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Enclosure 2

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Class I
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Licensing Topical Report

Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring

D. W. Armstrong

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ABSTRACT

A Gamma Thermometer (GT) System for LPRM calibration and power shape monitoring is described. The major hardware and software components are identified and a practical GT response model is developed. Three in-plant tests at Limerick 2 (Exelon), Tokai 2 (JAPC) and Kashiwazaki-Kariwa 5 are provided to qualify the sensors and assess accuracy. An adaptive core monitoring simulation is used to assess the impact of the GT System on core monitoring. Lastly, an uncertainty analysis is performed to quantify the impact on bundle power uncertainty and on thermal limits.

ACKNOWLEDGEMENTS

Numerous individuals deserve credit in one way or another for the design, development and testing of GT technology. The author gratefully acknowledges the many and varied contributions of the following and apologizes to anyone that is inadvertently left off:

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ACRONYMS AND ABBREVIATIONS

Term	Definition
BOC	Beginning of cycle
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
CPR	Critical Power Ratio
DACS	Data Acquisition and Calibration System
DAS	Data Acquisition System
DLC	Data Logging Computer
EOC	End Of Cycle
ESBWR	Economic Simplified Boiling Water Reactor
GETAB	General Electric Thermal Analysis Basis
GT	Gamma Thermometer
GTC	Gamma Thermometer Control Unit
GTM	Gamma Thermometer Monitoring Unit
HPS	Heater Power Supply
HSU	Heater Switching Unit
LPRM	Local Power Range Monitor
LTR	Licensing Topical Report
MCPR	Minimum Critical Power Ratio
MLHGR	Maximum Linear Heat Generation Rate
NA	Not Applicable
NRC	Nuclear Regulatory Commission
O&M	Operation and Maintenance
PANAC11	PANACEA, GEH BWR Core Simulator
TIP	Traversing In-core Probe

1. INTRODUCTION

A Gamma Thermometer (GT) is a simple, solid-state device for measuring the thermal effects of intense gamma ray fields. GTs show great promise in simplifying BWR in-core instrumentation for future plants by providing an economical alternative to the Traversing In-core Probe (TIP) system.

The TIP system, which may be based on either gamma or neutron sensitive detectors, provides measurements for calibrating the Local Power Range Monitors (LPRMs) and for adapting (improving) the power distribution from the Core Monitoring System. Although TIP systems fulfill the intended purpose quite satisfactorily, the Operating and Maintenance (O&M) costs are high. This is due to the many moving parts in the system, the complex under-vessel tubing which must often be disconnected during maintenance, the radiation dose to maintenance personnel in the neighborhood of the stored TIP probes and other problems. A GT system, on the other hand, fulfills the functions of the TIP system, yet it has no moving parts, no under vessel tubing, no radiation problems and is expected to be very reliable.

A Gamma Thermometer based instrument system has been selected in place of a TIP system for the Economic Simplified Boiling Water Reactor (ESBWR) and is likely to be incorporated in all future BWR designs.

1.1 Purpose

The purpose of this document is to supply regulators (and others) with sufficient information to understand the technical features of the GT system and to confirm the suitability of the GT system for LPRM calibration and power distribution monitoring.

1.2 Scope of Review

GEH requests that the NRC approve the GT system for calibration of LPRMs and for supplying power shape information to the core monitoring system.

1.3 Description of a Gamma Thermometer

A Gamma Thermometer is a device used for measuring the gamma flux in a nuclear reactor. A section of a typical GT is shown in [[ ]]. It consists of a stainless steel rod that has short sections of its length thermally insulated from the reactor coolant. The insulation, normally a chamber of Argon gas, allows the temperature to rise in the insulated section in response to gamma energy deposition. A two-junction thermocouple measures the temperature difference between the insulated and non-insulated sections of the rod. The thermocouple reading is thus related in a straightforward way to the gamma flux. When properly adjusted for the number and spectrum of the gamma rays produced from fission and neutron capture, the fission density in the surrounding fuel can be inferred from the gamma flux and therefore indirectly from the thermocouple reading.

An ohmic heater wire is placed in the center of the GT rod to provide a means of calibration of the thermometers, which are expected to decline slowly in sensitivity during the first few months of operation. The calibration procedure consists of passing a known current through the heater wire and noting the increase in thermocouple response. When properly calibrated in this manner, the GT can perform both of the normal functions of a (TIP): Calibration of the LPRMs and providing power shape information to the plant monitoring system.

A diagram of a GT assembly that is designed to replace a standard LPRM/TIP assembly is shown in [[ ]]The GT assembly consists of a GT rod with several GT sensors and the normal compliment of four LPRMs.

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1.4 Advantages of the GT System

The GT System has many advantages over the TIP system:

- No moving parts to wear out
- Reduced occupation exposure
- Reduced radioactive waste
- No open tube penetrations to the containment
- Reduced space requirements in the reactor building
- More frequent LPRM calibrations
- More frequent adaptive monitoring calculations

2. GT SYSTEM REQUIREMENTS

2.1 Design Requirements

There are two general functional requirements for the GT system:

- Provide accurate information for the calibration of the LPRMs. Such calibration must occur at least every 30 days, although it is expected that it will occur much more frequently, even multiple times in a single day.

- Provide accurate axial shape information for use by the core monitoring system. This information should be available at any time, even during slow transients (Xenon, flow, etc.) as long as the time frame is substantially longer than the thermal time constant of the GT sensors.

2.2 Codes and Standards

LPRM/GT assemblies must be designed, manufactured and tested according to all applicable U.S. Codes and Standards.

When manufactured for use in a nation other than the U.S., LPRM/GT assemblies must also comply with that nation's codes and standards.

3. GT SYSTEM DEFINITION

3.1 Hardware Components

The hardware configuration for a typical GT core monitoring system is shown in [[ ]]. The hardware includes new components such as the LPRM/GT assemblies, the Data Acquisition System (DAS) and the Heater Power Supplies (HPS). A listing of the new components is provided in Table 3-1. Also listed is the number of each type of component that is required for a complete system.

Table 3-1, GT Core Monitoring Component List

›mponent Name	Number (Typical)
LPRM/GT Assembly	64
GT Sensors per Assembly	4
Data Acquisition System Cabinet	2
Heater Power Supplies	8
GT Control Cabinet (including Work-Station)	1

3.1.1 LPRM/GT Assembly

The LPRM/GT assemblies are similar to standard LPRM assemblies: each has four LPRMs and is designed to meet all of the normal requirements. In the ESBWR configuration, each assembly has four GTs with one GT adjacent each LPRM. In other designs, up to nine GTs are possible. In the nine GT configuration, the GTs are positioned as follows: one adjacent to each LPRM, one midway between each pair of LPRMs, one midway between the bottom of the core and the lowest LPRM and finally, one midway between the highest LPRM and the top of the core.

There are many requirements that the GT sensors must meet. For example, the range in gamma heating rate should be 0.0 to 2.4 W/g for a typical BWR. In addition, the GT sensitivity at beginning of life at operating temperature (286°C) should be 1.5 mV-g/W ±20%. (For a complete list of requirements see [[Table 9-1.)

The environmental design ratings, including the operating temperature, neutron flux, gamma dose rate and seismic loadings are the same as the standard LPRM assemblies. The GT sensors are designed to last at least as long as the LPRMs.

For demonstration systems only, a calibration tube is included in the assembly so that the TIP system remains fully operational. This permits a direct comparison between the TIP and GT systems.

3.1.2 Data Acquisition System

The main function of the Data Acquisition System (DAS) is to transform the GT readings from an analog signal to a digital value. The environmental design ratings are similar to other electronics in the reactor building. In addition, the DAS system performs digital filtration to remove noise as well as digital compensation to account for delayed gammas (see section 4.5 for a discussion of delayed gamma compensation).

3.1.3 Heater Power Supply

The purpose of the Heater Power Supply (HPS) is to provide a DC electrical current to the internal GT heaters during calibration. The current must be of sufficient magnitude to allow an accurate calibration of each GT sensor. The HPS, for economic reasons, is multiplexed such that several GT assemblies are serviced sequentially by a single power supply. In [[ ]], the HPS is included in the DAS cabinets.

3.1.4 GT Control Cabinet

The GT Control Cabinet contains an Engineering Work-Station (EWS) that is the principal interface to the GT system. It provides a manual way of initiating the GT calibration and in addition, provides color graphic displays of all useful output: GT readings, GT sensitivities and others.

The EWS communicates with the other units including the DAS and ATLM cabinets through a fiber optic link.

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3.2 Software Components

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3.2.1 GT Monitor Module

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3.2.2 GT Calibration Module

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3.2.3 3D Simulator

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3.2.4 User Interface

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4. GT RESPONSE MODEL

4.1 GT Response to Gamma Energy Deposition

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4.2 GT Factory Calibration

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4.3 GT In-Plant Calibration

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4.4 Sensitivity Decrease Model

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4.5 Delayed Gamma Compensation

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The following table shows the values of the constants used in this report:

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* Average thermal time constant (Joule method) of the detectors in the Joint Study

5. GT SYSTEM FUNCTIONS

The two functions of the GT System, LPRM calibration and power shape monitoring, are briefly described in the following sections.

5.1 LPRM Calibration

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5.2 Core Monitoring with GT Adaption

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6. FACTORY TESTS

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6.1 GT Factory Tests

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6.2 LPRM/GT Assembly Factory Tests

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7. IN-PLANT QUALIFICATION TESTS

There have been three in-plant tests of GT sensors in BWRs thus far. The first test was at Limerick 2 and lasted for two cycles, a total of four years. The second test, which was at Tokai 2, lasted for a single cycle of one year duration. These two tests will be described in detail in sections 7.1 and 7.2 , respectively. Published data from a third test at Kashiwazaki-Kariwa 5 are available in the open media and are summarized in section 7.3.

7.1 Limerick 2 In-Plant Test

The Limerick 2 plant, operated by Exelon (formerly PECO Energy) is an 1100 MWe BWR4. It has 764 bundles arranged in a "C" lattice configuration (equal water gaps). It has a gamma sensitive TIP system with a total of 43 calibration tubes and associated LPRM strings.

7.1.1 Test Plan

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7.1.2 Hardware Description

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7.1.3 GT Calibration Results

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7.1.4 Comparison with Gamma TIPs

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7.1.5 Conclusions

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7.2 Tokai 2 In-Plant Test

The Tokai 2 plant, operated by Japan Atomic Power Company (JAPC), is an 1100 MWe BWR5 with 764 fuel bundles arranged in a C lattice. It has a neutron sensitive TIP system with a total of 43 calibration tubes.

7.2.1 Test Plan

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7.2.2 Hardware Description

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7.2.3 GT Calibration Results

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7.2.4 GT Sensitivity Projection

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7.2.5 Steady State Response

7.2.5.1 Comparison with Neutron TIPs

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* $\varepsilon_i^{(k)} = 100 \cdot \left(GT_i - TIP_i\right) / TIP_i$

** GT readings have been converted to equivalent fission detector readings.

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* $\varepsilon_i^{(k)} = 100 \cdot \left(GT_i - TIP_i \right) / \, TIP_i$

** GT readings have been converted to equivalent fission detector readings.

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* $\delta_i = 100 \cdot \left(GT_i \,/\, \frac{1}{9}\sum_{j=1}^{9} GT_j - TIP_i \,/\, \frac{1}{9}\sum_{j=1}^{9} TIP_j \right)$

** GT readings have been converted to equivalent fission detector readings.

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* $\delta_i = 100 \cdot \left(GT_i / \frac{1}{9}\sum_{j=1}^{9} GT_j - TIP_i / \frac{1}{9}\sum_{j=1}^{9} TIP_j \right)$

** GT readings have been converted to equivalent fission detector readings.

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* $\delta_i = 100 \cdot \left(P4B_i^{GT} / \frac{1}{9}\sum_{j=1}^{9} P4B_j^{GT} - P4B_i^{TIP} / \frac{1}{9}\sum_{j=1}^{9} P4B_j^{TIP} \right)$

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* $$\delta_i = 100 \cdot \left(P4B_i^{GT} \Big/ \frac{1}{9}\sum_{j=1}^{9} P4B_j^{GT} - P4B_i^{TIP} \Big/ \frac{1}{9}\sum_{j=1}^{9} P4B_j^{TIP} \right)$$

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* $RMS^{(k)} = \sqrt{\frac{1}{18}\sum_{i=1}^{18}\delta_i^{(k)2}}$

** GT readings have been converted to equivalent fission detector readings.

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7.2.5.2 Comparison with LPRMs

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7.2.6 Response During Transients

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7.2.6.1 Response During Startup

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7.2.6.2 Response to Flow Change

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7.2.6.3 Response to Control Rod Movement

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7.2.6.4 Response During Power Down

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7.3 Kashiwazaki-Kariwa 5 In-Plant Test

The Kashiwazaki-Kariwa 5 plant is an 1100 MWe BWR5 operated by Tokyo Electric Power Company. The core has 764 bundles arranged in a "C" lattice configuration. The TIP system is neutron sensitive and has 43 calibration tubes and associated LPRM strings.

The research reported here was sponsored jointly by Tokyo Electric Power Company, Tohoku Electric Power Company, Chubu Electric Power Company, Hokuriku Electric Power Company, The Chugoku Electric Power Company, The Japan Atomic Power Company, Toshiba Corporation, Hitachi, Ltd. and Global Nuclear Fuel – Japan (see reference 4).

7.3.1 Test Plan

The test plan was to install 8 LPRM/GT assemblies (4 each from two separate suppliers) into an octant of the core. A comprehensive core monitoring study would therefore be possible, subject only to the condition of octant symmetry. Standard TIP calibration tubes were installed in the LPRM/GT assemblies so that normal TIP set measurements could be taken.

In order to assess the accuracy of core monitoring with GT readings, a bundle gamma scan was to be performed at the end of one cycle of operation. The scan was to include all of the bundles in the octant of the core as well as three additional bundles chosen so that all four bundles around each LPRM/GT assembly were included.

In addition, comparisons of core monitoring results between the GT and the neutron TIP systems were to be made throughout the cycle.

The LPRM/GT assemblies were to have nine sensors each, arranged in a manner similar to the Tokai 2 In-Plant test. The core locations for the assemblies are shown in [[.

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7.3.2 Test Results

The gamma scan measured the strong photo peak of ^{140}La the short-lived daughter of the common fission product ^{140}Ba. Measurements were taken at 17 axial locations, generally every six inches, but excluding nodes obscured by spacers and excluding the top and bottom nodes. The ^{140}Ba distribution was calculated by an off-line core monitoring system throughout the cycle on a timeinterval of every 3 days. TIP adaptive core monitoring calculations were made 36 times during the cycle for the standard simulation. An equal number of GT adaptive calculations were made for the GT core monitoring simulation. Data were available only for seven of the eight GT assemblies[2], but this did not significantly detract from the results of the study.

The results showed very good agreement between the calculated and measured ^{140}Ba distributions for both the GT adaptive monitoring and the TIP adaptive monitoring. Table 7-18 shows the RMS differences between the calculated and measured distributions as measured for the 1D (axial) distribution, for the 2D (bundle) radial distribution and for the 3D (nodal) distribution.

Table 7-18, RMS Differences between Calculated and Measured ^{140}Ba Distributions

Distribution	n TIP vs. γ Scan	GT vs. γ Scan
1D (axial)	1.7%	2.1%
2D (bundle)	2.5%	2.3%
3D (nodal)	3.9%	4.1%

In addition to the gamma scan studies, comparisons were also made between the thermal limits calculated by the two core monitors. The RMS difference for the whole cycle between the MCPR calculated by the GT core monitor and the MCPR calculated by the neutron TIP monitor was 0.008. The maximum difference was 0.02.

Similarly, the RMS difference between the MLHGR calculated by the GT core monitor and the MLHGR calculated by the neutron TIP was 0.4 KW/m and the maximum difference was 1 KW/m.

7.3.3 Conclusions

The comparison with the gamma scan established that core monitoring based on GTs is nearly equivalent in accuracy to core monitoring with neutron TIPs. In addition, it was shown that the thermal limits, MCPR and MLHGR, evaluated by the two core monitoring systems were very similar throughout the cycle.

The overall conclusion was that the GT system is "practical as a substitute" for the TIP system.

[2] According to a personal communication, one of the assemblies planned for the test experienced a failure that affected all nine sensors in the assembly. Modern core monitors such as 3DMonicore are tolerant of this type of fault and are able to produce accurate results with several assemblies out of service.

8. ADAPTIVE CORE MONITORING SIMULATION

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8.1 Power Distribution Comparison

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8.2 Thermal Limit Comparison

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* In terms of delta CPR, this value is –0.030 with a standard deviation of 0.022 and a standard error of 0.002.

9. UNCERTAINTY ANALYSIS

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9.1 GT Sensor Accuracy

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4 A "meter unit" is 1% of the average peak APLHGR (highest of the eight values surrounding an LPRM) divided by LIMHGR (ex., 12.0 KW/ft) and the fraction of rated power. The value of a meter unit changes slightly with each monitoring case. As a practical matter, the value of one meter unit for the last monitoring case for Tokai 2 at the end of cycle 17 was determined by dividing the core average power density by the average LPRM reading in meter units: 46.02 KW/l / 51.13 meter units = 0.900 KW/l.

5 59.3 meter units * (46.02 KW/l / 51.13 meter units) = 53.4 KW/l

6 Includes neutron and gamma detector correlation errors.

7 When delayed gamma compensation is used.

9.2 GT Calibration Accuracy

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9.2.1 Interval Between Calibrations

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* $\sigma = ½\ 0.5\%\ 6mV/3.46mV$

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9.3 GT Adaptive Core Monitoring Accuracy

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9.3.1 GT Nodal Power Uncertainty

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9.3.2 GT CPR Bias

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9.3.3 GT LHGR Bias

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9.4 Estimated Bundle Power Uncertainty

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* Estimate based on two GT strings: additional data is required for application.

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10. CONCLUSIONS

The Gamma Thermometer System has been successfully evaluated as a replacement for the TIP system by a comprehensive In-Plant Test Program. The primary objectives of the Test Program have been met:

1. GT sensor accuracy relative to gamma TIP, neutron TIP and LPRM measurements has been evaluated; and

2. GT sensor reliability under BWR operating conditions has been established.

The GT sensitivity trends have been followed throughout a total of three cycles of operation at two BWRs. The sensitivity trend in the most recent test consisted of a relatively rapid initial rise during the first 500 hours of operation, followed by a slow decline for the rest of the cycle.

The GT response in the steady state has been compared with gamma TIP and neutron TIP response as well as the LPRM response. The GT response during changing conditions (startup, flow change, control blade change and power down) has been compared with the LPRM response. Additionally, a GT adaptive core monitoring study has been performed to compare nodal power, CPR and LHGR with corresponding results from neutron TIP adaption.

The GT sensors were evaluated for accuracy with a combination of factory, in-plant and core monitoring tests:

1. The factory tests proved that the GT sensors met all of the requirements of the SRS.

2. The in-plant tests proved the accuracy, linearity and range of the GT sensors with respect to the TIPs and LPRMs.

3. The core monitoring accuracy tests, including nodal power, CPR and LHGR, ascertained GT core monitoring accuracy with respect to neutron TIP monitoring. In addition, core monitoring simulations determined the minimal loss of accuracy in a GT system due to the limited number of readings in the axial direction, as opposed to the nodal data provided by a TIP system.

The overall conclusion of the GT in-plant test program is:

The GT system can be used in place of a TIP system for both LPRM calibration and power shape monitoring.

REFERENCES

1. R.H. Leyse, R.D. Smith: "Gamma Thermometer Developments for Light Water Reactors," IEEE Transactions on Nuclear Science, Vol.N5.26, No. 1, February 1979, pp. 934–943.

2. F. Loisy, M. Huver, M. Janvier: "Technology and Use of Gamma Thermometers," Specialist Meeting on In-Core Instrument Proceedings, France, June 1988.

3. "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999.

4. H. Shiraga, et al., "Verification of Core Monitoring System with Gamma Thermometer," International Conference on Global Environment and Advanced Nuclear Power Plants, GENES4/ANP2003, Sep. 15-19, 2003, Kyoto, Japan.

MFN 07-500

Enclosure 3

Affidavit

GE-Hitachi Nuclear Energy, LLC

AFFIDAVIT

I, David H. Hinds, state as follows:

(1) I am the General Manager, New Units Engineering, GE-Hitachi Nuclear Energy Americas LLC (GEH) have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GEH letter MFN 07-500, Mr. James C. Kinsey to U.S. Nuclear Regulatory Commission, entitled *Licensing Topical Report NEDE-33197P, Revision 1, Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring.* The proprietary information in Enclosure 1, which is entitled *GEH Nuclear Energy, "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring," NEDE-33197P, September 2007 – Proprietary Version* is delineated by a [[dotted underline inside double square brackets.[3]]]. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation [3] refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.790(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, <u>Critical Mass Energy Project v. Nuclear Regulatory Commission,</u> 975F2d871 (DC Cir. 1992), and <u>Public Citizen Health Research Group v. FDA</u>, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH competitors without license from GEH constitutes a competitive economic advantage over other companies;
b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a, and (4)b, above.

(5) To address 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements, which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GEH is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it identifies detailed GEH ESBWR methods, techniques, information, procedures, and assumptions related to its gamma thermometer system. The information is consistent in its scope of application with information in NEDE-33197P, Revision 0, September 2005, Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring, which is maintained as proprietary.

The development of the evaluation process along with the interpretation and application of the regulatory guidance is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 27th day of September 2007.

David H. Hinds
GE-Hitachi Nuclear Energy Americas LLC

MFN 07-500

Enclosure 4

DCD Tier 2 Changes to Reflect NEDE-33197P, Revision 1

7.7.9 References

7.7-1 GE-Hitachi Nuclear Energy, "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring," NEDE-33197P, Class III (Proprietary); and "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring," NEDO-33197, Class I (Non-proprietary) September 2007.