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Michael A. Krupa
Director
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GNRO-2007/00018

April 4, 2007

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

SUBJECT: Supplement to Amendment Request
Changes to the Local Power Range Monitor (LPRM) Calibration Frequency Grand Gulf Nuclear Station, Unit 1 (GGNS)
Docket No. 50-416
License No. NPF-29

REFERENCE: Letter GNRO-2006/00058 from W. R. Brian, Entergy Operations, Inc., to Document Control Desk, USNRC, "License Amendment Request Changes to the Local Power Range Monitor (LPRM) Calibration Frequency," dated November 1, 2006 (ADAMS Accession No. ML063130372)

Dear Sir or Madam:

By the above referenced letter, Entergy Operations, Inc. (Entergy) proposed a change to the Grand Gulf Nuclear Station, Unit 1 (GGNS) Technical Specifications (TS) to extend the Local Power Range Monitor (LPRM) calibration interval from 1000 megawatt days per ton (MWD/T) to 2000 MWD/T (i.e., from approximately every 36 days to approximately every 72 days).

Entergy and members of your staff held calls on January 31, 2007, February 8, 2007, and March 8, 2007 to discuss the technical basis for the proposed TS change. As a result of the calls, five questions were determined to need formal response. Two of the questions from the Instrumentation and Controls Branch reviewers were similar to those from the Reactor Systems Branch reviewer. A common response is provided for these questions. Entergy's response is contained in Attachment 1.

There are no technical changes proposed. The original no significant hazards consideration included in the referenced letter is not affected by any information contained in the supplemental letter. There are no new commitments contained in this letter.

If you have any questions or require additional information, please contact Ron Byrd at 601-368-5792.

I declare under penalty of perjury that the foregoing is true and correct. Executed on April 4, 2007.

Sincerely,

MAK/RWB/amt

Attachment: Response to Request For Additional Information

cc: Dr. Bruce S. Mallett
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NRC Senior Resident Inspector
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Attachment 1

To

GNRO-2007/00017

Response to Request for Additional Information

Response to Request for Additional Information Related to Changes to the Local Power Range Monitor (LPRM) Calibration Frequency

1. Describe how the 4.3 % LPRM uncertainty is accounted for in the GGNS MCPRSL calculation including the relevant reference documents. Please justify the radial bundle power uncertainty and SLMCPR value remain valid with this 4.3% LPRM uncertainty.

   Response:

   The current Grand Gulf Nuclear Station (GGNS) Minimum Critical Power Ratio Safety Limit (SLMCPR) was previously reviewed and approved by the NRC and issued as Amendment No. 146 (Reference 1). The License Amendment Request (LAR) included a summary of the SLMCPR analysis in Attachment 4 of letter GNRO-2000/00084 (Reference 2). The SLMCPR analysis uses a measured bundle power uncertainty that is based on the generic uncertainty analysis described in EMF-2158(P)(A) (Reference 3) with adjustments for an extended calibration interval and various nuclear instrumentation out of service limits. The adjustments to the measured bundle power uncertainty were performed based on methods described in Reference A.9 of GNRO-2000/00084 (Reference A.9 is herein listed as Reference 5). The measured bundle power uncertainty is based on equation 9-7 of EMF-2158(P)(A). An extended Local Power Range Monitor (LPRM) calibration interval only affects the synthesized Traversing In-core Probe (TIP) uncertainty (equation 9-13 of EMF-2158(P)(A)) component of the measured bundle power uncertainty.

   Based on previous analysis experience, the measured bundle power uncertainty was determined assuming that the extended LPRM interval would increase the LPRM uncertainty from the original 3.4% to 4.3 %. As described in response to question 3 below, this assumption has been verified by the evaluation of GGNS specific LPRM calibration data.

   Section 9.1 of EMF-2158(P)(A) notes that the measured bundle power uncertainty relies upon the 3.4% LPRM uncertainty described in NEDO-20340 (Reference 6). As described in NEDO-20340-1, Request 13, the LPRM uncertainty includes allowances for detector and cable non-linearity, uncertainty in the sensitivity loss between calibrations, amplifier drift and non-linearity and the interpolation to axial locations between detectors. The uncertainties associated with the TIP system are derived in EMF-2158(P)(A).

2. On Page 4 of Attachment 1 in your submittal, you stated that "Data points for cycle exposure intervals of up to (emphasis added) 3,000 MWD/T were used for the 2,000 MWD/T calibration interval". Please clarify if the data points with exposure interval of 1,600 to 3,000 MWD/T were used or from 0 to 3,000 MWD/T? How many of the 900 data points were used for 2,000 MWD/T analysis? The current allowed interval by TS is 1,000 MWD/T with +25% allowance. Please explain how it can be possible to have data points with exposure interval greater than 1,250 MWD/T (1,000 x 1.25).

   Response:

   The standard deviation for 1000 megawatt days per metric ton (MWD/MTU)[1] calibration interval was determined by evaluating the data collected for calibration intervals that varied from 100 to 1600 MWD/MTU. The equivalent data for 2000 MWD/MTU calibration interval was determined by evaluating the data collected for calibration intervals from 1600 to 3000 MWD/MTU. Calibration intervals larger than the technical specification requirement of 1250 MWD/MTU are possible since the calibration may not involve a physical adjustment of the gain amplifier associated with an LPRM as the calibration can be accounted for with a gain adjustment factor (GAF) in the core monitoring system. In addition the process of comparing a predicted vs. measured calibration can be achieved by making the prediction from a previous calibration and ignoring the intermediate calibration data.

   Over 900 points of actual calibration data were used to establish a database of various calibration intervals. Some of the actual calibration data may be used more than once since the predicted calibration data may skip intermediate calibrations to evaluate the uncertainty of longer calibration intervals. For the 0 to 1600 MWD/MTU collection of data points there were over 1100 predictions to compare to actual calibration data. Over 1500 predictions were used to compare predicted and actual calibration data between calibration intervals of 1600 to 3000 MWD/MTU.

   The database was obtained from Grand Gulf specific calibration data from 168 LPRM detectors spanning up to 10 years of operation. The numbers of calibration points vary based on the detector age, from less than 10 for newly installed detectors to over 50 for older detectors. While the LPRM calibration is performed at least every 1000 MWD/MTU, the frequency of individual detector amplifier adjustments varies since the sensitivity loss occurs at different rates in the reactor. This variation is due to the presence of control rods, fuel depletion, and other neutron flux distribution effects. The amplifier gains for individual detectors that are within the calibration tolerance are not adjusted for a given calibration. The database contains calibration data for amplifier gain adjustments that typically range between 700 – 2500 MWD/MTU.

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[1] The Technical Specifications express the calibration interval as MWD/T. The ton (T) unit of weight used for this analysis of the calibration interval is calculated in terms of metric tons of initial uranium fuel residing in the reactor core, herein expressed as MWD/MTU.

3. Request a) and b) below were provided by separate reviewers. A common response is provided for these requests due to their similarity.
   a) Describe the method used to develop the relative standard deviations for different calibration periods and decay factors (Table 1 of Attachment 1). Include in the description how data was developed for calibration intervals greater than the current 30 day calibration interval. Describe how the "nominal" value in Table 1 is obtained and why it's conservative.
   b) Provide the AREVA NP plant specific LPRM uncertainty analysis which confirms that the 4.3% LPRM response uncertainty used in the MCPR safety limit analysis would remain bounding if the LPRM calibration interval were extended from 1000 MWD/T to 2000 MWD/T. This analysis should include supporting information for sensors and electronic outputs. Please provide the statistical bases and supporting data for the standard deviation results in Table 1 of Attachment 1. Please include consideration of uncertainty in the reference measurements.

Response:

LPRM sensitivity is reduced as the fissile material in the detector is depleted. This loss follows an exponential decay which allows calibration currents to be predicted by the following equation:

$$I_n = I_{n-1} e^{\lambda E}$$

where I_n is the predicted calibration current

I_{n-1} is the previous calibration current

λ is the effective exposure decay factor

E is the accumulated LPRM exposure (snvt) since the previous calibration

From a given calibration, the calibration currents are predicted for future calibrations within the exposure range of interest.

The relative difference between the predicted and actual calibration currents ([actual - pred] / actual) are collected along with the corresponding cycle exposure calibration interval. The data is then sorted by calibration interval and the standard deviation is calculated for the desired exposure interval as discussed in the response to question 2.

GGNS assigns an effective exposure decay factor for each LPRM based on a least-squares fit of the observed calibration data when at least 4 data points are available. During the initial period of operation the conversion of fertile material compensates for detector loss. The fit excludes this data. This method accounts for variations in detector sensitivity due to variations in manufacturing. As noted in Attachment 1, Table 1 of

GNRO-2006/00058 (Reference 4), the calibration current uncertainty was evaluated using the detector specific decay factors. This approach includes the effect of variations in the decay constants in the calibration current uncertainty.

For example, some data from one LPRM is presented in the table below.

Delta exposure	Cycle exposure	Date	Accumulated exposure (snvt)	Decay Factor (λ)	Calibration Current
1489.2	1489.2	970127	4.4	-0.109	403
810.8	2300	970225	4.54	-0.101	392
943	3243	970401	4.66	-0.096	382
960	4203	970506	4.76	-0.094	372
955	5158	970610	4.87	-0.095	350
2107	7265	970826	5.13	-0.099	330
749	8014	970923	5.21	-0.104	314
4613	12627	980317	5.55	-0.109	301

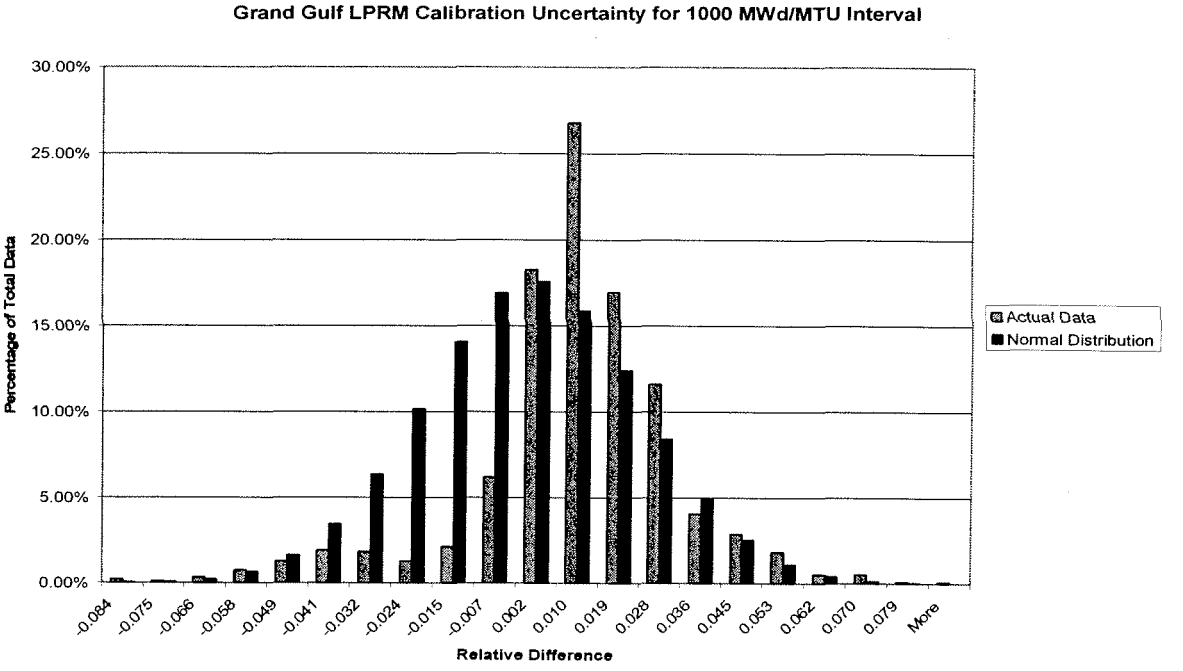
The calibration current at a cycle exposure of 4203 MWD/MTU was 372. At a cycle exposure of 5158 MWD/MTU when a new calibration was performed the calibration current was 350. The corresponding LPRM exposure values were 4.76 and 4.87 SNVT. The predicted current for a cycle exposure of 5158 MWD/MTU would be:

$$I_n = 372\ e^{(-.094\ *(4.87-4.76))} = 368$$

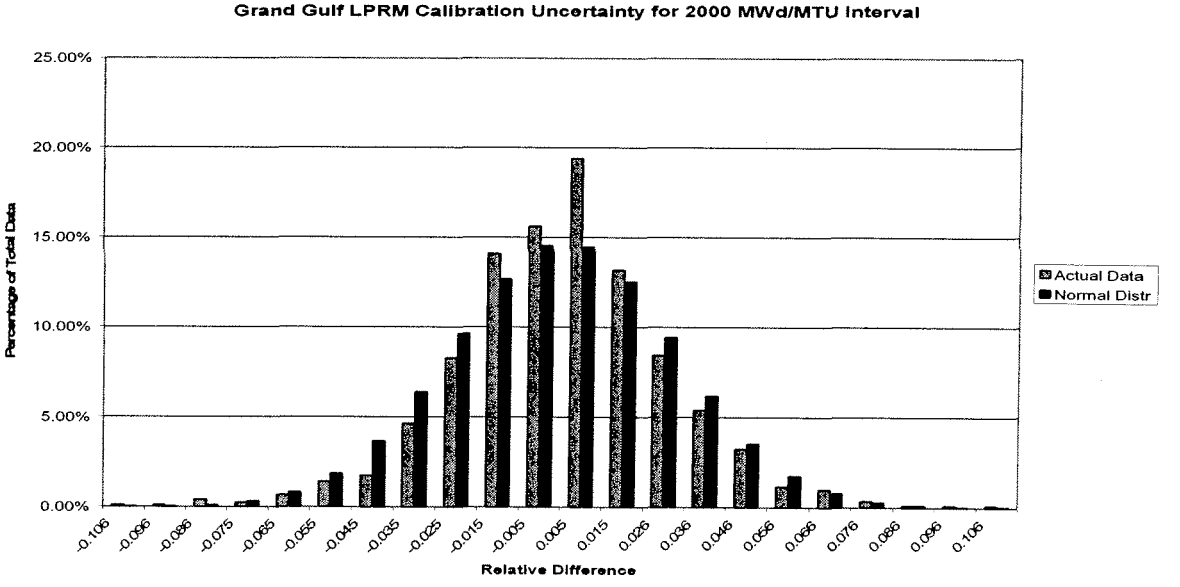
In this example, this value compared to the actual calibrated current of 350 yields 5.2% difference. This corresponds to a calibration interval of 955 MWD/MTU.

Additionally, the calibration uncertainty was also determined using a fixed "nominal" decay factor. By choosing a fixed sensitivity one expects to maximize the uncertainty in the predicted response since a fixed decay constant does not account individual detector differences as the least squares fit value does. A nominal value was chosen as representative. An evaluation of various fixed values demonstrated that the change in standard deviation was insensitive to the value of the exposure decay factor. Actual plant practices have lower uncertainties than are covered by this analysis with a fixed decay factor.

In order to demonstrate the data analyzed, a frequency plot was generated for data taken with calibration intervals ranging from 100 to 1600 MWD/MTU and is presented in the following figure. The normal distribution data is determined using the calculated standard deviation of 2.17%.



The equivalent data for calibration intervals ranging from 1600 to 3000 MWD/MTU is presented in the following figure. The normal distribution data is determined using the calculated standard deviation of 2.74%.



The distribution based upon actual data appears to be narrower than the normal distribution indicating that a normal distribution is conservative.

4. Request a) and b) below were provided separate reviewers. A common response is provided for these requests due to their similarity.
   a. On Page 5 of the Attachment 1 of your submittal, you stated "This 25% extension would allow the calibration to be performed prior to 2,500 MWd/T...the 25% percent extension in SR 3.0.2 is not intended to be used repeatedly." Your submittal provided the study, which used the data points up to 3,000 MWd/T, and stated that the 4.3 % LPRM response uncertainty value used in the calculation of total radial bundle power uncertainty is satisfied up to 2,000 MWd/T based on TABLE 1 results. The NRC staff has a concern that if the analysis was performed for 2,500 MWD/T instead of 2,000 MWD/T, the increase of standard deviation would be higher than that stated in TABLE 1. And thus the uncertainty value (4.3%) assumed in MCPR analysis could be exceeded. The +25% allowance might not be suitable for 2,000 MWD/T. Please address this concern.
   b. Confirm that the change in LPRM calibration frequency continues to allow the 25 percent extension of the calibration interval as stated in the TS provisions of SR 3.0.2. Provide the analysis that shows that the LPRM response uncertainty remains bounded by the MCPR safety limits at 2500 MWD/T.

Response:

An additional analysis was performed to evaluate the data with a fixed lambda in intervals from 1500 to 2500 MWD/MTU (representative of 2000 MWD/MTU nominal) as well as 2500 to 3500 MWD/MTU (representative of 3000 MWD/MTU nominal). The results from 1500 to 2500 MWD/MTU were a standard deviation of 3.00% which is 0.48% higher than the results from 100 to 1600 MWD/MTU. The results from 2500 to 3500 MWD/MTU were 3.51 % which is 1.00% higher than the results from 100 to 1600 MWD/MTU. These results indicate that the 4.3% uncertainty would support calibration intervals up to 2800 MWD/MTU using linear interpolation to get 0.9% change which is well beyond the requested calibration interval with the 25% extension.

5. With the extension of calibration period from 1,000 MWD/MTU to 2,000 MWD/MTU, please address the aspect of reduced possibility of identifying instrument errors in LPRM.

Response:

There are various methods routinely used to identify LPRMs that are in error. The actual calibration process is only one such method.

The core monitoring system (CMS) (PowerPlex®) continually monitors all LPRMs for electronic drift. Specific criteria are used to detect and flag via computer alarms any detectors which change suddenly and unexpectedly. These alarms appear immediately to the control room operators and require acknowledgement. The operator then investigates and contacts the on-call reactor engineer if needed. Corrective actions are taken as appropriate.

Another way to identify detector malfunctions is via the CMS monitoring cases that run automatically every 2 hours as a minimum. An LPRM detector failure or significant

detector changes can impact the calculated thermal limit values and the preconditioning envelope values. These values do not normally show sudden, unexplained changes and such changes will be evident to the control room operators (specifically the Shift Technical Advisors) who closely monitor the CMS display.

In addition, there are two Technical Specification (TS) Surveillance Requirements (SR) which require APRM readings to be routinely checked. SR 3.3.1.1.1 requires a Channel Check of the APRM readings (eight channels) every 12 hours. SR 3.3.1.1.2 requires a weekly verification that the absolute difference between the APRM channel readings and the reactor power is not more than 2% of Rated Thermal Power (RTP). Not only are these APRM readings recorded and checked twice daily during the operator rounds, the APRM gain adjustment factors (GAFs) are continuously calculated and displayed for the operators. Errors in detectors which are significant will cause the APRM values to change and the GAFs to change. Any GAFs that fall outside of the TS required 2% accuracy limit will change color and prompt an investigation by the operators.

Another process used involves the weekly APRM Channel Functional Test required by TS SR 3.3.1.1.3. During this surveillance, operators cycle the LPRM function switches to check the APRM count circuit. An LPRM reading edit is taken before and after. Any malfunctions or problems with the detector operability will be noted at that time.

Operators also have panel alarms (annunciators) for detectors which fail high or low during normal operation. This would be investigated promptly.

Finally, during the LPRM calibration, there is an additional opportunity to detect any LPRM errors. LPRM GAFs are determined during the calibration process so that the detector gains may be adjusted to match the values corresponding to the incore probe traces. These GAFs are checked to make sure they are not abnormal relative to those typically seen. Typically, properly functioning detectors have GAFs between 0.8 and 1.2. Any GAF that falls outside of that range is investigated. Also, during the actual adjustment process for those detectors needing an adjustment from the calibration results, any detector instabilities or unusual responses are noted.

The LPRM response is frequently monitored between calibration intervals therefore, extending the calibration interval from 1,000 to 2,000 MWD/MTU will not have an adverse impact on the ability to identify a detector error.

REFERENCES

1. Letter from Mr. S. Patrick Sekerak, USNRC to Mr. William A. Eaton, Entergy Operations, Inc., "Grand Gulf Nuclear Station, Unit 1 – Issuance of Amendment RE: Revision of the Minimum Critical Power ratio Safety Limit for Cycle 12 Operation (TAC NO. MB0514)," dated April 26, 2001 (ADAMS Accession No. ML011230243)

2. Letter GNRO-2000/00084 from Mr. William A. Eaton, Entergy Operations, Inc. to Document Control Desk, USNRC, "Cycle 12 Reload - Proposed Amendment to the Operating License, LDC-2000-076," dated November 10, 2000 (ADAMS Accession No. ML003773595).

3. EMF-2158(P)(A), "Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2."

4. Letter GNRO-2006/00058 from W. R. Brian, Entergy Operations, Inc., to Document Control Desk, USNRC, "License Amendment Request Changes to the Local Power Range Monitor (LPRM) Calibration Frequency," dated November 1, 2006 (ADAMS Accession No. ML063130372).

5. Letter HDC:96:012 from H. Donald Curet, SPC to H. J. Richings, USNRC, "POWERPLEX® Core Monitoring: Failed or Bypassed Instrumentation and Extended Calibration," dated May, 6, 1996.

6. NEDO-20340, "Process Computer Performance Evaluation Accuracy," General Electric, June 1974.