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NL-16-129

November 3, 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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SUBJECT: Response to Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools", Response to NRC Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f)
Indian Point Unit Number 3
Docket No. 50-286
License No. DPR-64

REFERENCE: NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Material in Spent Fuel Pools"

Dear Sir or Madam:

The purpose of this letter is to respond to Generic Letter (GL) 2016-01 the NRC issued on April 7, 2016 to all power reactor licensees except those that have permanently ceased operation with all power reactor fuel removed from on-site spent fuel pool storage.

For purposes of this response, Indian Point Unit 3 (IP3) has been determined to be a Category 4 licensee in accordance with the Reference. As a Category 4 licensee, information on the neutron absorber material, criticality analysis of record and neutron absorber monitoring program is requested depending on the type of neutron absorber material present and credited in the spent fuel pool. The IP3 spent fuel pool credits Boral® and therefore is required to provide information requested in Appendix A of the Generic Letter in areas 1, 2, and 4. The Attachment contains responses to the requested information.

This letter contains no new regulatory commitments. Should you have any questions regarding this submittal, please contact Mr. Robert Walpole, Manager, Regulatory Assurance at (914) 254-6710.

A158
NRR

I declare under penalty of perjury that the foregoing is true and correct; executed on November 3, 2016.

Sincerely,

AJV / sp

Attachment: Response to Requested Information for Generic Letter 2016-01

cc: Mr. Douglas V. Pickett, Senior Project Manager, NRC NRR DORL
Mr. Daniel H. Dorman, Regional Administrator, NRC Region 1
NRC Resident Inspectors Office
Mr. John B. Rhodes, President and CEO, NYSERDA
Ms. Bridget Frymire, New York State Public Service Commission

ATTACHMENT TO NL-16-129

RESPONSE TO REQUESTED INFORMATION

FOR GENERIC LETTER 2016-01

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NO. 3
DOCKET NO. 50-286

Response to Requested Information in for Generic Letter 2016-01

A. - Background

On April 7, 2016, the U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" (GL-2016-01) [1]. The following information provides the IPEC, Unit 3 response to the GL-2016-01, including the applicable Areas of Requested Information (ARI) in Appendix A. This response has been developed based on a reasonable search of the plant's records, including docketed information.

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

ARI 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:

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

Response

Manufacturer: The Boral material was manufactured by Brooks and Perkins [an AAR Company]. The racks were designed by US Tool and Die.

Date of manufacture: After a reasonable search of IP3 records, including docketed information, IP3 determined that the date of manufacture 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.

Date of material installation: Installation was completed by 07/02/1990.

b) *neutron-absorbing material specifications:*

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

Response

The Boral Panels used are a composite material made of boron carbide and aluminum in three distinct layers. The outer layers are 0.0125 inches thick aluminum cladding (type 1100 alloy aluminum). The center layer is a vented 0.05 inch thick uniform aggregate of boron carbide particles held in an aluminum alloy matrix. "Vented" means that it is clad on the front and back only, while the sides are unclad to allow for gas migration and release. These Strips of Boral are scalloped such that they may be held in place by welded coins and are not themselves welded. Strips of Boral poison are retained on the outer sides of the rack modules by a thin sheet of stainless steel. The individual spent fuel pool (SFP) cells are fabricated from ASTM A-240, Type 304 stainless steel.

The IP3 Boral is not specified on a weight percent basis of the neutron absorbing component. See the response to ARI 1 b) ii for the certified areal density.

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

Response

Minimum Certified Areal Density = 0.020 g-B^{10}/cm^2
Nominal Design Areal Density = 0.028 g-B^{10}/cm^2

After a reasonable search of IP3 records, including docketed information, IP3 determined that the as-built areal 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.

iii. material characteristics, including porosity, density and dimensions

Response

Materials Characteristics (porosity, density, dimensions):
Nominal Boral Length: 133 in. $\pm$0.25 in. **(Region 1)**
Nominal Boral Length: 136 in. $\pm$0.25 in. **(Region 2)**
Nominal Boral Thickness: 0.075 in. $\pm$0.005 in.
Nominal Boral Width: 7.5 in. $\pm$0.06 in.

After a reasonable search of IP3 records, including docketed information, IP3 determined that the Boral porosity and density 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.

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

Response

The Boral, with a B-10 areal density of 0.020 g/cm^2, was manufactured at the AAR Brooks & Perkins facility under the control and surveillance of a computer aided Quality Assurance/Quality Control Program conforming to requirements found in 10CFR50 Appendix B.

The Boral was subjected to accelerated irradiation tests. The test specimens were exposed to cumulative doses of 3×10^{11} rads gamma and 16×10^{19} neutrons per cm^2. The testing was conducted in demineralized water and borated water. These tests verified that Boral will maintain long-term material stability and mechanical integrity and therefore can safely be utilized as the poison material for neutron absorption in the IP3 spent fuel racks.

d) *configuration in the SFP*

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

Response

Region 1 is a flux trap design consisting of a welded honeycomb array of identical square stainless steel boxes spaced in both directions by a narrow stainless steel water box. The long cross-sectional dimension of this narrow rectangular box is the same as the square box. A sheet of Boral poison material is captured between all adjacent walls of the square and rectangular boxes and on the outside box walls of each of the two racks at rack-to-rack interfaces. A double row of mating flat round raised areas is coined into the walls of all the square boxes and into the two cross-sectional long walls of the narrow rectangular boxes. The raised dimension of each of these local coined areas is half the thickness of the Boral poison sheet. Thus the space provided by the mating raised areas on adjacent box walls is the thickness of the poison sheet. With the poison installed, the boxes are welded together by fusing them at these local coined areas. The poison sheets are axially centered on the active fuel region. These sheets are approximately 11" shorter than the active fuel, 5 1/2" at each end, to take advantage of the reduced flux at the ends of the active fuel region. The sheets are scalloped along the two long edges to clear the raised areas on the box walls. They are thus contained axially and laterally by these raised areas. Also, each sheet is contained axially at the bottom by a stainless strip, of the same thickness as the poison sheet, which is welded to the wall of one of the two adjacent boxes. On the outside wall of each of the two racks at a rack-to-rack interface a sheet of poison is captured on each box under a thin sheet of stainless steel. All four edges of this stainless steel are bent the thickness of the poison sheet and these bent edges are intermittently welded to the box wall.

Region 2 is an egg crate design consisting of a welded honeycomb array of identical square stainless steel boxes. There are no intermediate water boxes in Region 2. A sheet of Boral poison material is captured between all adjacent walls of the square boxes and on the outside wall of one of the two racks at a rack-to-rack interface. At rack-to-rack interfaces between Region 1 and Region 2, a sheet of Boral poison is captured on the outside box walls of each of the two racks. The Region 2 rack construction is the same as Region 1 racks, where all box walls are coined and fusion welded together at the mating local coined areas.

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

Response

The aluminum cladding prevents direct contact of the matrix with water in the spent fuel pool, except for the outer edges of the Boral panels. The Boral panels are sandwiched tight between cell box walls. However, there is a small amount of empty space between the corners where four cells come together. This is due to the Boral panels not being as wide as the cell walls are. Therefore, the potential exists for a small amount of flow in

this area.

The wettable amount of boron carbide matrix at the outer edges of Boral sheets is less than one percent of the total boron carbide contained therein.

e) *current condition of the credited neutron-absorbing material in the SFP*

i. *estimated current minimum areal density*

Response

Results of coupon testing of the neutron absorber have provided no indication of loss of neutron absorbing material. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP, which is provided in the response to ARI 1 b) ii.

ii. *current credited areal density of the neutron-absorbing material in the NCS AOR*

Response

Current Credited Areal Density = 0.02 g-B^{10}/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)*

Response

Results from the Unit 3 Boral Couponing surveillances have shown instances of severe blistering and minor pitting on the front and back of the coupons. There is a wide range in blister severity between tested coupons. The most severe blistering was observed in 2013 on coupon DI-711703-2-4 with 242 blisters in total. Although over 40% of the coupon's surface was blistered, the maximum recorded blister height was only 0.1045 inches, with no loss of neutron attenuation capability. In contrast, the second coupon tested in 2013 (KI-711814-2-3) had only 7 blisters, with a maximum blister height of 0.0600 inches, and no loss of neutron absorbing capability. See the response to ARI 2 a) iv for more information.

ARI 2

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:

Response

The Boral surveillance program at IP3 consists of a coupon surveillance program. The coupons were taken from the same lots of material used in construction of the racks, and encased in a similar manner as the in-service material. The coupons are thus able to detect aging/degradation mechanisms that the in-service materials experience.

i. approach used to determine frequency, calculations and sample size

Response

The coupon test frequency, provided in the response to ARI 2(b)ii(4), and minimum sample size, two coupons per test interval, were based on operating experience with Boral and not based on an analytic determination. Based on accelerated test programs and years of operating experience, Boral is considered a satisfactory material for reactivity control. Ongoing programs at various spent fuel pools have not demonstrated cases where loss of neutron absorbing capability has occurred when utilizing industry standard monitoring programs.

The frequency of Boral inspection and testing activities is consistent with the guidance in NUREG-1801, which states that the frequency is "not to exceed 10 years." In letter NL-11-074 to the NRC, IP3 acknowledges a Boral inspection and testing frequency of at least once every 10 years. However, the administrative requirement at IP3 is a 5-year monitoring frequency ± 15 months for both types of coupons.

The minimum surveillance requirements consist of visual inspection of one full-length Boral strip and removal of one or two (preferably two) coupons for subsequent laboratory testing.

ii. parameters to be inspected and data collected

Response

As described in the License Renewal Application (LRA), Appendix B, measurement trending of the following parameters should be performed for the short length coupons:

- Neutron Attenuation
- Blister Size, Thickness, and Location
- Coupon Dimensional Measurements (length, width, shape, and thickness)
- Specific Gravity and Density

The full-length coupons are visually examined and returned to the SFP.

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*

Response

The purpose of the surveillance program is to characterize certain properties of the Boral with the objective of providing data necessary to assess the capability of the Boral panels in the racks to continue to perform their intended function. The surveillance program is capable of detecting the onset of significant degradation which could impede the safety function of the in-service material. In the event that an acceptance criterion is not met, the corrective action program will be used confirm the safety function of the in-service material. Note that these acceptance criteria were put into place as part of the License Renewal Application in 2015, and there were no formal acceptance criteria prior to this point.

The acceptance criteria of the IP3 monitoring program are as follows:

- The neutron attenuation of the Boral has to be greater than or equal to the areal density assumed in the AOR (0.02 g B-10/cm^2).
- Data trending analysis has to demonstrate that future performance will not violate the acceptance criteria for neutron attenuation before the next inspection (i.e., $\leq$ 10 years).
- Blisters have to be of acceptable size and shape so that they will not subsume the available space between the fuel assembly and the cell wall before the next inspection.

The blister size acceptance criterion is in place for operational flexibility only, and has no effect on ensuring the material is maintained within the assumptions of the AOR.

iv. *monitoring and trending of the surveillance or monitoring program data*

Response

IP3 has performed monitoring of the Boral surveillance coupons as described above. The most recent tests of coupons from the IP3 SFP were conducted in 2002, 2008, and 2013. All coupons tested have been installed in Region 1, where exposure to gamma radiation can be manipulated. As part of the IP3 testing program, the areal densities recorded during the test being conducted to ensure that these remain above the areal density assumed in the AOR (0.02 g B-10/cm^2). Furthermore, the measured areal densities are compared to as-manufactured values to ensure that no significant loss of Boron has occurred. The following information was summarized from the surveillance reports.

A. Year 2002

Testing consisted of two Boral coupons. Both coupons were in good overall condition. There was no significant deterioration or degradation noted. Coupon 1 had one blister on the front side and five blisters on the back side. Coupon 2 had three blisters on the front side and six blisters on the back side. Some minor pitting was noted, which appeared to be caused by localized corrosion.

The Boron-10 (B-10) areal density of the coupon was measured via neutron attenuation testing. The average areal density from five test locations of Coupon 1 is 0.0236 g B-10/cm^2, which is above the pre-exposure areal density of 0.0229 g B-10/cm^2 for that coupon. The average areal density from five test locations of Coupon 2 is 0.0242 g B-10/cm^2, which is above the pre-exposure areal density of 0.0233 g B-10/cm^2 for that coupon. Also, note that these B-10 areal densities are both above the acceptance criteria and the assumption in the NCS AOR (i.e., 0.02 g B-10/cm^2). This provides a margin of at least 0.0033 g B-10/cm^2.

B. Year 2008

Testing consisted of two Boral coupons. Each coupon was observed to have large and small blisters on both sides of the Boral cladding. Despite an advanced stage of blistering, the neutron attenuation testing for B-10 areal density demonstrated that the neutron absorbing function of the blistered Boral is unaffected (see results below).

Visual inspection of the coupons conducted saw that the coupons were fully intact with no apparent areas of missing Boral. However, both coupons had multiple blisters on both sides and a few randomly distributed corrosion pits on both side. There were 48 blisters on the front side and 37 blisters on the back of coupon Al-720784-2-3. The blisters range in size from 0.25 inches across to 1.5 inches across. The coupon being identified as DI-711688-2-5 had more than 100 blisters on each side. The blisters range in size from less than 0.25 inches across to more than 2.75 inches across.

The B-10 areal density was measured via neutron attenuation testing and measurements were conducted at five locations on each coupon. The average areal density for Coupon 1 (Al-710784-2-3) is 0.0241 g B-10/cm^2, which is above the pre-exposure areal density of 0.0234 g B-10/cm^2 for that coupon. The average areal density for Coupon 2 (DI-711688-2-5) is 0.0248 g B-10/cm^2, which is above the pre-exposure areal density of 0.0247 g B-10/cm^2 for that coupon. Also, note that these B-10 areal densities are both above the acceptance criteria and the assumption in the NCS AOR (i.e., 0.02 g B-10/cm^2).

C. Year 2013

Testing consisted of two Boral coupons. Visual inspection showed that Coupon KI-711814-2-3 is in overall good condition. Scattered patches of light pitting were noted on both sides of the entire surface. On coupon KI-711814-2-3 a few small blisters and one large one was found. Coupon DI-711703-2-4 was noted to be severely blistered. However, the cladding was intact. There was pitting across the entire surface, but it was

shallow. The total blisters volume on coupon DI-711703-2-4 is 1.7058 in^3. A trending analysis of the volume and area was performed. It was noted that since the last campaign the blister volume increased by approximately 25% and the blister area increased by 35%.

The B-10 areal density was measured via neutron attenuation testing and measurements were conducted at five locations on each coupon. The average areal density for Coupon 1 (KI-711814-2-3) was determined to be 0.0239 g-Boron $10/cm^2$, which is higher than the pre-exposure areal density of 0.0233 g-Boron $10/cm^2$ for that coupon. The average areal density for coupon 2 (DI-711703-2-4) is 0.0252 g-Boron $10/cm^2$, which is slightly lower than the pre-exposure areal density of 0.0253 g-Boron $10/cm^2$ for that coupon. Note that these values are significantly higher than the 0.020 g-B-$10/cm^2$areal density value assumed in the IP3 criticality analysis, and the stated criteria for acceptance. This demonstrates acceptable neutron attenuation performance of the coupons.

Conclusive Statement

The three most recent, separate surveillance-testing periods show a uniform result of coupons remaining intact through the surveillance periods, even with some large extent of blistering with no apparent areas of missing Boral. Data trending has shown the no loss of neutron absorbing capability has occurred, thus the acceptance criterion of future performance is met. The IP3 results show an acceptable coupon performance.

The full length coupons are reinserted after each visual inspection. These can be trended over time via the photos taken.

v. *industry standards used*

Response

There are no specific codes and standards outlined in the LAR documents pertaining directly to the coupon surveillance program; however, the IP3 program is consistent with the recommendations outlined in NUREG-1801. As recommended in NUREG-1801, parameters that should be monitored "include the physical condition of the neutron-absorbing materials, such as in-situ gap formation, geometric changes in the material (formation of blisters, pits, and bulges) as observed from coupons or in situ, and decreased boron areal density, etc." In accordance with the above guidance, IP3 monitors the following parameters:

- physical condition of the neutron absorbing materials (see ARI 2 a ii.)
- geometric changes in the material (e.g., formation of blisters, pits, and bulges) (see ARI 2 a ii.)
- boron areal density (see ARI 2 a ii.)

IP3 also follows the recommendation in NUREG-1801, which states that the "frequency of the inspection and testing depends on the condition of the neutron-absorbing material and is determined and justified with plant-specific operating experience by the licensee, not to exceed 10 years." This is demonstrated in the ARI 2 a i, that indicates testing will not exceed a timeframe of 10 years. Furthermore, IP3 has adopted an administrative requirement of a 5-year surveillance frequency ± 15 months.

Conclusive Statement

The responses given in sub-parts *i, ii, and iv* of ARI 2 a) provide satisfactory conclusions that the IP3 Boral Surveillance Program meets the regulatory guidelines.

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

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

1. Describe the visual inspection performed on each sample.

Response

N/A – No visual inspection of in-service material is performed (coupons are not considered in-service).

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

Response

N/A – No visual inspection of in-service material is performed.

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.

Response

The surveillance program at IP3 is expected to provide conservative results. Poison coupons used in the surveillance program were taken from the production lot poison. Each poison specimen was encased in a type 304 stainless steel jacket. The jacket was mechanically closed (via bolting) without welding in such a manner as to retain its form yet allow rapid and easy opening without contributing mechanical damage to the poison

specimen contained within. The size of the blisters on the surveillance coupons is expected to be larger than the blisters within the rack walls themselves because the surveillance coupons are held in place with bolts, and the installed Boral strips are held by welded plates. The welded seams provide a firmer hold than the bolted covers and thus provide greater resistance to the formation of thick blisters. This is expected to result in blisters that are larger in area but shallower, and therefore less likely to result in SFP cell deformation.

Two jacketed full-length poison sheets and two jacketed strings of shorter length specimens were furnished and installed in Region 1 where exposure to gamma radiation can be manipulated. No Boral coupons have been installed in Region 2. Region 1 is expected to provide the most conservative results as freshly offloaded fuel, which has the highest radiation levels, is discharged into Region 1. Each coupon tree is suspended at the proper axial location, from a removable lead-in guide in a water box.

One of the two full-length specimens are removed from the pool, photographed, and visually inspected on a 5 year (+25% grace) frequency and immediately returned to the pool. These full length coupons are not sent out for laboratory testing. The multi coupon (short-length) specimens are removed two at a time, and subjected to laboratory testing for physical properties and neutron transmissibility at the same frequency as the full length visual inspections.

2. *Provide the dates of coupon installation for each set of coupons.*

Response

June, 1990.

3. *If the coupons are returned to the SFP for further evaluation, provide the technical justification of why the reinserted coupons would remain representative of the materials in the rack.*

Response

In 1992, 2 coupons were removed for analysis and one year later they were subsequently returned to the pool for further testing, only to be removed in 1996 for reanalysis (along with 2 additional coupons). However, this was the only time that Unit 3 returned short length coupons to the SFP. This is no longer performed as the drying and decontamination process could potentially yield inaccurate results for coupons returning to the pool. This was a conservative measure to ensure that observed blistering on coupon DI-711688-2-7 did not advance in severity (it did not). Reinsertion of coupons was not repeated once an adequate surveillance frequency of 5 years was established via the second performance of this surveillance in 1996.

The full-length coupons are returned to the pool immediately following each visual inspection. This is because they are only visually inspected and are not subjected to drying, decontamination, and other testing which could alter the appearance and performance of the neutron absorber. The full-length coupons are not tested for neutron

transmissibility and are for trending purposes only.

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.*

Response

Removal Date (1)	Multiple Coupon (MC) Surveillance		Full Length (FL) Surveillance
	Assembly No.	Coupon No.	
July 31, 1992 (completed)	MC(XX)[2] MC(UU)[2]	8 3	None
July 31, 1993 (completed)	MC(XX) MC(UU)	8(3) 3(3)	None
Nov. 16, 1996 (completed)	MC(XX) MC(UU)	3,8 6,3	FL(XX)
May 19, 2002 (completed)	MC(XX) MC(XX)	2 10	FL(UU)
Nov. 19, 2007 (completed)	MC(UU) MC(UU)	7 5	FL(UU)
Oct. 28, 2013 (completed)	MC(UU) MC(UU)	11 2	FL(XX)
TBD	MC(XX) MC(XX)	7 1	FL(UU)
TBD	MC(XX) MC(XX)	4 6	FL(UU)
TBD	MC(UU) MC(UU)	8 4	FL(XX)
TBD	MC(XX) MC(XX)	11 5	FL(UU)
TBD	MC(UU) MC(UU)	9 10	FL(XX)
TBD	MC(XX) MC(UU)	9 1	FL(UU)

(1) Removal date is per normal surveillance requirements for a 5-year test + 15 months
(2) (XX) and (UU) are the IDs for TWO different coupon trees. With four trees in to total, there are two Multi-Coupon (MC) trees and two Full-Length (FL) trees.
(3) Reinstallation of previously removed coupon.

As outlined in the above graph, 10 coupons have been permanently removed from the pool, therefore, 12 coupons (6 in each assembly) are still remaining in the pool. Although there are only 2 full length coupons in the pool, they are returned to the pool after each inspection. Therefore, at a 5 year frequency, the multiple coupon surveillance provides for another 30 years of surveillance testing in the SFP. With the potential for an additional 20 years of Operation, given a license extension, this provides more than enough inventory for surveillances through the end of the operating license extension.

iii. If RACKLIFE is used:

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

Response

RACKLIFE is applicable only for Boraflex, and is thus not used at IP3

2. Note the frequency at which the RACKLIFE code is run.

Response

RACKLIFE is applicable only for Boraflex, and is thus not used at IP3

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

Response

RACKLIFE is applicable only for Boraflex, and is thus not used at IP3

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

Response

RACKLIFE is applicable only for Boraflex, and is thus not used at IP3

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.

Response

In-Situ Testing is not used at IP3

2. *State if the results of the in-situ testing are trended and whether there is repeat panel testing from campaign to campaign.*

Response

In-Situ Testing is not used at IP3

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

Response

In-Situ Testing is not used at IP3

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.*

Response

In-Situ Testing is not used at IP3

   b. *Describe how potential material changes in the SFP rack materials caused by degradation or aging are accounted for in the calibration and results.*

Response

In-Situ Testing is not used at IP3

   c. *If the calibration includes the in-situ measurement of an SFP rack "reference panel", explain the following:*

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

Response

In-Situ Testing is not used at IP3

ii. *whether all surveillance campaigns use the same reference panel(s)*

Response

In-Situ Testing is not used at IP3

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

Response

In-Situ Testing is not used at IP3

ARI 3

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.*

Response

N/A – IP3 utilizes Boral.

ARI 4

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.*

Response

The Boral in the NCS AOR is modeled at the minimum certified areal density with no consideration of deformation (i.e. blisters and pits). Industry and IP3 experience has shown that Boral deformations (blisters and pits) do not cause a loss in neutron

absorbing capability, so modeling the material in this manner is appropriate.

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.*

Response

The technical basis and acceptance criteria of the coupon monitoring program are provided in the responses to ARI 2 a). The details on the coupon results are provided in the response to ARI 2 a) iv.

The results of the monitoring program have shown no loss of neutron attenuation from pre-irradiation to post-irradiation testing. Significant blistering and some pitting have been observed. However, all tested coupons have had a measured areal density that is greater than the areal density assumed in the AOR (0.02 g-B^{10}/cm^2). The smallest measured average areal density was recorded in the 2002 surveillance at 0.0236 g-B^{10}/cm^2. This is well above the minimum certified value assumed in the AOR. For more information on surveillance results, please see the response to ARI 2 a) iv.

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

Response

The bias and uncertainty of the monitoring program is not used in the NCS AOR. Industry and IP3 experience indicates that Boral does not lose neutron absorbing capability, so not including any bias or uncertainty from the monitoring program is appropriate. For Boral, the monitoring program is used as a confirmation that no loss of neutron absorbing capability has occurred.

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

Response

As described in the response to ARI 4 a) above, the NCS AOR does not account for degradation in adjacent panels.

ARI 5

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).

a) *For each design-basis event that would have an effect on the neutron-absorbing material, describe the technical basis for determining the effects of the design-basis event on the material condition of the neutron-absorbing material during the design-basis event, including:*

   i. *shifting or settling relative to the active fuel*

   ii. *increased dissolution or corrosion*

   iii. *changes of state or loss of material properties that hinder the neutron-absorbing material's ability to perform its safety function*

b) *Describe how the monitoring program ensures that the current material condition of the neutron-absorbing material will accommodate the stressors during a design-basis event and remain within the assumptions of the NCS AOR, including:*

   i. monitoring methodology

   ii. *parameters monitored*

   iii. *acceptance criteria*

   iv. *intervals of monitoring*

Response

N/A – IP3 utilizes Boral.

References:

[1] (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" [ML16097A169]