Entergy Operations, Inc.
P. O. Box 756
Port Gibson, MS 39150

Michael A. Krupa
Director, Extended Power Uprate
Grand Gulf Nuclear Station
Tel. (601) 437-6684

GNRO-2011/00080

September 15, 2011

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

SUBJECT: Request for Additional Information Regarding
Extended Power Uprate
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCES: 1. License Amendment Request, Extended Power Uprate, dated September 8, 2010 (GNRO-2010/00056, Accession Number ML102660403)

Dear Sir or Madam:

The Nuclear Regulatory Commission (NRC) requested additional information regarding certain aspects of the Grand Gulf Nuclear Station, Unit 1 (GGNS) Extended Power Uprate (EPU) License Amendment Request (LAR) (Reference 1). Attachment 1 provides responses to the additional information requested by the Health Physics and Human Performance Branch.

No change is needed to the no significant hazards consideration included in the initial LAR (Reference 1) as a result of the additional information provided. There are no new commitments included 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 September 15, 2011.

Sincerely,

MAK/FGB/dm

Attachments:

1. Response to Request for Additional Information, Health Physics and Human Performance Branch

cc: Mr. Elmo E. Collins, Jr.
Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
612 East Lamar Blvd., Suite 400
Arlington, TX 76011-4125

U. S. Nuclear Regulatory Commission
ATTN: Mr. A. B. Wang, NRR/DORL (w/2)
ATTN: ADDRESSEE ONLY
ATTN: Courier Delivery Only
Mail Stop OWFN/8 B1
11555 Rockville Pike
Rockville, MD 20852-2378

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

NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

Attachment 1

GNRO-2011/00080

Grand Gulf Nuclear Station Extended Power Uprate

Response to Request for Additional Information

Health Physics and Human Performance Branch

**Response to Request for Additional Information
Health Physics and Human Performance Branch**

By letter dated September 8, 2010, Entergy Operations, Inc. (Entergy) submitted a license amendment request (LAR) for an Extended Power Uprate (EPU) for Grand Gulf Nuclear Station, Unit 1 (GGNS). By letters dated March 9, 2011 and August 29, 2011, Entergy submitted responses to the initial requests for additional information (RAI) from the Health Physics and Human Performance Branch. Subsequently the U.S. Nuclear Regulatory Commission (NRC) staff has determined that the following additional information requested by the Health Physics and Human Performance Branch is needed for the NRC staff to complete their review of the amendment. Entergy's response is also provided below.

RAI # 1 (Per telecom)

Based on the information provided in the licensee's letter dated August 29, 2011 additional clarifying information related to development of the EPU dose rate scaling factors is requested.

Response

Section 2.10.1.2.3 of EPU LAR Attachment 5 states that due to conservative assumptions in the current licensing basis (CLB) analyses, the estimated post-accident radiation levels specified for Current Licensed Thermal Power (CLTP) are bounding for EPU operations. Provided below is a summary of the assessment performed which resulted in the above conclusion and demonstrated continued accessibility to vital areas within the plant (consistent with NUREG 0737 item II.B.2) under EPU accident conditions.

Note that post-EPU habitability of vital areas that require continuous occupancy, i.e., the Control Room and Technical Support Center, are addressed separately in Sections 2.9.2 and 2.9.3 of EPU LAR Attachment 5 and are not addressed in this response.

Summary of Current Licensing Basis (CLB)

GGNS Updated Final Safety Analysis Report (UFSAR) Table 12.6-2 lists the plant locations where personnel access is required post-accident. Post-LOCA radiation dose rate zone maps are provided in UFSAR Figures 12.6-1 through 12.6-6. Per the NRC License Amendment letter dated June 30, 2003 (Issuance of Amendment Re: Elimination of Requirements for Post Accident Sampling System (TAC NO. MB8061)), the post-accident sampling system is no longer required.

The design inputs and assumptions used to develop the CLB post-LOCA vital access mission doses are discussed in UFSAR Section 12.6.3. As stated in UFSAR Section 12.6.3.1, the vital access personnel mission doses are conservatively based on a core power level of 4025 MWt, which corresponds to 105% of the Original Licensed Thermal Power (OLTP) of 3833 MWt.

A review of the source term analyses supporting the vital area access mission doses presented in UFSAR Table 12.6-2 indicated that the pre-EPU source terms were highly conservative, not only relative to the assumed core power, but also in the development of the source terms. Briefly, the pre-EPU source terms were generated using a subset of the total list of isotopes identified in the core inventory. An activity adjustment factor of 1.266 was applied to all isotopes in the selected subset in order to conserve the total t=0 hr core activity. This adjustment factor was based on the ratio of total activity in the initial list of core isotopes at t=0 hr, to the total activity of the isotopes selected for the subset. Application of this adjustment factor was very conservative since at t=0 hr post-accident, the total core activity includes isotopes with short half-lives (less than 30 minutes). It was determined that after decay of the short half-life isotopes, the adjustment factor would essentially become 1.0, however, the factor of 1.266 was conservatively retained for all time intervals. Thus, for time periods greater than 30 minutes, the CLB source terms used in the post-accident mission doses were effectively based on a core power level of 5095 (1.266 x 4025) MWt.

Per License Amendment No. 145, GGNS has been approved for the use of Alternative Source Terms (AST) as outlined in 10 CFR 50.67, Standard Review Plan 15.0.1, Revision 0, and Regulatory Guide 1.183, Revision 0, for post-accident dose assessments associated with the site boundary and on-site locations that require continuous occupancy such as the Control Room and the Technical Support Center (TSC).

However, the CLB post-LOCA vital area access mission doses (with the exception of the control room and TSC), continue to be based on TID-14844 Source Terms as documented in UFSAR Section 12.6.3. This approach is acceptable based on the AST benchmarking study reported in SECY-98-154, which concluded that results of analyses based on TID-14844 would be more limiting earlier on in the event, after which time the AST results would be more limiting. Areas designated as vital for purposes of accident mitigation usually require access within the first week when the original TID-14844 source terms are more limiting. Thus, with the implementation of AST, the conclusions of UFSAR Section 12.6.3 were retained and considered conservative for the Current Licensed Thermal Power (CLTP) of 3898 MWt.

EPU Assessment

The EPU core power level is 4408 MWt. Radiological safety analyses supporting the EPU have been performed at a reactor power level of 4496 MWt (i.e., the core power level of 4408 MWt with a 2 percent margin for power uncertainty) and a 24-month fuel cycle.

The EPU assessment takes into account the following:

- The EPU equilibrium core inventory which was developed based on 4496 MWt, and at the expected fuel enrichment and burnup. The radiation source terms in equipment/structures containing post-accident fluids, and the corresponding environmental radiation levels, will change accordingly.

- The GGNS EPU does not impact the post-LOCA vital area mission requirements defined in UFSAR Section 12.6.3, including the task description, access route and required time for access. In addition, there are no EPU-related modifications that impact the operation and layout/arrangement of plant radioactive systems that are considered when estimating mission doses. Thus the impact of the EPU on the post-LOCA gamma environmental conditions in the areas that require access can be assessed based on a comparison of the source terms (containment atmosphere, suppression pool water, etc) developed based on the core inventory used for the CLB vital area access dose assessment versus the source terms developed based on the EPU core inventory. Since the relative abundance of each isotope and the average energy of each isotope are the key parameters that affect direct exposure, a source term scaling factor that addresses the change in these parameters is sufficient to assess the radiological impact of the EPU on the pre-EPU mission dose estimates.

Thus source term scaling techniques are used to demonstrate continued compliance with the operator exposure dose limits of 5 rem whole body provided in NUREG-0737, II.B.2, following EPU. Specifically, a comparison is made of the gamma source terms based on the original core inventory utilized to develop the post-LOCA dose rates in vital areas, to the gamma source terms based on the EPU core inventory.

Theoretically, following the EPU, the post-LOCA environmental gamma dose rates and the operator dose per identified mission should increase by approximately 11.7 percent (4496 MWt/4025 MWt). Taking into consideration the existing conservatism in the CLB methodology, which included an adjustment factor of 1.266 on a core inventory based on 4025 MWt (see prior discussion under Summary of Current Licensing Basis), the post-accident mission doses after t=30 minutes were effectively based on a core power level of 5095 MWt. Thus based on power level alone, the mission dose scaling factor for EPU operations is likely to be approximately 0.9 (i.e., 4496 MWt/5095 MWt). However, because the EPU analyzed core reflects: a) operation with a 24-month fuel cycle and b) more advanced fuel burnup modeling/libraries than used in the original analyses, the calculated EPU scaling factor values will deviate from those determined using the core power ratio.

Table 3 presents the t=30 minute post-accident radioactive isotopic inventory of the major (dose consequent) isotopes in the suppression pool water and airborne activity used to develop the current vital area access dose estimates, and the corresponding EPU isotopic inventory for the same radiation sources. A comparison of the CLB isotopic activity with the corresponding EPU isotopic activity shows that with the exception of a few isotopes, the CLB isotopic activity utilized in the pre-EPU analyses is greater than that estimated for the EPU.

However, a more rigorous assessment than that presented above was undertaken for the EPU, primarily to address the fact that the EPU core inventory includes many more isotopes than the core inventory utilized to develop the CLB vital area access source terms/dose estimates.

The EPU assessment is essentially a two-step process. The first step develops a bounding EPU dose rate scaling factor versus time, and the second multiplies the CLB personnel dose rates at the target areas identified in the licensing basis, by the bounding EPU scaling factor.

Development of the bounding EPU scaling factor takes into consideration that uprate gamma dose rate scaling factors will vary with source, time, and shielding. Thus to cover all types of analysis models/assessments, a bounding approach is utilized that takes into account the potential for the presence of multiple radiation sources that are shielded or unshielded, and missions that are undertaken at different time periods post-LOCA. In summary, the bounding EPU dose rate scaling factor is the largest factor estimated taking into account all radiation source types, lightly or heavily shielded configurations, and all applicable time periods post-LOCA. Note that the radiation source dilution volumes used in the CLB analysis are not significantly impacted by EPU, thus there is no volume adjustment component to the EPU source term scaling factor.

Development of the EPU scaling factors starts with a compilation of the gamma energy release rates (Mev/sec) for each energy group (18 energy groups are considered) versus time, for each radiation source type (i.e., suppression pool water, pressurized reactor coolant, airborne releases). This compilation was performed for both the core inventory used in the CLB analyses (i.e., the core isotopic inventory subset discussed previously inclusive of the activity multiplier of 1.266) and the EPU core inventory subset as discussed below. The EPU core inventory as developed by GEH had over 1100 isotopes. Isotopes with total activities less than 0.001% of the total {fission product + activation product} activity were screened out and the remaining 478 isotopes were used in this assessment. The reduced set of core isotopes accounts for 99.97% of the activity associated with the original list of isotopes provided by GEH.

To develop the EPU dose rate scaling factors, gamma energy release rate weighting factors are applied to the referenced energy release rates for each energy group to account for the effects of attenuation and flux-to-dose-rate conversion (obtained from ANSI/ANS 6.1.1-1977). The resulting weighted energy release rates for each energy group are summed to obtain a total weighted energy release rate at each time post-accident. The EPU dose rate scaling factors for each radiation source type and shielding configuration are then estimated by obtaining the ratio of the total weighted EPU gamma energy release rate to the total weighted CLB source term gamma energy release rate at each time post-accident.

Table 1 provides a summary of the maximum EPU dose rate scaling factor at a given time for each source category. The earliest vital area access time is after 30 minutes post-accident. Since the EPU post-LOCA vital area access scaling factors from one-half hour to 30 days post-accident are approximately 1 (one), a factor of one is used. The EPU doses are obtained by multiplying the pre-uprate doses by the EPU scaling factor. Thus, the EPU post-LOCA vital area access mission doses remain the same as those applicable to the CLTP (and recorded in UFSAR Table 12.6-2), and are presented in Table 2. In all cases, the EPU post-LOCA vital area access mission doses are less than the NUREG-0737 II.B.2 dose limit of 5 rem.

Post-LOCA Radiation Zone Maps

UFSAR Figures 12.6-1 through 12.6-6 present post-accident radiation zone maps that address the contributions of post-LOCA airborne sources through the containment wall as well as contribution through penetrations, and contained sources outside containment. Based on the assessment documented above, these zone maps will not be impacted by the EPU.

Table 1 - Summary of EPU Scaling Factors for Vital Area Access

Time post-LOCA	EPU Scaling Factors		
	Press. RCS	Recirc. Liquid	Airborne Releases
0.5 hr	0.97	0.94	0.97
1 hr	0.97	0.93	0.98
2 hrs	0.98	0.93	0.99
8 hrs	1.00	0.99	0.99
24 hrs	1.00	1.00	0.97
168 hrs	0.95	0.95	0.98
720 hrs	0.98	0.98	1.01

Table 2 - Locations Requiring Accessibility Following an Accident

Location	Pre-uprate Integrated Personnel Dose (Rem) [(1)]	EPU Integrated Personnel Dose (Rem) [(2)]
Remote Shutdown Panel	4	4
Diesel Generator Buildings	0.12	0.12
Post-Accident Sampling Station [(3)]	-----	-----
SGTS Sampling Station	0.44	0.44
Laboratories	4.38	4.38
ADS Air Supply Makeup Connection	3.46	3.46
ADS Booster Compressor Area	1.13	1.13

Notes:

(1) See UFSAR Table 12.6-2

(2) EPU Integrated Dose = Pre-uprate Integrated Dose x Scaling Factor (= 1)

(3) As indicated in the NRC letter of June 30, 2003 and the accompanying safety evaluation, the PASS is no longer required

Table 3 – Comparison of t=30 Minutes Post-accident Source Inventory (CLB vs EPU)

Suppression Pool Activity (0/50/1)[1]					Airborne Activity (100/25/0)[1]			
	Activity (Ci) @ t=30 min		Ratio			Activity (Ci) @ t=30 min		Ratio
Isotope[2]	CLB[3] 4025 MWt	EPU 4496 MWt	EPU/CLB		Isotope[2]	CLB[3] 4025 MWt	EPU 4496 MWt	EPU/CLB
	(Ci)	(Ci)	(Ci)			(Ci)	(Ci)	(Ci)
BA139	2.20E+06	1.91E+06	0.87		I131	3.73E+07	3.04E+07	0.81
BA140	2.41E+06	2.14E+06	0.89		I132	4.56E+07	3.78E+07	0.83
BR 83	6.61E+06	6.54E+06	0.99		I133	6.03E+07	6.09E+07	1.01
BR 84	6.20E+06	6.84E+06	1.10		I134	5.33E+07	4.61E+07	0.86
CE141	2.51E+06	2.03E+06	0.81		I135	5.95E+07	5.50E+07	0.92
CE143	2.11E+06	1.87E+06	0.88		KR 83M	1.33E+07	1.31E+07	0.99
CE144	1.79E+06	1.66E+06	0.93		KR 85M	3.08E+07	2.97E+07	0.97
CS138	1.46E+06	1.24E+06	0.85		KR 87	4.49E+07	4.70E+07	1.05
I131	7.47E+07	6.09E+07	0.82		KR 88	7.62E+07	7.67E+07	1.01
I132	9.14E+07	7.59E+07	0.83		XE133	2.87E+08	2.38E+08	0.83
I133	1.21E+08	1.22E+08	1.01		XE133M	9.90E+06	7.72E+06	0.78
I134	1.07E+08	9.28E+07	0.87		XE135	5.18E+07	8.42E+07	1.63
I135	1.19E+08	1.10E+08	0.92		XE135M	2.92E+07	1.91E+07	0.65
LA140	2.56E+06	2.27E+06	0.89		XE138	5.17E+07	4.67E+07	0.90
LA141	2.43E+06	1.95E+06	0.80					
LA142	1.94E+06	1.72E+06	0.89					
MO 99	2.56E+06	2.29E+06	0.90					
NB 95	2.41E+06	2.17E+06	0.90					
PR143	2.11E+06	1.82E+06	0.86					
PR144	1.79E+06	1.66E+06	0.93					
RU103	2.08E+06	1.93E+06	0.93					
SR 89	1.15E+06	1.17E+06	1.02					
SR 91	1.41E+06	1.41E+06	1.00					
SR 92	1.39E+06	1.39E+06	1.00					
TE132	2.11E+06	1.72E+06	0.81					
TE134	1.47E+06	1.25E+06	0.85					
Y 91	1.57E+06	1.50E+06	0.96					
Y 92	1.65E+06	1.58E+06	0.96					
Y 93	1.89E+06	1.78E+06	0.94					
ZR 95	2.37E+06	2.16E+06	0.91					

<u>Notes</u>:

1 TID-14844 source term mix: isotopic inventory presented below reflects the stated percentage of core activity of noble gas, iodine and remainder

2 Major isotopes in each radiation source type at t=30 min (e.g., suppression pool water, airborne releases). Listed isotopes represent:
~98 percent of the t=30 min total activity in the radiation source based on the core inventory used in the CLB analyses
~ 86% to 90% of the t=30 min total activity in the radiation source based on the EPU core inventory.

3 CLB isotopic activity includes the previously discussed multiplier of 1.266