ATTACHMENT 3

GE-HITACHI NUCLEAR ENERGY AMERICAS LLC, NEDO-33636, NINE MILE POINT NUCLEAR STATION - UNIT 2 FUEL STORAGE CRITICALITY SAFETY ANALYSIS OF NEW FUEL STORAGE RACKS – GE14 (NON-PROPRIETARY)

Certain information, considered proprietary by GE-Hitachi Nuclear Energy Americas LLC, has been deleted from this Attachment.

Nine Mile Point Nuclear Station, LLC
March 23, 2011

HITACHI GE Hitachi Nuclear Energy

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NINE MILE POINT NUCLEAR STATION - UNIT 2
FUEL STORAGE CRITICALITY SAFETY ANALYSIS
OF
NEW FUEL STORAGE RACKS – GE14

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IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

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Revision Status

Revision Number	Date	Description of Change
0	March 2011	Initial edition

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1.0 INTRODUCTION

This report describes the criticality analyses and results for the Nine Mile Point Nuclear Station, Unit 2 (NMP2) new fuel storage racks. It includes sufficient detail on the methodology and analytical models utilized in the criticality analysis to verify that the storage rack systems have been accurately and conservatively represented.

The racks are analyzed using the MCNP-05P Monte Carlo neutron transport program and the k_∞ criterion methodology. A beginning-of-life (BOL) cold, uncontrolled, in-core eigenvalue (k_∞) of 1.34 as defined by the lattice physics code TGBLA06A is specified as the rack design limit for GE14 fuel in the NMP2 new fuel racks. As demonstrated in Table 1, the analyses result in a storage rack maximum k-effective (K(95/95)) less than 0.95 for normal and credible abnormal operation with tolerances and uncertainties taken into account.

Table 1 – Summary K-95/95 Results

Region	$K_{max(95/95)}$
New Fuel Rack	0.87697

2.0 REQUIREMENTS

Title 10 of the Code of Federal Regulations (10 CFR) Part 50 defines the requirements for the prevention of criticality in fuel storage and handling at Nuclear Power Plants. The regulations require that the storage rack eigenvalue for both the new and spent fuel storage racks be demonstrated to be ≤ 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account. Reference 1 outlines the standards that must be met for these analyses.

3.0 METHOD OF ANALYSIS

In this evaluation, in-core k_∞ values and pin-by-pin isotopic specifications are generated using the GEH/GNF lattice physics production code TGBLA06A. TGBLA06A solves 2D diffusion equations with diffusion parameters corrected by transport theory to provide system multiplication factors and perform burnup calculations.

The fuel storage criticality calculations are then performed using MCNP-05P, the GEH/GNF Proprietary version of MCNP5 (Reference 2). MCNP-05P is a Monte Carlo program for solving the neutron transport equation for a fixed source or an eigenvalue problem. The code implements the Monte Carlo process for neutron, photon, or electron transport or coupled transport involving all these particles, and can compute the eigenvalue for neutron-multiplying systems. For the present application, only neutron transport was considered.

3.1 Cross Sections

TGBLA06A uses ENDF/B-V cross-section data to perform coarse-mesh, broad-group, diffusion theory calculations. It includes thermal neutron scattering with hydrogen using an $S(\alpha,\beta)$ light water thermal scattering kernel.

MCNP-05P uses point-wise (i.e., continuous) cross section data, and all reactions in a given cross section evaluation (e.g., ENDF/B-VII.0) are considered. For the present work, thermal neutron scattering with hydrogen was described using an $S(\alpha,\beta)$ light water thermal scattering kernel. The cross section tables include all details of the ENDF representations for neutron data. The code requires that all the cross sections be given on a single union energy grid suitable for linear interpolation; however, the cross section energy grid varies from isotope to isotope. The libraries include very little data thinning and utilize resonance integral reconstruction error tolerances of 0.001%.

3.2 Geometry Treatment

TGBLA06A is a two-dimensional lattice design computer program for BWR fuel bundle analysis. It assumes that a lattice is uniform and infinitely long along the axial direction and that the lattice geometry and material are reflecting with respect to the lattice boundary along the transverse directions.

MCNP-05P implements a robust geometry representation that can correctly model complex components in three dimensions. An arbitrary three-dimensional configuration is treated as geometric cells bounded by first and second-degree surfaces and some special fourth-degree elliptical tori. The cells are described in a Cartesian coordinate system and are defined by the intersections, unions and complements of the regions bounded by the surfaces. Surfaces are defined by supplying coefficients to the analytic surface equations or, for certain types of surfaces, known points on the surfaces. Rather than combining several pre-defined geometrical bodies in a combinatorial geometry scheme, MCNP-05P has the flexibility of defining geometrical shapes from all the first and second-degree surfaces of analytical geometry and elliptical tori and then combining them with Boolean operators. The code performs extensive checking for geometry errors and provides a plotting feature for examining the geometry and material assignments.

3.3 Validation and Computational Basis

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Table 2 – Summary of the Critical Benchmark Experiments

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Table 3 – Area of Applicability Covered by Code Validation

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An additional uncertainty is also added to the fuel rack studies related to eigenvalue calculations performed using TGBLA06A. [[

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3.4 In-Core K_∞ Methodology

The design of the fuel storage racks provides for a subcritical multiplication factor for both normal and credible abnormal storage conditions. In all cases, the storage rack eigenvalue must be ≤ 0.95 (Reference 1). To demonstrate compliance with this limit, the in-core k_∞ method is utilized.

The in-core k_∞ criterion method relies on a well-characterized relationship between infinite lattice k_∞ (in-core) for a given fuel design and a specific fuel storage rack k_∞ (in-rack) containing that fuel. The use of an infinite lattice k_∞ criterion for demonstrating compliance to fuel storage criticality criteria has previously been used for all GE-supplied storage racks, including racks of the NMP2 design.

The analysis performed to calculate the lattice k_∞ to confirm compliance with the above criterion uses the NRC-approved lattice physics methods encoded into the TGBLA06A Engineering Computer Program (ECP). One of the outputs of TGBLA06A solution is the lattice k_∞ of a specific nuclear design for a given set of input state parameters (void fraction, control state, fuel temperature, etc.).

Compliance of GE14 fuel with specified k_∞ limits will be confirmed for each lattice as part of the bundle design process. Documentation that this has been met will be contained in the fuel design information report, which defines the maximum lattice k_∞ for each bundle nuclear design. The process for validating that specific assembly designs are acceptable for storage in the NMP2 new fuel storage racks is provided below.

1. [[

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3.5 Definitions

<u>Fuel Assembly</u> – is a complete fuel unit consisting of a basic fuel rod structure that may include large central water rods. Several shorter rods may be included in the assembly. These are called "part length rods". A fuel assembly includes the fuel channel.
<u>Gadolinia</u> – The compound Gd2O3. The gadolinium content in integral burnable absorber fuel rods is usually expressed in weight percentage Gadolinia.
<u>Lattice</u> – An axial zone of a fuel assembly within which the nuclear characteristics of the individual rods are unchanged.
<u>Dominant Lattice</u> – An axial zone of a fuel assembly typically located in the bottom half of the bundle within which all possible fuel rod locations for a given fuel design are occupied.
<u>Vanished Lattice</u> – An axial zone of a fuel assembly typically in the upper half of the bundle within which a number of possible fuel rod locations are unoccupied.
<u>Rack Efficiency</u> – the ratio of a particular lattice statepoint in-rack eigenvalue (k_∞) to its associated lattice nominal in-core eigenvalue (k_∞). This value allows for a straightforward comparison of a rack's criticality response to varying lattice designs within a particular fuel product line. A lower rack efficiency implies increased reactivity suppression capability relative to an alternate design with a higher rack efficiency.
<u>Design Basis Lattice</u> – The lattice geometry, exposure history, and corresponding fuel isotopics for a fuel product line that result in the highest rack efficiency in a sensitivity study of reasonable fuel parameters at the desired in-core reactivity. This lattice is used for all normal, abnormal, and tolerance evaluations in the fuel rack analysis.

3.6 Assumptions and Conservatisms

The fuel storage rack criticality calculations are performed with the following assumptions to ensure the true system reactivity is always less than the calculated reactivity:

- [[

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4.0 FUEL DESIGN BASIS

Criticality safety analyses to determine storage system reactivity are performed using the GE14 fuel design.

4.1 GE14 Fuel Description

The GE14 fuel lattice configuration is a 10x10 fuel rod array minus eight fuel rods that have been replaced with two large water rods, as shown in Figure 1 with corresponding dimensions in Table 4. [[

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Figure 1 - GE14 Fuel Lattice Configuration

Table 4 - Nominal Dimensions for GE14 Fuel Lattice

Features	Ref.	(mm)	(inches)
[[			
			]]

[[

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4.2 Fuel Model Description

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Figure 2 – GE14 Lattice in MCNP-05P

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]] The lattice type and fuel loading that results in the worst-case rack efficiency for an in-core k_∞ greater than the proposed limit is then used to define the design basis lattice. This lattice is assumed to be stored in every location in the rack being analyzed. Details on the determination of the design basis lattice using the process outlined above is presented in Section 5.3.

5.0 CRITICALITY ANALYSIS OF NEW FUEL STORAGE RACKS

5.1 Description of New Fuel Storage Racks

The new fuel storage vault contains 27 sets of castings which may contain up to 10 fresh fuel assemblies each. There are three tiers of castings in each set which are positioned by fixed box beams. The castings are made of aluminum and support the assemblies in a vertical position. The lower casting supports the weight of the fuel assembly and restricts lateral movement; the center and top casting restricts lateral movement only. The assemblies are maintained in the castings with a nominal center-to-center spacing within the rack module of 7 inches. The nominal center-to-center spacing between racks is 12.25 inches. The loaded assemblies can be channeled or unchanneled. Fuel assembly placement between rows is not possible.

Figure 3 provides a 3D representation of one row of storage locations in the new fuel vault.

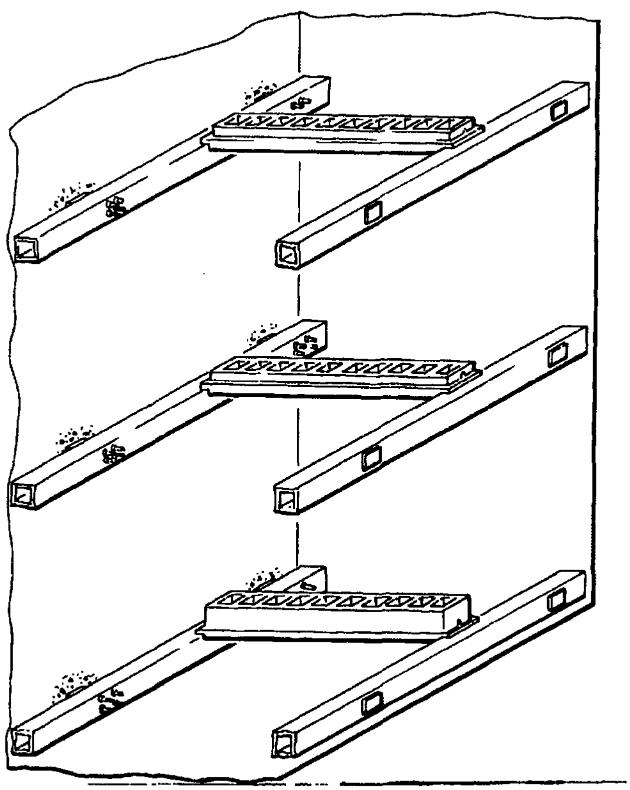

Figure 3 – 3D Representation of New Fuel Storage Rack Module

5.2 New Fuel Storage Rack Model

A two-dimensional, infinite model has been defined to conservatively describe the new fuel rack storage system in MCNP-05P. The model contains no rack structural materials to conservatively limit the number of neutron absorptions by non-fuel components in the system. An image of a single storage element of the new fuel rack is provided in Table 4.

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Figure 4 – Single New Fuel Rack Element

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]] This array, based on nominal dimensions, is used to define the design basis lattice. Sensitivity studies are also performed on this array to determine the most reactive normal configuration.

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Figure 5 – New Fuel Rack Module

5.3 Design Basis Lattice Selection

Table 5 defines the lattice designs that were explicitly studied in the new fuel storage rack to determine the effect of geometric configuration and isotopic composition on rack efficiency. These lattices were selected by examining different fuel loadings using the process outlined in Section 4.2. [[

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Table 5 – Design Basis Bundle Candidates Studied in the New Fuel Rack

Case	Lattice Type	Average Lattice Enrichment	Number of Gad Rods	Gad Enrichment (%)	Exposure (GWd/ST)	TGBLA06A Defined In-Core k_∞	MCNP-05P defined In-Rack k_∞	Rack Efficiency
[[								
								]]

5.4 Normal Configuration Analysis

5.4.1 Analytical Models

The most reactive normal configuration was determined by studying the reactivity impact of the following credible normal scenarios:

- [[

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5.4.2 Results

The results of the study are provided in Table 6. [[

]] This configuration will be used for all abnormal and tolerance studies.

Table 6 – New Fuel Storage Rack Normal Configuration In-Rack K_∞ Results

Configuration	In-Rack k_∞	Error (1σ)
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5.5 Accident/Abnormal Configuration Analysis

5.5.1 Analytic Models

The following abnormal configurations were explicitly considered for the new fuel rack:

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The following additional abnormal configurations are considered bounded by the analyses in Section 5.4, with the justification provided:

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5.5.2 Results

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5.6 Tolerance Analysis

5.6.1 Analytic Models

The following tolerance study configurations were explicitly considered for the new fuel rack:

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[[ ]] The models developed for these studies were all based off the limiting normal configuration presented in Section 5.4.

5.6.2 Results

The results of the tolerance studies are provided in Table 7. [[

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[[(1)
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Table 7 – New Fuel Storage Rack Tolerance Configuration ΔK Results

Term	Description	K_{eff}	Error (1σ)	ΔK	ΔK Uncertainty (2σ)
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					]]

5.7 Uncertainty Values

The total contribution to the maximum K(95/95) of the new fuel rack from problem and code specific uncertainties is found to be [[ ]]

[[ ]] (2)

Table 8 – New Fuel Storage Rack Uncertainty ΔK Values

Term	Description	Value
[[		
		]]

5.8 Maximum Reactivity

The maximum reactivity of the new fuel rack, considering all biases, tolerances, and uncertainties, is calculated to be **0.87697** using Equation 3 and the values in Table 9.

[[ ]] (3)

Table 9 – New Fuel Storage Rack Results Summary

Term	Value
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$\Delta K_{max(95/95)}$	0.87697

6.0 CONCLUSIONS

The NMP2 new fuel racks have been analyzed for the storage of GE14 fuel using the MCNP-05P Monte Carlo neutron transport program and the k_∞ criterion methodology. A maximum cold, uncontrolled BOL in-core eigenvalue (k_∞) of 1.34 as defined by TGBLA06A is specified as the rack design limit for GE14 fuel in the new fuel racks. The analysis resulted in a storage rack maximum k-effective (K(95/95)) less than 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account.

7.0 REFERENCES

1. US NRC Standard Review Plan (SRP) 9.1.1 "Criticality Safety of Fresh and Spent Fuel Storage and Handling," Revision 3, March 2007.
2. LA-UR-03-1987, 'MCNP – A General Monte Carlo N-Particle Transport Code, Version 5', April 2003.
3. NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology". USNRC, January 2001.

APPENDIX A - MCNP-05P CODE VALIDATION

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Table A-1 - MCNP-05P Results for the Benchmark Calculations

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Figure A-1 shows the bias results of Table A-1 when all the results are treated as a single population. The top plot in the figure is a histogram plot of the results with an overlaying Normal curve fit. The resulting P-value of this Normal curve fit is 0.341 thus the data passes the normality tests (P-value>0.05). The remaining plots and data in Figure A-1 show the simple mean, median, and sample standard deviation of this data, and their corresponding 95% confidence intervals.

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Figure A-1 - Statistical Analysis of the Benchmark Results

In order to account for the uncertainty in the experimental values, the weighted sample mean and standard deviation were calculated using the following equations:

$$B = Benchmark - MCNP05P$$

$$\overline{B} = \frac{\sum_{i=1}^{n} \frac{B_i}{\sigma_i^2}}{\sum_{i=1}^{n} \frac{1}{\sigma_i^2}}$$

$$S_P = \sqrt{s^2 + \overline{\sigma}^2}$$

$$\overline{\sigma}^2 = \frac{n}{\sum_{i=1}^{n} \frac{1}{\sigma_i^2}}$$

$$s^2 = \frac{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n} \frac{1}{\sigma_i^2}\left(B_i - \overline{B}\right)^2}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{\sigma_i^2}}$$

Where:
$\overline{B}$ = Average weighted bias
σ_i = Uncertainty in bias Bi
S_P = Pooled standard deviation
s^2 = Variance about the mean
$\overline{\sigma}^2$ = Average total variance
n = number of data points (=96)

Table A-2 summarizes the results of these calculations.

Using the average weighted bias and pooled standard deviation; the upper one-sided 95/95-tolerance limit was calculated for use in criticality calculations. [[

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Table A-2 - Bias and Bias Uncertainty for MCNP-05P with ENDF/B-VII

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[[ ]]

Table A-3 - Recommended Bias and Bias Uncertainty in Criticality Analyses for MCNP-05P with ENDF/B-VII

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[[ ]]

ATTACHMENT 4

GE-HITACHI NUCLEAR ENERGY AMERICAS LLC
AFFIDAVIT JUSTIFYING WITHHOLDING
PROPRIETARY INFORMATION

Nine Mile Point Nuclear Station, LLC
March 23, 2011

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, James F. Harrison, state as follows:

(1) I am Vice President, Fuel Licensing, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and 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 GEH proprietary report NEDC-33636P, "Nine Mile Point Nuclear Station - Unit 2 Fuel Storage Criticality Safety Analysis of New Fuel Storage Racks – GE14," Revision 0, dated March 2011. GEH proprietary information in NEDC-33636P is identified by a dark red dotted underline inside double square brackets, [[This sentence is an example.{3}]]. Figure and large equation objects containing GEH proprietary information 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 or licensee, 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 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that 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's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

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

d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(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, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited to 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 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 and/or confidentiality agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains details of the nuclear fuel criticality licensing methodology for the GEH Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results 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 and obtaining 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 9th day of March 2011.

James F. Harrison
Vice President, Fuels Licensing
Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
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