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U.S. Nuclear Regulatory Commission
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Subject: James A FitzPatrick Nuclear Power Plant
Docket No. 50-333
Calibration Methodology of Local Power Range Monitors (LPRMs).

Dear Sir:

This letter documents the Authority's position regarding the methodology for LPRM calibration during reactor operation using the Traversing Incore Probe (TIP) system. This includes the methodology used when LPRM locations can not be probed by the TIP system. During power ascension following refuel outage 13, one of the three TIP machines used to calibrate the LPRMs was inoperable. The NRC has questioned the methodology used to calibrate the LPRMs under these conditions versus the calibration requirements stated in the FitzPatrick Technical Specifications (TS). Attachment 1 provides background information regarding the TIP system and the methodology used to perform a calibration of the LPRMs. The Authority's position is that the LPRM calibration methodology described in Attachment 1 is consistent with the Current Licensing Basis and BWR industry practice.

The Authority is submitting a Technical Specification Amendment regarding LPRM calibration requirements that is consistent with NUREG-1433, "Standard Technical Specifications - General Electric Plants, BWR/4." This will provide consistency with other utilities and prevent further confusion with regard to the current FitzPatrick LPRM TS requirements.

If you have any questions, please contact Mr. Arthur Zaremba, Licensing Manager, at (315) 349-6365.

Very truly yours,

MICHAEL J. COLOMB
Site Executive Officer

MJC:RFS:las
cc: Next page.

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TIP System Background:

The FitzPatrick plant has three gamma-sensitive TIP machines that are used periodically to determine the power distribution in the core and to calibrate the Local Power Range Monitors (LPRMs). The TIP system consists of three independent, gamma photon detection units. Each unit contains an ion chamber, which is driven from outside the primary containment by a motor drive mechanism. The detector is attached to the drive mechanism by means of a flexible cable. Operation of the drive mechanism causes the ion chamber to be inserted into or retracted from the reactor core within individual TIP guide tubes. The TIP guide tubes are located in the same instrument tubes that house the LPRM strings. There are 31 TIP guide tubes distributed in a symmetric pattern throughout the FitzPatrick core (the axis of symmetry lies along a diagonal through the core center). Each TIP machine uses an indexer device to route the detector to the desired LPRM string assembly. The three TIP machines can traverse one common location near the center of the core to allow for normalization of the outputs from the three machines. With one TIP machine out of service, 10 of the 31 LPRM strings cannot be probed.

The TIP system provides a signal proportional to the axial neutron flux shape at the 31 core locations. This signal provides the following:

a. Reliable calibration of the LPRM flux amplifier gains for changes in LPRM detector sensitivity which accompany prolonged neutron exposure.

b. Core wide flux shapes to the computer to minimize uncertainties in core power and exposure distribution calculations.

During power ascension from refuel outage 13, it was discovered that the "C" TIP machine was unable to drive its detector due to a high torque experienced by the drive mechanism. The high torque is believed to have been caused by moisture intrusion and subsequent interaction with the tip drive lubricant resulting in a higher than normal lubricant friction. The moisture was removed by purging the machine with nitrogen. The nitrogen purge has resulted in a reduction in the friction within the "C" TIP machine and success in restoring the machine to an operable status.

Calibration:

LPRMs at FitzPatrick are fission chambers used to monitor neutron flux (and thermal power) at fixed locations (31 radial locations, with 4 detectors distributed at 36 inch intervals axially) within the reactor core. Among other uses, outputs from the LPRMs are used as input to Average Power Range Monitors (APRMs). APRMs are used to provide continuous monitoring of total core thermal power.

LPRM sensitivity changes as the content of fissile material in the detector varies as a result of exposure to neutron flux. Therefore, LPRM amplifier gain must be adjusted to maintain the proportionality constant between neutron flux and the signal input to APRMs approximately invariant.

LPRM Calibration During Reactor Operation

To calibrate the LPRMs during reactor operation, the neutron flux that the detector is exposed to must be known. Neutron flux is determined using the TIP system in conjunction with core monitoring software. The TIP system uses gamma sensitive detectors to measure the detailed axial gamma flux distribution of selected radial locations within the reactor core. Core monitoring software is used to relate the steady-state gamma flux to steady-state neutron flux. TIP detectors traverse a tube located in the in-core instrument tubes that house the LPRMs. Gamma TIPs are used to reduce the uncertainty (relative to neutron TIPs) associated with TIP tube radial location in the in-core instrument tubes, since neutron flux varies significantly across the radial gap in which the tubes are located. FitzPatrick has three TIP machines, each of which is able to traverse eleven radial locations. One of these locations is shared by the three machines, and is used to normalize the output of the TIP detectors.

FitzPatrick currently uses General Electric 3D-Monicore (RL3D) software for core monitoring. 3D Monicore uses 3D diffusion theory (GE PANACEA) with adaptation to plant TIP and LPRM signals to provide estimates of core power distribution. The adaptation process alters nodal nuclear parameters such that calculated TIP distributions agree with the input measured distributions. Since this core-monitoring model is based on diffusion theory, it is capable of compensating for missing TIP information when calibrating LPRMs. This is done either by substituting TIP readings from symmetric TIP strings (when fuel operating histories and control rod patterns permit), or by using the 3D-Monicore calculated TIP distribution. Options permitting these substitutions are built-in features of 3D-Monicore software.

The effect of missing TIP data on 3D-Monicore accuracy has been evaluated, and it has been shown that uncertainty remains within acceptable limits with up to 1/3 of the locations (any one TIP machine out-of-service) not probed (references 1, and 2). Therefore, LPRM calibration can be successfully completed with a TIP machine out-of-service, since the neutron flux distribution obtained from 3D-Monicore provides an acceptable representation of the real neutron flux distribution.

New LPRM Calibration Prior to Reactor Operation

Operable (hence calibrated) LPRMs are required to provide input to APRMs that are required for reactor operation, however reactor operation is required to provide the flux distribution to be measured to allow LPRM calibration. Therefore alternative methods are provided to calibrate newly installed LPRMs prior to reactor startup. The method is to use either vendor supplied sensitivity information (calibration current) for detector types that were not in the previous cycle core, or historical data (initial calibration current at 100% power) for detector types that were present in the previous cycle core. Following reactor startup, these detectors are calibrated using the methods described in the previous section.

Technical Specifications:

The FitzPatrick TS calibration requirements for LPRMs are contained in TABLE 4.1-2, "Reactor Protection System (Scram) Instrument Calibration Minimum Calibration Frequencies for Reactor Protection Instrument Channels." Under the column titled "Calibration" corresponding to the LPRM Signal Instrument channel are the words "TIP System Traverse." In the bases section for the surveillance requirements it states that "The sensitivity of LPRM detectors decreases with exposure to neutron flux at a slow and approximately constant rate. This is compensated for in the APRM system by calibrating twice a week using heat balance data and by calibrating individual LPRM's every 1000 effective full power hours, utilizing TIP traverse data." The Table 4.1-2 and TS bases requirements for "TIP traverse data" has not been interpreted by the Authority to mean data at each LPRM. The FitzPatrick conversion to Improved Technical Specifications for the TS bases section will revise the wording to "LPRM gain settings are determined from the flux profiles measured by the Traversing Incore Probe (TIP) System. This establishes the relative local flux profile for appropriate representative input to the APRM System." This is also not interpreted to mean data at each LPRM location and is consistent with the calibration description above to establish the LPRM gain adjustments. There are no operability requirements contained in the TS for the TIP system.

Final Safety Analysis Report:

The original FitzPatrick Final Safety Analysis Report (FSAR) section 7.5.6, "Local Power Range Monitor Subsystem states "The LPRM subsystem supplies signals proportional to the local neutron flux to the process computer to be used in power distribution calculations, local heat flux calculations, minimum critical heat flux calculations, and fuel burnup calculations. Also, the FSAR subsection 7.5.6.4, "Inspection and Testing" states that "LPRM channels are calibrated as required by the Technical Specifications using data from previous full power runs and TIP data, and are tested by procedures in the applicable instruction manuals." The applicable instruction manuals have always employed a combination of TIP data, historical power data, and computer generated calculational data to calibrate the LPRMs.

Conclusion:

The calibration methodology used to perform gain adjustments of the LPRMs with 1/3 of the LPRM locations not probed (a single TIP machine out-of-service) with a TIP traverse is acceptable. The associated uncertainties are within those assumed by the GETAB Safety Limit Evaluations (references 1, and 2). The FitzPatrick TS require that the LPRMs be calibrated to account for detector sensitivity decreases utilizing TIP traverse data. In conjunction with 3D-Monicore core power distribution models, the data can be from direct readings, symmetrical readings, or calculated data. The above methodology is consistent with the TS and Licensing basis, General Electric documents, and BWR industry practice.

References

1. NEDE-32321, 3D Monicore (RL3D) Performance Evaluation Accuracy, General Electric Company, January 1994

2. NEDC-32694P, Power Distribution Uncertainties for Safety Limit MCPR Evaluations, General Electric Company, January 1997