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GNRO-2011/00104

November 21, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Request for Additional Information Regarding
Criticality Safety Analysis

Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCE: Entergy Operations, Inc. letter to the NRC (GNRO-2011/00076), *License Amendment Request - Criticality Safety Analysis*, September 9, 2011 (ADAMS Accession No. ML112521287)

Dear Sir or Madam:

Entergy submitted a license amendment request (LAR) to the Nuclear Regulatory Commission (NRC) on September 9, 2011 (see referenced letter). The LAR proposed changes to the criticality requirements of Technical Specification 4.3.1.1 based on a criticality safety analysis that had been submitted for review. The Chemical Engineering Branch of the NRC has identified additional information needed to support their review. Responses to the requests for additional information (RAIs) are provided in the attachment to this letter.

No change is needed to the no significant hazards consideration included in the initial LAR (referenced letter) as a result of the additional information provided. There are no new commitments made in this letter.

If you have any questions or require additional information, please contact Jerry Burford at 601-368-5755.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 21, 2011.

Sincerely,

MAK/FGB

Attachment: Responses to Requests for Additional Information - Chemical Engineering Branch

cc: Mr. Elmo E. Collins, Jr.
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U. S. Nuclear Regulatory Commission
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U. S. Nuclear Regulatory Commission
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NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

State Health Officer
Mississippi Department of Health
P. O. Box 1700
Jackson, MS 39215-1700

Attachment 1

GNRO-2011/00104

Grand Gulf Nuclear Station

Criticality Safety Analysis

Responses to Requests for Additional Information

Chemical Engineering Branch

Response to Request for Additional Information
Chemical Engineering Branch

By letter dated September 9, 2011, Entergy Operations, Inc. (Entergy) submitted a license amendment request (LAR) for the review of the Criticality Safety Analysis (CSA) for Grand Gulf Nuclear Station, Unit 1 (GGNS). The NRC Chemical Engineering Branch has reviewed the LAR and has requested additional information. The questions and responses are provided below.

RAI 1

In the GGNS response letter dated May 3, 2011, it states that RACKLIFE analysis will be performed each cycle. Please discuss and justify why performing RACKLIFE once a cycle, instead of increasing the frequency, is acceptable for determining Boraflex degradation.

RESPONSE

The Racklife analysis update is performed each cycle as part of the current Boraflex monitoring program. This update incorporates information obtained since the last update, such as additional chemistry data and additional fuel moves. As a part of this update, the Racklife model escape coefficients are adjusted, as needed, to bound the plant data. The adjusted escape coefficients are conservative and apply to several cycles. The update also includes conservative predictions of the rack performance until the next planned update. The predictions are based on conservative fuel performance characteristic, such as core burnup and bundle power. Based on these predictions, restrictions on the storage locations for freshly discharged fuel are implemented to manage the degradation.

Updating the Racklife model once each cycle is sufficient as the Boraflex degradation is a slowly varying, longer-term effect. Table 1 provides the maximum boron loss for various time periods over the lifetime of the racks.

Table 1: Racklife Boraflex Degradation Rates

Date Range	Maximum Panel Boron Loss increase over period (%)	Maximum Panel Average. Boron Loss Rate (% / Yr)
09/14/1986 to 03/05/2004	6.06	0.35
03/05/2004 to 09/21/2008	2.29	0.50
09/21/2008 to 05/25/2010	1.19	0.71

The slowly increasing trend shown above is also reflected in the silica levels measured in the spent fuel pool (SFP) shown in Figure 1. Figure 1 presents the Racklife predicted silica levels (i.e., reactive silica), which are significantly higher than those actually being measured in the pool. Note that the rapid drops in silica levels correspond to a dilution of the pool water that occurs during refueling outages. The silica predictions reflect the conservative assumptions in the Racklife evaluation and demonstrate the ability of the Racklife analysis to account for and conservatively model the increasing loss rate.

While the loss rate is increasing over time as expected, it is still relatively low at less than 1% per year. This is not significant compared to the margin between the current condition and condition assumed in the CSA under review. Thus, performing Racklife evaluations once per cycle is acceptable.

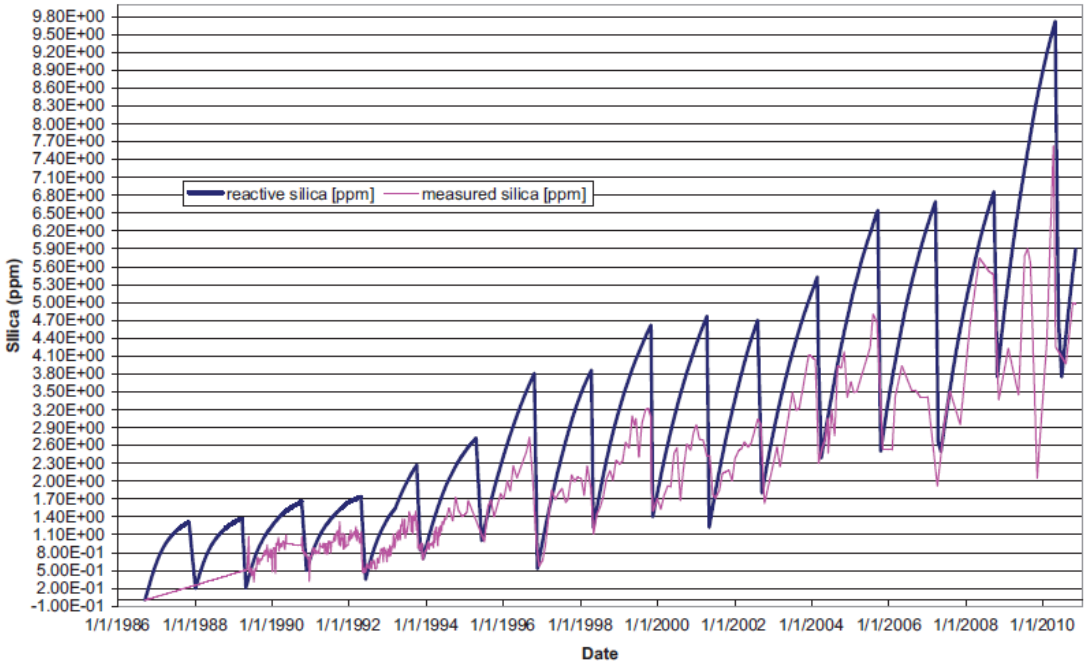


Figure 1: Racklife Predicted and Measured SFP Silica

RAI 2

In the GGNS response letter dated April 21, 2011, in the response to RAI 34, it states that the difference in the distributions between the BADGER and RACKLIFE areal density results is based on a visual comparison to the normal cumulative probability distribution. Please discuss how this visual comparison is conducted and discuss how it is statistically significant.

RESPONSE

The visual comparison to the normal cumulative probability distribution was a tool used in conjunction with the Shapiro-Wilk test to show that the difference in the distributions between the BADGER and RACKLIFE areal density results were essentially a normal distribution and could statistically be treated as such. Figure 2 shows the cumulative distribution for both the BADGER/RACKLIFE comparison results and a normal distribution. The x-axis is the number of standard deviations about the mean and the y-axis is the cumulative probability.

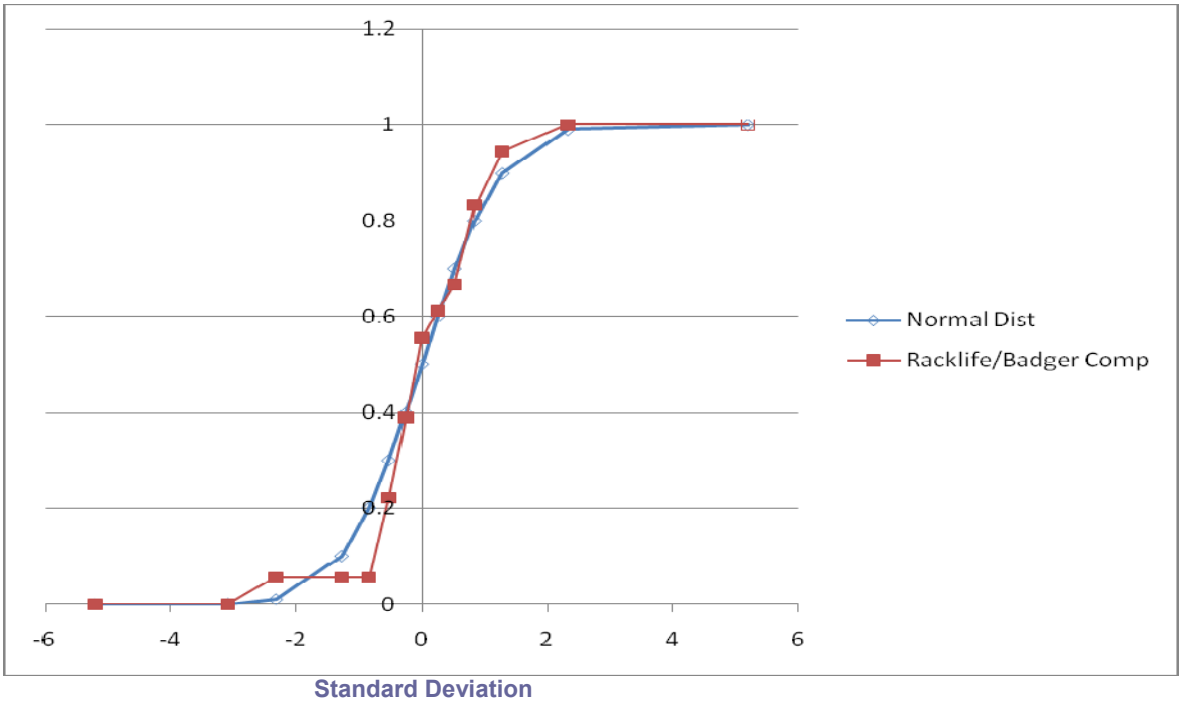


Figure 2: Comparison of Rack/Badger Difference to a Normal Cumulative Distribution

RAI 3

In the GGNS response letter dated April 21, 2011, in the response to RAI 37, it states that the BADGER campaign report is revision 1 of the original report issued in October 2010, and includes a correction to a data processing error that was identified after the original version of the report was completed. Please discuss the error that was identified, specifically:

a. **Discuss why the error was not identified until two years after the original report version was issued.**

b. **Describe the data processing error.**

c. **Discuss the significance of the data processing error.**

d. **Discuss whether this error has a wider impact.**

e. **Discuss how the error affected the report.**

RESPONSE

The Boron-10 Areal Density Gauge for Evaluating Racks (BADGER) was developed by NETCO for EPRI. BADGER is a device that allows the in-situ measurement of the boron-10 areal density of the neutron absorber material in the spent fuel racks. The results are used to validate the performance of the site-specific RACKLIFE model. NETCO performed a BADGER measurement campaign at GGNS and provided a summary report (i.e., the original report) to Entergy in 2008.

During a similar measurement campaign at another utility in 2010, NETCO identified a latent software error that incorrectly incorporated the drift correction factor into the areal density calculations for each analyzed panel in a BADGER campaign. They then notified all impacted sites including GGNS. The correction factor is used to account for physical differences between the un-attenuated region of the reference panel and each of the other panels subjected to BADGER measurements. NETCO corrected the error in their software, recalculated the areal densities for each measured panel, and provided a new summary report with the revised results to each site.

While the impact of the identified error varied from site to site, a comparison of the original and revised panel areal density results for GGNS is provided in Table 2. The revised results have also been considered in the degradation rates reported in the second two periods reported in Table 1. As shown below, the change in panel density from the Revision 0 to the Revision 1 report ranged from (-) 0.0032 g/cm^2, a reduction in areal density, to 0.0033 g/cm^2, an increase in areal density. The average change in the areal density over the 32 panels was a reduction of about 0.0017 g/cm^2.

Table 2: Comparison of Revision 0 and Revision 1 GGNS BADGER Results

Panel	Areal Density (g/cm^2)		Panel	Areal Density (g/cm^2)	
	Rev 0	Rev 1		Rev 0	Rev 1
ZQ14 South	0.0213	0.0195	AA12 South	0.0221	0.0196
ZQ16 North	0.0208	0.0191	CC27 South	0.0214	0.0182
ZR15 East	0.0204	0.0204	EE27 East	0.0221	0.0202
ZP15 West	0.0228	0.0201	HH24 North	0.0188	0.0198
FF28 South	0.0199	0.0184	DD26 South	0.0210	0.0188
DD28 South	0.0237	0.0216	HH24 South	0.0195	0.0178
GG29 East	0.0217	0.0194	HH24 East	0.0214	0.0190
FF30 North	0.0200	0.0185	HH22 North	0.0171	0.0213
EE29 West	0.0208	0.0192	HH22 South	0.0170	0.0173
CC29 West	0.0220	0.0196	HH22 East	0.0177	0.0184
DD30 North	0.0208	0.0182	AA27 North	0.0221	0.0206
EE29 East	0.0207	0.0192	CC27 West	0.0210	0.0183
P7 South	0.0195	0.0183	AA27 West	0.0239	0.0220
DD28 North	0.0195	0.0173	AA27 East	0.0213	0.0189
T13 South	0.0204	0.0190	CC27 North	0.0210	0.0184
T13 North	0.0209	0.0197	CC27 East	0.0194	0.0166

RAI 4

In the GGNS letter dated September 9, 2011, in attachment 1 page 1 and attachment 2 page 4, it states that "any Boraflex panel which has…a Boron-10 areal density less than 0.0165…" will be treated a Region II panel. Please clarify that the unit for the areal density in this statement is grams per centimeter squared (g/cm^2) and confirm that unit will be reflected in the proposed technical specification changes.

RESPONSE

The units were inadvertently omitted in the correspondence and should be g/cm^2. The proposed Technical Specification changes will include these units. A revised insert for Technical Specification 4.3.1.1 is included on the next page.

Insert 1 – REVISED

TS 4.3.1.1

c. Fuel assemblies having a maximum k-infinity of 1.26 in the normal reactor core configuration at cold conditions;

d. Fuel assemblies having a maximum nominal U-235 enrichment of 4.9 weight percent;

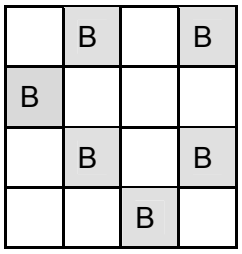
e. Region II is controlled as follows:

1. Any Boraflex panel which has received a gamma dose in excess of 2.3E10 rads or which has a Boron-10 areal density less than 0.0165 g/cm^2, is designated as a Region II panel.

2. Storage cells face-adjacent to Region II panels are either restricted from fuel storage by physically blocking the isolated cells or are configured to meet, as a minimum (i.e., additional cells may be blocked), the Region II fuel storage configuration requirements in Figure 4.3-1.

3. When a 4x4 array of cells is classified as Region II and face-adjacent to another Region II 4x4 storage array, the new Region II 4x 4 array is required to be blocked in the same 6-of-16 pattern and at the same orientation as the adjacent Region II 4x4 storage configuration.

Figure 4.3-1
Region II 4X4 Storage Configuration



Fuel Assembly Storage Location

B Location Physically Blocked to Prevent Storage