Boron is not specified on a weight percent basis for the Boral NAM; therefore, this subsection is not applicable to Boral.

CPS Metamic Racks

The Metamic weight percent boron carbide is 25 percent.

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

CPS Boral Racks

The minimum certified areal density for the Boral NAM is 0.027 $g^{10}B/cm^2$.

CPS Metamic Racks

The minimum certified areal density for the Metamic NAM is 0.0168 $g^{10}B/cm^2$.

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral and Metamic as-built areal densities were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved these neutron absorber monitoring programs.

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

CPS Boral Racks

The Boral plate dimensions are as follows:

- Thickness = 0.110 inches
- Width = 4.25 +/- 0.0625 inches
- Length = 150.0 +0.5/-0.0 inches

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral material density and porosity were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

CPS Metamic Racks

The Metamic plate dimensions are as follows:

- Thickness = 0.075 +/- 0.004 inches
- Width = 4.75 +/- 0.0625 inches
- Length = 150.0 inches

Metamic is a fully dense material with zero porosity.

After a reasonable search of the plant's records, including docketed information, EGC determined that the Metamic material density was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

CPS Boral Racks

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral compatibility testing approach and results were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

CPS Metamic Racks

Metamic has been subjected to an extensive array of tests sponsored by EPRI that evaluated the performance of the material at elevated temperatures and radiation levels. The results, documented in EPRI Report 1003137 (10/2001) indicate that Metamic maintains its physical and neutron absorbing properties with little variation in its properties from the unirradiated state.

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

Both the Boral and Metamic materials are maintained in-place through their inclusion between the fuel rack tubes and wrapper plates welded to the fuel rack tubes. Both fillet and spot welding is used on the wrapper plates to fix them to the rack tubes while also providing a smooth surface for the fuel to slide against when being moved in the SFP racks.

ii) sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

Both the Boral and Metamic materials are held in place by stainless steel wrapper plates which are vented and thus allow a limited amount of water exchange between the bulk SFP water and the Boral and Metamic materials. The Boral and Metamic materials are shielded sufficiently to prevent water flow induced degradation.

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

i) estimated current minimum areal density;

Industry experience with Boral and Metamic in addition to CPS coupon testing of the Metamic have provided no indication of the loss of boron carbide from these materials in the SFP environment. Therefore, the estimated current minimum areal densities are the same as when the materials were fabricated and installed in the SFP (i.e., the minimum certified areal density provided in the response to item 1 above).

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

CPS Boral Racks

The current credited areal density in the Boral NCS AOR is the minimum certified areal density of 0.027 $g^{10}B/cm^2$. This is reflected by the NCS AOR modeling the more limiting Metamic material only, as it has been shown to be the limiting material for fuel storage in the SFP at CPS. This makes the use of either type of rack acceptable for the spent fuel.

CPS Metamic Racks

The current credited areal density in the Metamic NCS AOR is the minimum certified areal density of 0.0168 $g^{10}B/cm^2$.

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).

No degradation or deformation of the NAMs at CPS have been identified.

2) 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:

CPS utilizes periodic coupon measurements to monitor the ability of the Metamic to perform its safety function. Coupon material monitoring methods rely on the strong correlation between aging/degradation impacts on a set of surrogate material pieces (coupons) from the same manufacturing process as the as-installed material. The station maintains the ability to detect aging/degradation mechanisms that the in-service NAM experiences through monitoring the coupon material characteristics. Metamic coupon trees are maintained in SFP locations that have conditions projected to be the most challenging to the materials (e.g., high gamma dose, high neutron dose, high temperature) to ensure early detection of aging/degradation mechanisms that are driven by environmental factors.

CPS currently has no coupon or other monitoring program for the Boral NAM in the SFP. EGC monitors Boral operating experience from its own fleet of plants with Boral racks and also through participation in industry groups such as INPO, EPRI Neutron Absorber Users Group, and the NEI Criticality Task Force. No mechanism has been found in the nuclear industry by which Boral material will lose any meaningful amount of boron carbide during operation in a SFP environment.

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

CPS utilizes a Metamic coupon surveillance program to confirm that the material is performing its safety function. The current surveillance program is documented in the rerack license amendment request (References 1 and 3) associated information and was approved in the rerack license amendment safety evaluation (Reference 2) from the NRC. Attachment 2 of Reference 3 states that one Metamic coupon is removed after 2, 4, 8, 12, 20, 28, and 36 years. Coupons are also subject to neutron attenuation measurements after 4, 12, and 20 years to confirm the attenuation capabilities. This periodicity is sufficient to provide an indication of degradation of the Metamic material prior to reaching an impact of more than 5 percent of the subcriticality margin. This is based on the industry experience with Metamic that has not shown any mechanism that leads to the loss of the boron from the Metamic material. The NRC accepted this coupon frequency and sampling size in

Reference 2. EGC also monitors industry experience with the Metamic NAM through operating experience reviews and through industry group participation (e.g., NEI, EPRI).

ii) parameters to be inspected and data collected;

The parameters inspected and data collected as part of the Metamic coupon monitoring program are listed in Reference 3, and were approved as acceptable for the program by the NRC in Reference 2.

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;

The acceptance criteria for the Metamic coupon monitoring program are listed in Reference 3, and were approved as acceptable for the program by the NRC in Reference 2.

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

The monitoring program for the Metamic coupon monitoring program is documented in Reference 3, and was approved as acceptable for the program by the NRC in Reference 2. CPS has not committed to specific trending activities.

v) industry standards used.

The industry standards utilized in the Metamic coupon surveillance plan are listed as References 4 and 5.

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

i) If there is visual inspection of inservice material:

There are no visual inspections of the NAM performed outside of what has already been discussed for the coupon monitoring program.

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;

The Metamic coupons are representative of the in-service material for the following reasons. The coupons were formed from the same material and manufactured in the same manner as the in-service material, thus ensuring that both items are equivalent. The rerack license amendment safety evaluation, Reference 2, states that the Metamic coupons maintain exposure to a gamma dose representative of the in-service material. This is reflected in current plant procedures governing coupon placement. Other coupon operating environmental conditions, such as flow and water temperature, will be more limiting due to the placement among the hottest fuel as well. The coupons are 4-inch by 8-inch nominal dimension Metamic slabs and are each placed in a vented stainless steel jacket to simulate any galvanic issues during the time in the SFP.

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

For the original Boral racks, there is not a coupon tree installed. For the newer racks that Holtec installed (i.e., that include the Metamic NAM), the coupon tree was installed in October 2007.

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

The station does not reinsert Metamic coupons into the coupon tree once they have been removed from the tree as the intent was that coupons would be removed on periodic intervals for testing and measurement per procedure. The commitment for CPS is that Metamic coupons will be removed from the SFP for testing after 2, 4, 8, 12, 20, 28, and 36 years per References 2 and 3.

(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.

For the original Boral racks, there is not a coupon sample tree installed. Of the 10 coupons that were installed in the Metamic coupon tree, CPS has seven remaining in the coupon tree in the SFP. This is consistent with the planned testing frequency upon installation in 2007. The plant preventive maintenance program and procedures control the performance of the monitoring of the coupons in the SFP.

iii) If RACKLIFE is used:

RACKLIFE is not applicable to Boral and Metamic.

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

In-situ testing at CPS is not performed; therefore, this subsection is not applicable.

3) ***For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.***

   CPS utilizes the Boral and Metamic NAMs and thus this section is not applicable.

4) ***For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.***

   a) ***Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.***

      CPS currently has no coupon or other monitoring program for the Boral NAM in the SFP. EGC monitors Boral operating experience from its own fleet of plants with Boral racks and also through participation in industry groups such as INPO, EPRI Neutron Absorber Users Group, and the NEI Criticality Task Force. No mechanism has been found in the nuclear industry by which Boral material will lose any meaningful amount of boron carbide during operation in a SFP environment.

   b) ***Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron-absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.***

      See response (a) above.

   c) ***Describe how the bias and uncertainty of the monitoring or surveillance program are used in the SFP NCS AOR.***

      See response (a) above. No evidence of boron carbide loss from Boral material has been identified. CPS SFP racks are not of the flux-trap type, thus impacts from blistering would be minimal if not negligible.

d) ***Describe how the degradation in adjacent panels is correlated and accounted for in the NCS AOR.***

See responses (a) and (c) above.

5) ***For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).***

CPS utilizes Boral and Metamic NAMs and thus this section is not applicable.

References

1. Letter from K. R. Jury (AmerGen Energy Company, LLC) to U.S. NRC, "Request for Technical Specification Change to Support Onsite Spent Fuel Storage Expansion," dated August 18, 2004

2. Letter from K. N. Jabbour (U.S. NRC) to C. M. Crane (AmerGen Energy Company, LLC), "Clinton Power Station, Unit 1 – Issuance of an Amendment – Re: Onsite Spent Fuel Storage Expansion (TAC NO. MC4202)," dated October 31, 2005

3. Letter from K. R. Jury (AmerGen Energy Company, LLC) to U.S. NRC, "Additional Information Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion," dated October 24, 2005

4. ASTM E2971, "Standard Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers Using Neutron Attenuation Measurements"

5. ASTM C1187, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks In a Pool Environment"

Exelon Generation Company, LLC (EGC) has determined that Dresden Nuclear Power Station (DNPS), Units 2 and 3, are Category 3 plants in accordance with Reference 1. The NRC issued license amendments for DNPS, Units 2 and 3, in Reference 2 that include license conditions for the neutron absorber monitoring program. EGC affirms that no changes have been made to the neutron absorbing material monitoring program as described in the referenced license amendments.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from E. A. Brown (U.S. NRC) to B. C. Hanson (Exelon Generation Company, LLC), "Dresden Nuclear Power Station, Units 2 and 3 – Issuance of Amendments to Amend Renewed Facility Operating License Nos. DPR-19 and DPR-25 to Support Use of a New Nuclear Criticality Safety Analysis Methodology (CAC Nos. MF5734 and MF5735)," dated April 29, 2016

Exelon Generation Company, LLC (EGC) has determined that LaSalle County Station (LSCS) Units 1 and 2, are Category 3 plants, in accordance with Reference 1. In Reference 2, the NRC issued renewed Facility Operating Licenses (FOLs) for LSCS, Units 1 and 2 (i.e., NPF-11 and NPF-18, respectively). These renewed FOLs include a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-2205, "Safety Evaluation Report Related to the License Renewal of LaSalle County Station, Units 1 and 2." Commitment 27 in Appendix A to NUREG-2205 addresses the neutron-absorbing material monitoring program for LSCS, Units 1 and 2.

This existing monitoring program is identified in NUREG-2205, Table 3.0-1, "LSCS Aging Management Programs," and described in Section 3.0.3.2.13, "Monitoring of Neutron-Absorbing Materials Other than Boraflex." Based on this description of the LSCS neutron-absorbing material monitoring program, the NRC concluded that EGC "demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3)." EGC affirms that no changes have been made to the neutron-absorbing material monitoring program, as described in the renewed FOLs, and the associated NRC Safety Evaluation Report.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from J. S. Mitchell (U.S. NRC) to M. P. Gallagher (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating Licenses for LaSalle County Station, Units 1 and 2 (TAC Nos. MF5347 and MF5346)," dated October 19, 2016

Exelon Generation Company, LLC (EGC) has determined that Limerick Generating Station (LGS) Units 1 and 2, are Category 3 plants, in accordance with Reference 1. In Reference 2, the NRC issued renewed Facility Operating Licenses (FOLs) for LGS, Units 1 and 2 (i.e., NPF-39 and NPF-85, respectively). These renewed FOLs include a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2." Commitment 28 in Appendix A to NUREG-2171 addresses the neutron-absorbing material monitoring program for LGS, Units 1 and 2.

This existing monitoring program is identified in NUREG-2171, Table 3.0.3-1, "Aging Management Programs," and described in Section 3.0.3.2.11, "Monitoring of Neutron-Absorbing Materials Other than Boraflex." Based on this description of the LGS neutron-absorbing material monitoring program, the NRC determined that the program elements and planned enhancements will make the neutron-absorbing material monitoring program adequate to manage the applicable aging effects. EGC affirms that no changes have been made to the neutron-absorbing material monitoring program, as described in the renewed FOLs, and the associated NRC Safety Evaluation Report.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from R. Plasse (U.S. NRC) to M. P. Gallagher (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating Licenses for Limerick Generating Station, Units 1 and 2, (TAC Nos. ME6555 and ME6556)," dated October 20, 2014

1) ***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:***

Nine Mile Point Nuclear Station (NMPNS) employs two types of SFP racks. There are two racks in the Unit 1 SFP that use Boraflex as the neutron-absorbing material (NAM). The Unit 2 SFP and the remainder of the racks in the Unit 1 SFP use Boral as the NAM.

Exelon Generation Company, LLC (EGC) has determined that NMPNS is a Category 3 plant for two Boraflex fuel racks, in accordance with Generic Letter 2016-01. In Reference 5, the NRC issued renewed Facility Operating License (FOL) DPR-63 for NMPNS Unit 1. This renewed FOL includes a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-1900, "Safety Evaluation Report Related to the License Renewal of Nine Mile Point Nuclear Station, Units 1 and 2." Commitment 16 in Appendix A to NUREG-1900 addresses the NAM monitoring program for Boraflex spent fuel racks at NMPNS Unit 1.

This existing monitoring program is identified in NUREG-1900, Table 3.0.3-1, "NMPNS's Aging Management Programs," and described in section 3.0.3.2.9, "Boraflex Monitoring Program (NMP1 Only)." On the basis of its audit and review of the Unit 1 Boraflex Monitoring Program, the NRC concluded "that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 50.54(a)(3)." EGC affirms that no changes have been made to the NAM monitoring program for Boraflex spent fuel racks, as described in the renewed FOL, and the associated NRC Safety Evaluation Report. Therefore, in accordance with Generic Letter 2016-01, additional information regarding the Boraflex racks is not required.

EGC has determined that NMPNS is a Category 4 plant for the Boral racks and the remaining information in this Attachment is applicable to the Boral racks.

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

<u>Unit 1 Boral SFP Racks</u>

The Unit 1 rerack effort was performed in two stages. For the first phase, AAR Brooks and Perkins manufactured the Boral panels in the years 1998-1999. Holtec manufactured new SFP storage racks using the Boral panels. The station installed the new Boral racks in the Unit 1 SFP in 1999.

For the second phase, AAR Brooks and Perkins manufactured the Boral panels. Holtec manufactured new SFP storage racks using the Boral panels. The station installed the new Boral racks in the Unit 1 SFP in 2004.

<u>Unit 2 Boral SFP Racks</u>

The NMP2 rerack effort was performed in two stages. For the first phase, AAR Brooks and Perkins manufactured the Boral panels. Note that while the name of the AAR business unit producing the Boral in this time frame was changing, the Boral was still made at the same facility in Lavonia, Michigan. Holtec manufactured new SFP storage racks using the Boral panels. The station installed the new Boral racks in the Unit 2 SFP in 2001.

For the second phase, AAR Advanced Structures manufactured the Boral panels. Holtec manufactured new SFP storage racks using the Boral panels. The station installed the new Boral racks in the Unit 2 SFP in 2007.

b) neutron-absorbing material specifications, such as:

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

Boron is not specified on a weight percent basis of the Boral NAM; therefore, this subsection is not applicable to Boral.

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

Unit 1 Boral SFP Racks

The minimum certified areal density for the Boral NAM is 0.0150 $g^{10}B/cm^2$.

Unit 2 Boral SFP Racks

The minimum certified areal density for the Boral NAM is 0.0200 $g^{10}B/cm^2$.

The as-built areal densities were not found in the available documentation. After a reasonable search of the plant's records, including docketed information, EGC determined that the as-built areal densities were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

Unit 1 Boral SFP Racks

The Boral NAM density is 2.51 g/cm^3. The Boral panel dimensions are as follows:

- Thickness = 0.070 inches
- Width = 5.00 +/- 0.0625 inches
- Length = 146.0 inches

<u>*Unit 2 Boral SFP Racks*</u>

The Boral NAM density is 2.51 g/cm^3. The Boral panel dimensions are as follows:

- Thickness = 0.075 +/- 0.007 inches
- Width = 4.75 +0.0625, -0.0 inches
- Length = 150.0 +0.25, -0.0 inches

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral porosity was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

At least two coupons from each lot of Boral, of width approximately equal to the Boral panel design and a length to width ratio of at least two, were immersed in demineralized water at 170°F for a period of at least 45 days. The exposed coupons were carefully examined for evidence of swelling or delamination (i.e., by comparison of pre-test and post-test thickness measurements) and were weighed prior to immersion, after exposure, and after drying to determine the amount of water absorbed and the extent of weight gain from oxidation. This testing was carried out by AAR and the results were approved by Holtec's Quality Assurance department.

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

Boral panels are secured by stainless steel sheathing in the cells of the spent fuel racks. The neutron absorber sheathing (cover plate) serves to position and retain the neutron absorber material in its designated space. This is accomplished by spot welding the cover sheet to the square tube along the former's edges at numerous locations. This manner of attachment ensures that the NAM will not sag or laterally displace during fabrication processes and under any subsequent loading conditions. This fixture method also produces a vented enclosure that will not retain gasses produced from neutron capture or other processes.

ii) sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

The Boral material is held in place by stainless steel wrapper plates which are vented (i.e., due to the spot welding method used) and thus allows a limited amount of water exchange between the bulk SFP water and the Boral material. The Boral is shielded sufficiently to prevent water flow induced degradation.

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

i) ***estimated current minimum areal density;***

Results of coupon testing of the Boral have provided no indication of the loss of boron carbide. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFPs (i.e., the minimum certified areal densities provided in the response to item 1 above).

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

Unit 1 Boral SFP Racks

The current credited areal density in the Boral NCS AOR is the minimum certified area density of 0.0150 $g^{10}B/cm^2$.

Unit 2 Boral SFP Racks

The current credited areal density in the Boral NCS AOR is the minimum certified area density of 0.0200 $g^{10}B/cm^2$.

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).***

There have been no findings of Boral blistering from the coupons tested. Coupon tests indicated no loss of material from the coupons (via mass, dimension, or areal density change). None of the other degradation mechanisms listed above were identified in the NMPNS Boral that is monitored by a coupon program.

A portion of the Unit 2 SFP Boral racks do not have coupons to monitor their material status. BADGER testing has been performed on these racks to validate the expectation of no detectable degradation. The BADGER testing showed no indication of any degradation of the Boral NAM.

2) ***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:***

NMPNS utilizes periodic coupon measurements (Unit 1 and Unit 2) and BADGER testing (Unit 2) to monitor the ability of the Boral to perform its safety function.

Coupon material monitoring methods rely on the strong correlation between aging/degradation impacts on a set of surrogate material pieces (coupons) from the same manufacturing method as the as-installed material. The station maintains the ability to detect aging/degradation mechanisms that the in-service NAM experiences through monitoring the coupon material characteristics. Coupon trees are maintained in SFP locations that have conditions projected to be the most challenging to the materials (e.g., high gamma dose, high neutron dose, high temperature) to ensure early detection of aging/degradation mechanisms that are driven by environmental factors.

BADGER testing is used for those Boral racks that were installed without corresponding material coupons for testing. Commitment 11 discussed in Reference 1 states that NMPNS will conduct in-situ boron-10 BADGER testing on the Phase 1 Boral racks installed at Unit 2 in 2001. The BADGER method uses neutron attenuation testing to determine the boron-10 areal density of a statistically significant subset of in-service Boral panels. Testing of this sub-population provides a picture of the in-service Boral material's condition (i.e., areal density loss or localized deformations of the panels).

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

NMPNS Unit 1 utilizes a Boral coupon surveillance program to confirm that the material is performing its safety function. The current surveillance program is documented in plant procedures and includes coupon sampling at a period not to exceed one coupon every 10 years. This periodicity is sufficient to provide an indication of degradation of the Boral material prior to reaching an impact of more than 5 percent of the subcriticality margin. This is based on the vast industry experience with Boral that has not shown any mechanism that leads to the loss of the boron from the Boral material. This sampling frequency is in agreement with the guidance in Section XI.M40 of the Generic Aging Lessons Learned (GALL) Report (Reference 3). EGC also monitors the industry experience with the Boral NAM through operating experience reviews and through industry group participation (e.g., NEI, EPRI).

NMPNS Unit 2 has two Boral surveillance programs to confirm that the material is performing its safety function. The first is a Boral coupon program for the racks installed in the SFP in Phase 2 of the rerack. Two coupon trees were installed when the Phase 2 Boral racks were installed in the SFP. These coupons are tested on a one per 10 year nominal frequency in accordance with guidance in References 2 and 3. This periodicity is sufficient to provide an indication of degradation of the Boral material prior to reaching an impact of more than 5 percent of the subcriticality margin. This is based on the vast industry experience with Boral that has not shown any mechanism that leads to the loss of the boron from the Boral material. This sampling frequency is in agreement with the guidance in Section XI.M40 of the GALL Report (Reference 3). EGC also monitors the industry experience with the Boral NAM through operating experience reviews and through industry group participation (e.g., NEI, EPRI).

NMPNS Unit 2 also has a Boral BADGER surveillance that was implemented via a site aging management plan. Commitment 11 to perform BADGER testing, as discussed in Reference 1, was made because there are no coupons for this series of racks. Per this commitment, BADGER testing on this Boral material is performed once every 10 years. The only BADGER test for NMPNS Unit 2 is from 2014 (i.e., the 2012 test had data collection issues and was re-performed in 2014). This periodicity is sufficient to provide an indication of degradation of the Boral material prior to reaching an impact of more than 5 percent of the subcriticality margin. This is also based on the vast industry experience with Boral that has not shown any mechanism that leads to the loss of the boron from the Boral material. This sampling frequency is in agreement with the guidance in Section XI.M40 of the GALL Report (Reference 3). A sample size of 60 panels is inspected with the BADGER equipment to provide a statistically meaningful result at the 95/95 level given a non-parametric set of data.

ii) parameters to be inspected and data collected;

In accordance with site procedures, the parameters inspected and data collected for the Unit 1 Boral coupons are as follows.

- Visual observation and photography
- Density
- Neutron attenuation
- Dimensional measurements (i.e., length, width, and thickness)
- Dry weight determination

In accordance with the Boral aging management program for Unit 2, the parameters inspected and data collected for the Unit 2 Boral coupons are as follows.

- Visual observation and photography
- Neutron attenuation
- Dimensional measurements (i.e., length, width, and thickness)
- Weight and specific gravity

The BADGER testing determines the areal density of in-service Boral panels in Unit 2 through the use of neutron attenuation data.

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;

The acceptance criteria for the Unit 1 and Unit 2 Boral coupon monitoring program are a decrease of no more than 5 percent in boron-10 content, as determined by neutron attenuation. This is tantamount to a requirement for no loss in boron within the accuracy of the measurement. The other acceptance criterion is that the coupon thickness increase at any point shall not exceed 10 percent of the initial thickness at that point.

Additional data is available for Unit 2 and is reviewed for signs of beginning degradation or distortion through visual or photographic evidence of unusual surface pitting, blistering, corrosion or edge deterioration, or unacceptable weight loss in excess of the measurement accuracy.

The Unit 2 BADGER acceptance criteria is that no measured Boral panel average areal density be below the minimum certified areal density of the material when the accuracy of the measurement result is taken into account. Also, there should be no indications of localized panel degradation from the measurements taken.

The acceptance criteria are designed to provide indication of any mechanism that could lead to a loss in the reactivity hold-down of the NAM, Boral, before the loss can challenge the 5 percent subcriticality margin built into the NCS AOR.

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

Boral coupon results are not trended. An Issue Report is generated for results not meeting the above acceptance criteria.

BADGER testing results for Unit 2 are trended for Boral panels that are tested in multiple BADGER campaigns. This is planned for a subset of the panels tested in the 2014 BADGER campaign to be executed near the year 2024.

v) industry standards used.

The primary industry standards used for the Boral coupon surveillance program are:

- ASTM E2971, "Standard Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers Using Neutron Attenuation Measurements," and

- ASTM C1187, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks In a Pool Environment."

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

i) If there is visual inspection of inservice material:

There are no visual inspections of the NAM performed outside of what has already been discussed for the coupon monitoring program.

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;

The Boral coupons are representative of the in-service Boral material for the following reasons. The coupons are formed from the same material and process used to make the in-service material, thus ensuring that both items used the same manufacturing process. The site procedures and aging management program require that the Boral coupons are bounding for the Boral material in all the spent fuel racks prior to the coupons being examined, by ensuring that the coupons have been surrounded with freshly discharged assemblies at each outage (currently the Unit 1 procedure stops this freshly discharged fuel loading late in reactor life). Other coupon operating environmental conditions, such as flow and water temperature, will be more limiting due to the placement among the hottest fuel as well. The coupons are 5-inch by 5-inch nominal dimension Boral slabs and are each placed in a vented stainless steel jacket to simulate any galvanic issues during the time in the SFP.

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

The Unit 1 Boral coupon tree was installed during the first Boral rerack modification in 2000.

The Unit 2 Boraflex coupons were retired in the 2007 Boral rerack. No Unit 2 Boraflex coupons remain in the SFP at this time.

The Unit 2 Boral was installed in two phases. Phase 1 was completed in 2001, and no coupon tree was installed for this Boral material. In Phase 2, two Boral coupon trees were installed at the time of rack installation in 2007.

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

Coupons are not reinserted into the SFP after testing.

(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.

For Unit 1, there are six Boral coupons remaining on the coupon tree out of the original 10 coupons. For Unit 2, there are 19 Boral coupons remaining on the coupon trees out of the original 20 coupons. As discussed above, the frequency of Boral coupon testing is one every 10 years for each SFP. Therefore, there are enough coupons for testing for the life of the SFPs.

iii) If RACKLIFE is used:

RACKLIFE is not applicable to Boral.

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;

Panels chosen for BADGER testing take into account several considerations. First and foremost is the testing of panels that have experienced the most severe service histories in the SFP. This is typically done by reviewing the fuel move records for Boral spent fuel racks.

Panel selection of Boral panels is mostly a manual process since no computer model is available to calculate the relative service duty (i.e., either absorbed dose or gamma heating) of the Boral panels (i.e., such as RACKLIFE does for Boraflex). Typically, assemblies are categorized based on some relative figure of merit and panels are selected accordingly.

Given that many pools are relatively full and a large buffer zone is needed for the BADGER test to avoid gamma interference, consideration must also be given to minimize the number of fuel assembly moves needed to vacate a testing area in the spent fuel racks.

Using a minimum of 60 panels in the testing provides a 95/95 result for the sampling of the panels given the non-parametric "distribution" of the panel data (Reference 4). Note that an absolute minimum of 59 panels are needed; however, 60 panels are typically used for conservatism since there is a possibility that a panel's test results might be unusable.

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

The conclusion of the 2014 BADGER test report indicates the intent to retest a subset of the panels tested in the next Unit 2 Boral test. The same practice has been used at other EGC stations to provide information for trending.

(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 (Agencywide Document Access and Management System 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

Uncertainties in the results caused by sources of uncertainties as outlined in the report above are not included in the test results. This would require an additional rack-specific neutron transport analysis for each test and panel. Since the measurement uncertainties in head configuration would be dependent on whether or not neighboring panels are degraded, it would not be practical to quantify each individual uncertainty without a destructive examination of each test panel. In addition, this would determine whether or not a bias in the test method occurs in various rack designs and/or with various absorbers.

(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;

Calibration of the BADGER tool is performed prior to and as needed during a Boral test by performing a scan of the calibration standards, with known areal density loadings, and the unattenuated region above the areal density standards. Calibration scans, at a minimum, must be performed at the beginning and end of each test day.

The materials in the calibration cell are subjected to a commercial grade dedication and are verified to conform to critical characteristics to meet the as-built rack drawings, or information provided in the license amendment request if drawings are not available. Critical characteristics are defined and verified via measurement, neutron attenuation testing, and/or chemical analysis (e.g., SS304 is verified to meet the compositions in chemical composition of SS304 used for cell walls and wrapper plates must meet ASTM Standard A240/A240M-12 and thicknesses that meet the tolerances of standard gage thickness per ASTM A480/A480M).

(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

Calibration cells have neutron absorbers of known areal densities. Since in-situ measurements are detecting the level of neutron-absorbing elements (i.e., boron-10 in this case) other materials have a very limited impact on the results of the measurements. The in-situ measurement is intended to detect the presence and amount of the neutron-absorbing elements.

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

There was no use of a reference panel in the 2014 BADGER test for Boral panels in Unit 2.

3) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited

neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.

NMPNS utilizes the Boral NAM and thus this section is not applicable.

4) ***For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.***

   a) ***Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.***

      The Boral in the NMPNS SFP racks is modeled in the as-manufactured condition (i.e., using minimum certified boron-10 areal densities). This is acceptable because there has been no indication of degradation or deformation of the coupon material to date. The BADGER testing has shown no non-uniform degradation of the Boral material (i.e., 2001 lot). Thus Boral distortion and deformation are not modeled in the NCS AOR.

   b) ***Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron-absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.***

      NMPNS does not currently have any deviation between the actual condition of the Boral material versus the as-manufactured condition. The NCS AOR protects this condition by utilizing the minimum certified boron-10 areal density when modeling the Boral, which is conservative to the as-built condition. Site procedures ensure that the coupons are subject to limiting conditions by requiring that they be surrounded by freshly discharged fuel. The results from the coupon monitoring programs are the basis for stating that the in-service material has not experienced any degradation or deformation. The link between the coupon monitoring program and the condition of the in-service material was discussed in Section 2(a) above. The acceptance criteria for the coupon monitoring program are discussed above and are implemented by site procedures and aging management programs. The areal density acceptance criteria is a decrease of no more than 5 percent in boron-10 content, as determined by neutron attenuation. This is tantamount to a requirement for no loss in boron within the accuracy of the measurement. This will ensure that the NCS AOR remains bounding. The other acceptance criterion is that the coupon thickness increase at the thickest point may not exceed 10 percent of the initial thickness at that point. This ensures that no meaningful coupon deformation (swelling, blistering) goes unaccounted for in the NCS AOR. Any failure to meet the acceptance criteria would initiate an entry into the Corrective Action Program. Coupon measurements and inspections that do not have set acceptance criteria (other measured dimensional changes, visual inspection, observed surface corrosion, observed corrosion, or other deformations of the material) are recorded and can trigger an entry into the Corrective Action Program should any of them be determined to show results of concern.

The BADGER testing for Unit 2 also showed good results with the data supporting the conclusion of no distortion or degradation for the Boral material.

c) ***Describe how the bias and uncertainty of the monitoring or surveillance program are used in the SFP NCS AOR.***

The NMPNS SFP NCS AORs do not reflect any uncertainty from the coupon monitoring program or BADGER Boral program as no indication of any deformation or degradation has been found.

d) ***Describe how the degradation in adjacent panels is correlated and accounted for in the NCS AOR.***

The NMPNS SFP NCS AORs do not reflect any adjacent panel degradation correlation from the coupon monitoring program or BADGER Boral program as no indication of any deformation or degradation has been found.

5) ***For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).***

NMPNS utilizes the Boral NAM and thus this section is not applicable.

References

1. Letter from R. V. Guzman (U.S. NRC) to K. Langdon (Nine Mile Point Nuclear Station, LLC), "Nine Mile Point Nuclear Station, Unit No. 2 – Issuance of Amendment Re: Extended Power Uprate (TAC No. ME1476)," dated December 22, 2011

2. NRC LR-ISG-2009-01, "Aging Management of Spent Fuel Pool Neutron-Absorbing Materials Other Than Boraflex," Final License Renewal Interim Staff Guidance

3. NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," December 2010

4. "Experimental Statistics," Mary Gibbons Natrella, February 2005

5. Letter from N. B. Le (U.S. NRC) to T. J. O'Connor (Nine Mile Point Nuclear Station, LLC), "Issuance of Renewed Facility Operating License Nos. DPR-63 and NPF-69 for the Nine Mile Point Nuclear Station, Units 1 and 2 (TAC Nos. MC3272 and MC3273)," dated October 31, 2006

1) ***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:***

Oyster Creek Nuclear Generating Station (OCNGS) has one SFP with 10 Boraflex high density racks and four Boral high density racks.

Exelon Generation Company, LLC (EGC) has determined that OCNGS is a Category 3 plant for 10 Boraflex high density fuel racks, in accordance with Generic Letter 2016-01. In Reference 5, the NRC issued a renewed Facility Operating License (FOL) for OCNGS (i.e., DPR-16). This renewed FOL includes a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-1875, "Safety Evaluation Report Related to the License Renewal of Oyster Creek Nuclear Generating Station." Commitment 15 in Appendix A to NUREG-1875 addresses the neutron-absorbing material (NAM) monitoring program for Boraflex spent fuel racks at OCNGS.

This existing monitoring program is identified in NUREG-1875, Table 3.1-1 "Staff Evaluation for Reactor Vessel, Internals, and Reactor Coolant System," and described in section 3.0.3.2.13, "Boraflex Rack Management Program." On the basis of its audit and review of the OCNGS Boraflex Rack Management Program, the NRC concluded "that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3)." OCNGS made one change to the Boraflex Rack Monitoring Program that is documented in the License Renewal Application and in NUREG-1875. The station stopped the use of Boraflex coupon surveillances as a part of the plan. This was done because the Boraflex coupons had become non-representative of the in-service material according to the BADGER testing results. This issue has been experienced by most in the industry that have had Boraflex coupons. The Generic Aging Lessons Learned (GALL) document (NUREG-1801) states, "The experience with Boraflex panels indicates that coupon surveillance programs are not reliable." The OCNGS commitment for performing Boraflex coupon surveillance was eliminated in March 2010. This change does not impact the effectiveness of the Boraflex Rack Management Program. No further change has been made to the Boraflex Rack Management Program as documented in the License Renewal Application. Therefore, in accordance with Generic Letter 2016-01, additional information regarding the Boraflex racks is not required.

The Boral racks were installed prior to submittal of the Reference 1 license renewal application; however, the license renewal application and Reference 2 Safety Evaluation Report did not describe a Boral monitoring program. Therefore, EGC has determined that OCNGS is a Category 4 plant for four Boral high density racks and the remaining information in this Attachment is applicable to the Boral high density racks.

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

AAR Advanced Structures manufactured OCNGS's Boral material in the years 1987, 1991, and 1992. Holtec manufactured the SFP racks using the Boral panels. The station installed the new Boral racks in the SFP in the year 2000.

b) neutron-absorbing material specifications, such as:

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

Boron is not specified on a weight percent basis of the Boral NAM; therefore, this subsection is not applicable to Boral.

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

The minimum certified areal density for the Boral NAM is 0.0150 $g^{10}B/cm^2$. The minimum, maximum, and nominal as-built areal densities are 0.0159 $g^{10}B/cm^2$, 0.0249 $g^{10}B/cm^2$, and 0.019149 $g^{10}B/cm^2$, respectively.

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

The Boral panel dimensions are as follows:

- Thickness = 0.070 inches
- Width = 5.0 inches (internal panels) and 4.5 inches (rack exterior panels)
- Length = 146.0 inches

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral porosity was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

After a reasonable search of the plant's records, including docketed information, EGC determined that the Boral qualification testing plan was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

Boral panels are secured by stainless steel sheathing in the cells of the spent fuel racks. The neutron absorber sheathing (cover plate) serves to position and retain the neutron absorber material in its designated space. This is accomplished by spot welding and skip welding the cover sheet to the square tube along the former's edges at numerous locations. This manner of attachment ensures that the NAM will not sag or laterally displace during fabrication processes and under any subsequent loading conditions. This fixture method also produces a vented enclosure that will not retain gasses produced from neutron capture or other processes.

ii) ***sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;***

Sheathing material is the same material as the rack construction itself, 304L stainless steel. The vented sheathing allows a limited amount of SFP water exchange. Thus the SFP water can come into contact with the NAM. The Boral is shielded sufficiently to prevent water flow induced degradation.

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

i) ***estimated current minimum areal density;***

Industry experience with Boral in addition to OCNGS coupon testing (i.e., References 1 and 2) have provided no indication of the loss of boron carbide from the NAM in the SFP environment. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP (i.e., the minimum certified areal density provided in the response to item 1 above).

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

The current credited areal density in the Boral NCS AOR is the minimum certified areal density of 0.0150 $g^{10}B/cm^2$.

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).***

OCNGS Boral coupon testing has identified no degradation or deformation of the Boral material for the coupons pulled to date.

2) ***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:***

OCNGS utilizes periodic coupon measurements to monitor the ability of the Boral to perform its safety function. Coupon material monitoring methods rely on the strong correlation between aging/degradation impacts on a set of surrogate material pieces (coupons) from the same manufacturing process as the as-installed material. The station maintains the ability to detect aging/degradation mechanisms that the in-service NAM experiences through monitoring the coupon material characteristics. Coupon trees are maintained in SFP locations that have conditions projected to be the most challenging to the materials (e.g., high gamma dose, high neutron dose, high temperature) to ensure early detection of aging/degradation mechanisms that are driven by environmental factors.

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

OCNGS utilizes a Boral coupon surveillance program to confirm that the material is performing its safety function. The current surveillance program is documented in site procedures. This surveillance plan has been structured to meet the guidance equivalent to Section XI.M40 of the GALL Report, Revision 2 (Reference 3). The plan was last updated based on the plant's response to NRC Information Notice 2009-26 (Reference 4). OCNGS has implemented the requirement for inspecting a minimum of one Boral coupon every 10 years. This periodicity is sufficient to provide an indication of degradation of the Boral material prior to reaching an impact of more than 5 percent of the subcriticality margin. This is based on the vast industry experience with Boral that has not shown any mechanism that leads to the loss of the boron from the Boral material. This sampling frequency is in agreement with the guidance in Section XI.M40 of the GALL Report (Reference 3). EGC also monitors industry experience with the Boral NAM through operating experience reviews and through industry group participation (e.g., NEI, EPRI).

ii) parameters to be inspected and data collected;

The data to be collected and parameters to be inspected for each Boral coupon are:

- Visual observation and photography (photo-microscopy as needed),
- Weight and specific gravity measurements,
- Dimensional measurements (length, width, and thickness), and
- Neutron attenuation measurement (boron-10 areal density determination).

Testing the coupons via neutron radiography and wet chemical analysis are listed as optional evaluations if desired. In-situ blackness testing is also referred to in the surveillance program as optional.

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;

There are two data points that have acceptance criteria for the coupon program.

- The coupon thickness may not increase more than 10 percent of the initial thickness at that point.
- A decrease of no more than 5 percent in boron-10 content, as determined by neutron attenuation, is acceptable. This is tantamount to a requirement for no loss in boron-10 within the accuracy of the measurements.

These two acceptance criteria reflect the importance of the boron areal density and the known blistering issues with Boral at other sites in the industry. If either of these two acceptance criteria is not met, then entry into the Corrective Action Program is required for resolution and an engineering evaluation is required. If issues are identified with other measured coupon parameters (e.g., significant blistering or pitting) then entry into the Corrective Action Program would also be necessary. The Boral coupon acceptance criteria above are consistent with the guidance in Section XI.M40 of the GALL Report (Reference 3) and are thus sufficient to ensure that the materials structure and safety function are maintained within the assumptions of the NCS AOR.

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

OCNGS procedures do not require trending of the Boral coupon monitoring results.

v) industry standards used.

The primary industry standards used for the Boral coupon surveillance program are:

- ASTM E2971, "Standard Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers Using Neutron Attenuation Measurements," and
- ASTM C1187, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks In a Pool Environment."

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

i) If there is visual inspection of inservice material:

There are no visual inspections of the Boral NAM performed outside of what has already been discussed for the coupon monitoring program.

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;

The Boral coupons are representative of the in-service Boral material for the following reasons. The coupons were formed using the same material and in the same manner as the in-service material, thus ensuring that the materials are equivalent. Site procedures require that the Boral coupon tree have four freshly discharged fuel assemblies placed face adjacent to it the outage after each sample is drawn such that the Boral coupons maintain exposure to gamma dose on the order of the more exposed in-service materials. Other coupon operating environmental conditions, such as flow and water temperature, will be representative as well due to the placement among the hottest fuel. The coupons are 4-inch by 6-inch nominal dimension Boral slabs and are each placed in a vented stainless steel jacket to simulate any galvanic issues during the time in the SFP.

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

The coupon tree was installed in 2000.

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

Boral coupons may be reinserted per site procedures but are not being reinserted at this time. Sufficient coupons remain in the SFP such that coupon re-use will not be necessary to reach the expected SFP end of life. Site procedures prohibit the return of a coupon to the SFP if a section has been removed from the coupon for wet chemical analysis (i.e., destructive analysis).

(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.

There are seven Boral coupons remaining. The next coupon is planned to be removed in 2018 for testing, and scheduled to repeat every tenth year thereafter. As discussed above, there are sufficient coupons to reach the expected SFP end of life at this time. OCNGS is scheduled to cease power operation in 2019.

iii) If RACKLIFE is used:

RACKLIFE is not applicable to Boral.

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

In-situ testing of the Boral material at OCNGS is not utilized as a required part of the monitoring program. Blackness testing is listed as an optional test procedure, but no record of its use since initial rack as-manufactured rack testing has been found.

3) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of

the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.

OCNGS utilizes the Boral NAM and thus this section is not applicable.

4) ***For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.***

   a) ***Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.***

   The Boral in the OCNGS SFP racks is modeled in the as-manufactured condition (i.e., using minimum certified boron-10 areal density). This is acceptable because there has been no indication of degradation or deformation of the coupon material to date. No blisters or pitting have been identified on OCNGS Boral coupons.

   b) ***Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron-absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.***

   OCNGS does not currently have any deviation between the actual condition of the Boral material versus the as-manufactured condition. The NCS AOR protects this condition by utilizing the minimum certified boron-10 areal density when modeling the Boral, which is conservative to the as-built condition. The results from the coupon monitoring program are the basis for stating that the in-service material has not experienced any degradation or deformation. The link between the coupon monitoring program and the condition of the in-service material was discussed in Section 2(a) above. The acceptance criteria for the coupon monitoring program are listed in Section 2(a)(3) and are implemented by site procedures. The areal density acceptance criteria is a decrease of no more than 5 percent in boron-10 content, as determined by neutron attenuation. This is tantamount to a requirement for no loss in boron within the accuracy of the measurement. This will ensure that the NCS AOR remains bounding. The other acceptance criterion is that the coupon thickness increase at the thickest point may not exceed 10 percent of the initial thickness at that point. This ensures that no meaningful coupon deformation (swelling, blistering) goes unaccounted for in the NCS AOR. Any failure to meet the acceptance criteria requires the analysis of the situation in an engineering evaluation to determine the acceptability of the NAM. Coupon measurements and inspections that do not have set acceptance criteria (other measured dimensional changes, visual inspection, observed surface corrosion, observed corrosion, or other deformations of the material) are recorded and can trigger an entry into the Corrective Action Program should they show results of concern.

c) Describe how the bias and uncertainty of the monitoring or surveillance program are used in the SFP NCS AOR.

The OCNGS SFP NCS AOR does not reflect any uncertainty from the coupon monitoring program as no indication of any deformation or degradation has been found. Thus there is no feedback into the SFP NCS AOR bias and uncertainty values.

d) Describe how the degradation in adjacent panels is correlated and accounted for in the NCS AOR.

The OCNGS SFP NCS AOR does not account for any degradation of the NAM as the coupon monitoring program has shown no indication of any deformation or degradation in the material.

5) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).

OCNGS utilizes the Boral NAM and thus this section is not applicable.

References

1. Letter from C. N. Swenson (AmerGen Energy Company, LLC) to U.S. NRC, "Application for Renewed Operating License," dated July 22, 2005

2. NUREG-1875, "Safety Evaluation Report Related to the License Renewal of Oyster Creek Generating Station," April 2007

3. NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," December 2010

4. NRC Information Notice 2009-26, "Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool," dated October 28, 2009

5. Letter from L. M. Regner (U.S. NRC) to T. Rausch (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating License No. DPR-16 for Oyster Creek Nuclear Generating Station," dated April 8, 2009

Exelon Generation Company, LLC (EGC) has determined that Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3, are Category 3 plants in accordance with Reference 1. The NRC issued license amendments for PBAPS, Units 2 and 3, in Reference 2 that modified the Technical Specifications and Facility Operating Licenses to allow the use of neutron absorbing inserts in the spent fuel pool storage racks for the purpose of criticality control in the spent fuel pools. The NRC added, as a condition of the amendment, the following words to ensure that a description of the Rack Insert Surveillance Program is incorporated into a mandated licensing basis document as part of the amendment implementation:

> Implementation of the amendment shall include revision of the Updated Final Safety Analysis Report as described in Attachment 11 to the licensee's letter dated November 3, 2011.

Attachment 11 of the November 3, 2011, letter (i.e., Reference 3) provided a commitment to revise the Updated Final Safety Analysis Report (UFSAR) to add a description of the Rack Insert Surveillance Program, which includes three surveillance programs as follows: the Fast Start Coupon Surveillance Program, the Long-Term Coupon Surveillance Program, and the Full Rack Insert Surveillance Inspection Program. The UFSAR has been revised, and the rack inserts have been installed in both spent fuel pools.

EGC affirms that no changes have been made to the neutron absorbing material monitoring program as described in the referenced license amendments.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from R. B. Ennis (U.S. NRC) to M. J. Pacilio (Exelon Nuclear), "Peach Bottom Atomic Power Station, Units 2 and 3 – Issuance of Amendments Re: Use of Neutron Absorbing Inserts in Spent Fuel Pool Storage Racks (TAC Nos. ME7538 and ME7539)," dated May 21, 2013

3. Letter from M. D. Jesse (Exelon Generation Company, LLC) to U.S. NRC, "License Amendment Request – Use of Neutron Absorbing Inserts in Units 2 and 3 Spent Fuel Pool Storage Racks," dated November 3, 2011

Exelon Generation Company, LLC (EGC) has determined that Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2, are Category 3 plants in accordance with Reference 1. The NRC issued license amendments for QCNPS, Units 1 and 2, in Reference 2 that include license conditions for the neutron absorber monitoring program. EGC affirms that no changes have been made to the neutron absorbing material monitoring program as described in the referenced license amendments.

References

1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016

2. Letter from B. Mozafari (U.S. NRC) to M. J. Pacilio (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Issuance of Amendments Regarding NETCO Inserts (TAC. Nos. MF2489 and MF2490)(RS-13-148)," dated December 31, 2014

1) ***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:***

The R.E. Ginna Nuclear Power Plant (Ginna) utilizes three types of SFP racks: Region 2 Type 1, Region 2 Type 2, and Region 1 Type 3 racks. The Region 2 Type 1 racks originally credited Boraflex as the neutron-absorbing material (NAM). The Region 2 Type 1 racks do not credit any NAM at this time to meet subcriticality requirements in the SFP. In accordance with Generic Letter 2016-01, additional information regarding this rack type is not required because no NAM is credited.

The Region 2 Type 2 racks are high density spent fuel storage racks with Borated Stainless Steel (BSS) plates used as the NAM. The BSS plates are for neutron control only and are not a part of the structural support of the SFP rack.

The Region 1 Type 3 racks are flux-trap style racks that use BSS plates as the NAM. The BSS plates are for neutron control only and are not part of the structural support of the SFP rack. Region 1 Type 3 racks are predominantly used to store high reactivity fuel that has been recently discharged from the reactor. Region 1 Type 3 racks contain five cells that are slightly oversized, and were designed to hold damaged fuel assemblies.

The specific type of BSS used at Ginna is ASTM - A887-89 Type 304 B6/B7 Grade B borated stainless steel.

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

The Societe Atlantique de Techniques Avancees (ATEA, a Framatome Group company) manufactured the BSS plate material in 1997. ATEA then used these BSS plates to make the two types of BSS SFP racks at Ginna. These SFP rerack fuel storage units were made and installed in 1998.

b) ***neutron-absorbing material specifications, such as:***

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

Ginna Region 2 Type 2 and Region 1 Type 3 SFP racks contain BSS with 1.7 weight percent boron (minimum), of which 18.14 weight percent is boron-10.

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

The minimum certified areal density of Ginna's BSS panels is 0.006 $g^{10}B/cm^2$ for Region 1 Type 3 normal size cells, and 0.007 $g^{10}B/cm^2$ for Region 2 Type 2 and Region 1 Type 3 oversized cells.

The BSS as-built areal densities were not found in the available documentation. After a reasonable search of the plant's records, including docketed information, Exelon Generation Company, LLC (EGC) determined that the BSS as-built areal densities were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program.

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

The BSS panel density ranges from 7.73 to 7.78 g/cm^3.

The BSS panel dimensions are as follows:

Region 2 Type 2

- Thickness = 0.3 +0.05/-0.0 cm
- Width = 20.68 +0.2/-0.1 cm
- Length = 370 cm

Region 1 Type 3, normal size

- Thickness = 0.25 +0.05/-0.0 cm
- Width = 22.0 +0.2/-0.1 cm
- Length = 370 cm

Region 1 Type 3, oversized cells for failed fuel

- Thickness = 0.3 +0.05/-0.0 cm
- Width = 20.68 +0.2/-0.1 cm
- Length = 370 cm

The BSS material is a fully dense metal with zero porosity.

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

Early studies of the corrosion behavior of BSS with boron contents up to 2.3 wt% confirmed that BSS exhibits corrosion resistance similar to that of Type 304 stainless steel in environments present in nuclear reactors. Corrosion rates for BSS containing 1.35 wt% boron in boiling 10 percent nitric acid have also been measured. The results were consistent with other stainless steel behavior with a rapid change in weight (i.e., passivation) within 48 hours and no further weight change. The maximum penetration was 0.09 mils. Corrosion tests of BSS with boron contents of 1.0 wt% and 1.75 wt% exposed to 2000 parts per million (PPM) boric acid solutions at 154°F for six month durations have also been recently reported. The 154°F test temperature represents the maximum normal operating temperature in SFPs. Various coupon configurations representing simple immersion, creviced, and galvanically-coupled conditions were included in these tests. The test showed essentially no detectable corrosion for all test conditions.

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

Region 2 Type 2
The BSS panels are placed in the rack and held in place by the standard stainless steel (SS) materials surrounding it and by tabs welded onto the standard SS material. This material is fabricated and installed without bending, welding, or mechanical fastening of the BSS material. The BSS material does not act as a structural member in the SFP rack.

Region 1 Type 3
The BSS panels are placed inside cells and held in place by eight axial belts to maintain geometry. This material is fabricated and installed without bending, welding, or mechanical fastening of the BSS material. The BSS material does not act as a structural member in the SFP rack.

ii) sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

There is no sheathing on the BSS material. Most panels are fully open to the SFP environment with some areas having additional "protection" simply by being situated between other SS structures.

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

i) estimated current minimum areal density;

Results of coupon testing of the BSS have provided no indication of the loss of boron-10. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP (i.e., the minimum certified areal density provided in the response to item 1 above).

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

Region 2 Type 2 and Region 1 Type 3 Oversized
The current credited areal density in the BSS NCS AOR is the minimum certified areal density of 0.007 $g^{10}B/cm^2$. This comes from crediting a minimum boron content of 1.7 w% and 18.14 w% boron-10 in boron and a minimum density in the BSS panel (7.73 g/cm^3) and a minimum panel thickness of 0.3 cm. This is acceptable as no mechanism for boron loss from BSS in the SFP has been identified.

Region 1 Type 3 Normal Size
The current credited areal density in the BSS NCS AOR is the minimum certified areal density of 0.006 $g^{10}B/cm^2$. This comes from crediting a minimum boron content of 1.7 w% and 18.14 w% boron-10 in boron and a minimum density in the BSS panel

(7.73 g/cm^3) and a minimum panel thickness of 0.25 cm. This is acceptable as no mechanism for boron loss from BSS in the SFP has been identified.

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).

Reference 1 provides a summary of the coupon testing program findings at Ginna. According to Reference 1 there have been no findings of BSS degradation or deformations from the coupons tested.

2) 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:

Ginna utilizes periodic coupon measurements to monitor the ability of the BSS to perform its safety function. Coupon material monitoring methods rely on the strong correlation between aging/degradation impacts on a set of surrogate material pieces (coupons) from the same manufacturing lot as the as-installed material. The station maintains the ability to detect aging/degradation mechanisms that the in-service NAM experiences through monitoring the coupon material characteristics. Coupon trees are maintained in SFP locations that have conditions projected to be the most challenging to the materials (e.g., high gamma dose, high neutron dose, high temperature) to ensure early detection of aging/degradation mechanisms that are driven by environmental factors.

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

Ginna utilizes a BSS coupon surveillance program to confirm that the material is performing its safety function. The current surveillance program is documented in Section B2.1.30 of the License Renewal Application (Reference 1) and was approved by the NRC in Section 3.3.2.3.7 of the License Renewal Safety Evaluation Report (Reference 2). The site program plan ensures that the surveillance procedures are in compliance with the License Renewal Application. Station procedures state that all 12 BSS coupons are removed from the SFP and tested every three refueling cycles (i.e., approximately every 54 months). This periodicity is sufficient to provide an indication of degradation of the BSS material prior to reaching an impact of more than 5 percent of the subcriticality margin. This conclusion is based on industry experience with BSS that has not shown any evidence of degradation that would cause loss of boron from the BSS. The sampling frequency is in agreement with the guidance in the Generic Aging Lessons Learned (GALL) Report, Revision 0, which was in effect when the License Renewal was granted

(Reference 3). This periodicity is also less than the 10 year allowance in the current GALL report (i.e., Revision 2).

ii) parameters to be inspected and data collected;

The parameters inspected and data collected for the coupon monitoring program are listed in Section B2.1.30.3 of the Reference 1 License Renewal Application. The parameters inspected and data collected are within the guidelines of the GALL Report (Reference 3) and were accepted by the NRC in Section 3.3.2.3.7.2 of the Reference 2 Safety Evaluation Report for the Ginna license renewal.

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;

The acceptance criteria of the coupon monitoring program are described in Section B2.1.30.6 of the Reference 1 License Renewal Application. The acceptance criteria are designed to aid in identification of any mechanism that could lead to a loss in the reactivity suppression of the BSS NAM, prior to the loss challenging the 5 percent subcriticality margin. The acceptance criteria are aligned with the Reference 3 GALL Report and were accepted by the NRC in Section 3.3.2.3.7.2 of the Reference 2 Safety Evaluation Report for the Ginna license renewal.

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

The monitoring and trending segments of the coupon monitoring program are detailed in Section B2.1.30.5 of the Reference 1 License Renewal Application. The monitoring and trending plans are aligned with the Reference 3 GALL Report and were accepted by the NRC in Section 3.3.2.3.7.2 of the Reference 2 Safety Evaluation Report for the Ginna license renewal.

v) industry standards used.

The primary industry standards utilized in the BSS surveillance plan are listed in References 4 through 6.

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

i) If there is visual inspection of inservice material:

There are no visual inspections of the NAM performed outside of what has already been discussed for the coupon monitoring program.

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;

The BSS coupons are representative of the in-service BSS material for the following reasons. The coupons were formed from the same material used to make the in-service material, thus ensuring that both items used the same manufacturing process. The licensing renewal Safety Evaluation Report, Reference 2, requires that the BSS coupons maintain exposure such that it is at the high end for the BSS material in all the spent fuel racks prior to the coupons being examined, by ensuring that the coupons have been surrounded with a greater number of freshly discharged assemblies than that of any other cell location. This commitment is reflected in current plant procedures governing coupon placement. Other coupon operating environmental conditions, such as flow and water temperature, will be more limiting due to the placement among the hottest fuel as well. The coupons are 4-inch by 8-inch nominal dimension BSS slabs and are each placed in a vented stainless steel jacket to simulate any galvanic issues during the time in the SFP.

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

The coupon tree was installed in 1998.

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

The same 12 coupons have been reinserted after each measurement. This is acceptable because the testing is non-destructive and the BSS material properties are not altered by the testing performed.

(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.

Twelve BSS coupons exist. These are the same 12 coupons that were delivered when the coupon tree was originally installed in 1998. The coupon tree is removed every three cycles for examination.

iii) If RACKLIFE is used:

RACKLIFE is not applicable to BSS.

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

In-situ testing of the BSS material at Ginna is not performed; therefore, this subsection is not applicable.

3) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.

Ginna Station utilizes the BSS NAM and thus this section is not applicable.

4) For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.

Ginna Station utilizes the BSS NAM and thus this section is not applicable.

5) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).

Ginna Station utilizes the BSS NAM and thus this section is not applicable.

References

1. Letter from R. C. Mecredy (Rochester Gas and Electric Corporation) to U.S. NRC, "Application for Renewed Operating License," dated July 30, 2002
2. NUREG-1786, "Safety Evaluation Report Related to the License Renewal of R.E. Ginna Nuclear Power Plant," May 2004
3. NUREG-1801, Revision 0, "Generic Aging Lessons Learned (GALL) Report," July 2001
4. ASTM C1187, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks in a Pool Environment"
5. ASTM C992, "Specification for Boron Based Neutron Absorbing Material Systems for Use in Nuclear Spent Fuel Storage Racks"
6. ASTM G4, "Guide for Conducting Corrosion Coupon Tests in Plant Equipment"

1) ***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:***

Three Mile Island Nuclear Station Unit 1 (TMI) has two SFPs, SFP A and SFP B. None of the SFP racks in SFP B contain neutron-absorbing material (NAM) that is credited in the NCS AOR. In accordance with Generic Letter 2016-01, additional information regarding SFP B is not required because no NAM is credited.

SFP A contains four types of spent fuel racks that differ either in design, NAM used, or both. There are 12 SFP racks in SFP A which are listed below along with their descriptions. Note that the nomenclature of Region I and Region II racks is a standard parlance for low-density flux trap type racks (Region I) and high-density type racks (Region II). These two types of racks are utilized for different fuel type storage scenarios (e.g., fresh fuel, high burnup fuel).

- Region I Boral SFP Racks (R1B) – A and B
- Region II Boral-1 SFP Racks (R2B-1) – C-1, C-2, D, and E
- Region II Boral-2 SFP Racks (R2B-2) – F-1 and F-2
- Region II Metamic SFP Racks (R2M) – F-3, F-4, F-5, and F-6

Thus, the TMI SFP A has eight Boral racks and four Metamic racks.

Exelon Generation Company, LLC (EGC) has determined that TMI is a Category 3 plant for eight Boral racks, in accordance with Generic Letter 2016-01. In Reference 9, the NRC issued a renewed Facility Operating License (FOL) for TMI (i.e., DPR-50). This renewed FOL includes a license condition that requires completion of EGC's commitments that are described in Appendix A to NUREG-1928, "Safety Evaluation Report Related to the License Renewal of Three Mile Island Nuclear Station, Unit 1." Commitment 43 in Appendix A to NUREG-1928 addresses the NAM monitoring program for Boral spent fuel racks at TMI.

This existing monitoring program is identified in NUREG-1928, Table 3.3-1 "Staff Evaluation for Auxiliary System Components in the GALL Report," and described in section 3.3.2.2.6, "Reduction of Neutron-Absorbing Capacity and Loss of Material due to General Corrosion." On the basis of its technical review of the TMI Boral Surveillance Program, the NRC concluded "that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3)." EGC affirms that no changes have been made to the NAM monitoring program for Boral spent fuel racks, as described in the renewed FOL, and the associated NRC Safety Evaluation Report. Therefore, in accordance with Generic Letter 2016-01, additional information regarding the Boral racks is not required.

EGC has determined that TMI is a Category 4 plant for four Metamic racks and the remaining information in this Attachment is applicable to the Metamic racks.

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

Nanotech Metals (Holtec) manufactured TMI's Metamic material in 2009. The station installed the new Metamic racks in the SFP in 2009.

b) neutron-absorbing material specifications, such as:

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

The nominal Metamic weight percent boron carbide is 30.5 percent.

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

The minimum certified areal density for the Metamic NAM is 0.0259 $g^{10}B/cm^2$, and the nominal as-built areal density is 0.0287 $g^{10}B/cm^2$. After a reasonable search of the plant's records, including docketed information, EGC determined that the Metamic as-built minimum and maximum areal densities were not part of the original licensing basis or previously requested by the NRC as part of the licensing action that provided the neutron absorber monitoring plan.

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

The Metamic plate dimensions are as follows:

- Thickness = 0.098 +/- 0.005 inches
- Width = 7.50 +/- 0.063 inches
- Length = 144 +/- 0.25 inches

Metamic is a fully dense material with zero porosity. The Metamic density ranges from 2.62-2.65 g/cm^3.

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

After a reasonable search of the plant's records, including docketed information, EGC determined that the TMI specific Metamic material qualification testing information was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that provided the neutron absorber monitoring plan.

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

The Metamic material is maintained in-place through its inclusion between the fuel rack tubes and formed wrapper plates welded to the fuel rack tubes. Welding is used on the wrapper plates to fix them to the rack tubes while also providing a smooth surface for the fuel to slide against when being moved in the SFP racks.

ii) sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

The Metamic material is held in place by 304 stainless steel formed wrapper plates which are vented and thus allow a limited amount of water exchange between the bulk SFP water and the Metamic material. The Metamic is shielded sufficiently to prevent water flow induced degradation.

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

i) estimated current minimum areal density;

Industry experience with Metamic in addition to TMI coupon testing have provided no indication of the loss of boron carbide from this material in the SFP environment. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP (i.e., the minimum certified areal density provided in the response to item 1 above).

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

- The current credited areal density for the Metamic NAM is 0.0255 $g^{10}B/cm^2$.

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).

No blistering or pitting of any consequence has been identified on Metamic coupons at TMI as documented in Reference 2 and coupon reports that have been produced after the license renewal application was approved.

2) 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:

TMI utilizes periodic coupon measurements to monitor the ability of the Metamic to perform its safety function. Coupon material monitoring methods rely on the strong correlation between aging/degradation impacts on a set of surrogate material pieces (coupons) from the same manufacturing lot as the as-installed material. The station maintains the ability to detect aging/degradation mechanisms that the in-service NAM experiences through monitoring the coupon material characteristics. Coupon trees are maintained in SFP locations that have conditions projected to be the most challenging to the materials (e.g., high gamma dose, high neutron dose, high temperature) to ensure early detection of aging/degradation mechanisms that are driven by environmental factors.

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

TMI utilizes a Metamic coupon surveillance program to confirm that the material is performing its safety function. EGC evaluated the use of Metamic as a neutron absorber for some of the TMI SFP racks instead of Boral, and concluded that use of Metamic was acceptable. The surveillance program for Metamic is based on the manufacturer's recommendations (frequency, calculations, sample size). The current frequency for Metamic coupon surveillances is one coupon every two years, since the racks are still within the first four cycles after installation. EGC expects to decrease this frequency over time as TMI experience is gained with the material. This type of frequency change is typical of coupon programs with newer materials or for a first application at a site.

ii) parameters to be inspected and data collected;

The parameters inspected and data collected as a part of the Metamic coupon monitoring program are:

- Visual observation with optional photography,
- Dimensional measurements (length, width, thickness),
- Weight,
- Density (via measurement and calculation), and
- Neutron attenuation (via measurement and calculation).

The parameters inspected and data collected above are aligned with the Reference 3 GALL Report.

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;

The acceptance criteria of the coupon monitoring program are:

- A decrease of no more than 5 percent in boron-10 as determined by neutron attenuation measurements, and
- An increase in thickness at any point should not exceed 10 percent of the initial thickness.

These acceptance criteria are designed to provide indication of any mechanism that could lead to a loss in the reactivity hold-down of the Metamic, before the loss can challenge the 5 percent subcriticality margin built into the NCS AOR. The acceptance criteria are aligned with the Reference 3 GALL Report. Any deviation from the acceptance criteria requires an investigation and engineering evaluation as directed by TMI Reactor Engineering.

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

The monitoring and trending portions of the Metamic coupon measurement plan are:

- Coupon results are compared against the pre-irradiated values to detect changes, and
- Coupon results are compared against previously tested coupons to check for trends that may be present.

The monitoring and trending plans are aligned with the Reference 3 GALL Report.

v) industry standards used.

The primary industry standards utilized in the Metamic coupon surveillance plans are listed in References 4 through 8.

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

i) If there is visual inspection of inservice material:

There are no visual inspections of the NAM performed outside of what has already been discussed for the coupon monitoring program.

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;

The Metamic coupons are representative of the in-service NAM material for the following reasons. The coupons were formed from material from NAM lots used to make the in-service material, thus ensuring that both items used the same manufacturing process. The Metamic coupons maintain exposure such that it is bounding for the Metamic material in all the spent fuel racks prior to the coupons being examined, by ensuring that the coupons have been surrounded with a greater number of freshly discharged fuel assemblies than that of any other cell location. Other coupon operating environmental conditions, such as flow and water temperature, will be more limiting due to the placement among the hottest fuel as well. Jacketed slabs of Metamic that are a nominal 8-inch by 6-inch represent the in-service Metamic material.

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

There is one coupon tree in the Region II racks containing Metamic. The coupon tree was installed in 2010.

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

Coupons are not reinserted into the SFP after testing.

(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.

There are eight Metamic coupons remaining.

iii) If RACKLIFE is used:

RACKLIFE is not applicable to Metamic.

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

In-situ testing of the Metamic material at TMI is not performed; therefore, this subsection is not applicable.

3) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.

TMI utilizes the Metamic NAM and thus this section is not applicable.

4) For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.

TMI utilizes the Metamic NAM and thus this section is not applicable.

5) For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).

TMI utilizes the Metamic NAM and thus this section is not applicable.

References

1. Letter from M. P. Gallagher (AmerGen Energy Company, LLC) to U.S. NRC, "Response to NRC Request for Additional Information related to Three Mile Island Nuclear Station, Unit 1, License Renewal Application," dated November 12, 2008

2. NUREG-1928, "Safety Evaluation Report Related to the License Renewal of Three Mile Island Nuclear Station, Unit 1," October 2009

3. NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," December 2010

4. ASTM E2971, "Standard Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers Using Neutron Attenuation Measurements"

5. ASTM C1187, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks In a Pool Environment"

6. ASTM C992, "Specification for Boron Based Neutron Absorbing Material Systems for Use in Nuclear Spent Fuel Storage Racks"

7. ASTM G4, "Guide for Conducting Corrosion Coupons Tests in Plant Equipment"

8. ASTM G69, "Practice for Measurement of Corrosion Potentials of Aluminum Alloys"

9. Letter from J. E. Robinson (U.S. NRC) to M. P. Gallagher (Exelon Generation Company, LLC), "Issuance of Renewed Facility Operating License No. DPR-50 for the Three Mile Island Nuclear Station, Unit 1," dated October 22, 2009