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LICENSING TOPICAL REPORT

GEH ESBWR SETPOINT METHODOLOGY

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1. INTRODUCTION

1.1 SCOPE AND PURPOSE

The purpose of this document is to establish the requirements and methodologies for determining and maintaining all safety-related automatic protective device settings as well as all automatic protective device settings having significant safety functions that meet the requirements of 10 CFR 50.36(c)(1) for Technical Specification required limiting safety system settings. The scope of the methodology described in this document is restricted solely to the GEH ESBWR.

2. APPLICABLE DOCUMENTS

2.1 CODES AND STANDARDS

1. The Instrumentation, Systems and Automation Society, ISA-S67.04.01, "Setpoints for Nuclear Safety Related Instrumentation," 2006.
2. U. S. Nuclear Regulatory Commission, Regulatory Guide (Reg. Guide) 1.105, Revision 3, "Instrument Setpoints for Safety Related Systems".

2.2 OTHER DOCUMENTS

1. U. S. Nuclear Regulatory Commission, NUREG-0800, Appendix 7-A, Branch Technical Position HICB-12, "Guidance on Establishing and Maintaining Instrument Setpoints," Revision 4, June 1997.
2. (Deleted)
3. The Instrumentation, Systems and Automation Society, ISA-RP67.04.02-2000 "Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation," 2000.
4. American National Standards Institute / National Conference of Standards Laboratories, ANSI/NCSL Z540-1-1994 (R 2002) "Calibration Laboratories & Measuring & Test Equipment – General Requirements," August 1, 1994.
5. GE Hitachi Nuclear Energy, ESBWR Design Control Document, Tier 2, Chapter 14, Initial Test Program, 26A6642BN, Revision 6, August 2009.
6. (Deleted)
7. U. S. Nuclear Regulatory Commission, Regulatory Issue Summary (RIS) 2006-17, "NRC Staff Position on the Requirements of 10 CFR 50.36, "Technical Specifications," Regarding Limiting Safety System Settings During Periodic Testing and Calibration of Instrument Channels," August 24, 2006.
8. U. S. Nuclear Regulatory Commission, Regulatory Issue Summary 2005-20, Revision to Guidance Formerly Contained in NRC Generic Letter 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability," September 26, 2005.
9. Letter MFN-09-692, Dennis Galvin (NRC) to Jerald G. Head (GEH), "Request for Additional Information Letter No. 387 Related to ESBWR Design Certification Application," October 30, 2009, containing enclosure from Oak Ridge National Laboratory, "TER for GE-Hitachi's Setpoint Methodology NEDE-33304P".

3. DEFINITIONS

Definitions of ISA-S67.04.01-2006 (Ref. 2.1.1) apply where specified.

Accuracy. Closeness of the agreement between the result of a measurement (value attributed to a measured parameter) and a true value of the measured parameter.

Allowable Value (AV). The limiting value of the sensed process variable at which the trip setpoint may be found, where that as-found condition continues to provide adequate assurance that the analytical limit remains protected.

Analytical Limit (AL). Limit of a measured or calculated variable established by the safety analysis to ensure that a safety limit is not exceeded. (ISA-S67.04.01-2006)

As Found Tolerance (AFT). Procedural tolerance zone that exists around the Nominal Trip Setpoint ($NTSP_F$). This tolerance ensures that channel operation is consistent with the assumptions or design inputs used in the setpoint calculations and that there is a high confidence in future acceptable channel performance.

As-Found Value. The instrument channel trip setting value measured during the subsequent performance of the calibration before making any adjustment to the instrument channel that could change the trip setting value.

As Left Tolerance (ALT). Procedural tolerance zone or allowable range of as-left instrument measurements or setpoints. This is also equal to the zone within which the instrument does not have to be recalibrated, or the setpoint does not have to be reset.

As-Left Value. The instrument channel trip setting value at which the channel is set at the completion of the calibration with no additional adjustment of the instrument channel.

Calibration Environment. The environmental conditions expected during instrument calibration.

Channel Calibration Error (C_L). Measurement error of the complete instrument channel introduced by the calibrating equipment used to calibrate the process instrument loop, and allowances for errors introduced by the as-left tolerance in the calibration procedures.

Channel Instrument Accuracy (A_L). Measurement error of the complete instrument channel with respect to an acceptable standard or reference. The value specified is the requirement for the combined uncertainties of the complete instrument channel used to monitor the process variable and/or to provide the trip functions. The channel instrument accuracy includes the combined linearity, hysteresis and repeatability errors of all the devices in the instrument channel. The accuracy of each individual component in the channel is the degree of conformity of the indicated value of that instrument to the value of a recognized and acceptable standard or reference device that is used to calibrate the device. The accuracy under trip conditions used for AV and LTSP calculations is designated as A_{LT}, and the accuracy under calibration conditions used for AFT calculations is designated as A_{LC}. [[

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Channel Instrument Drift (D_L). Change, unrelated to input, environment or load, in the sensor or instrument channel output of the process variable at which the trip action will actually occur, between the time the nominal trip setpoint is calibrated and the subsequent channel calibration.

Channel instrument drift is a variable considered to be independent from channel calibration error and channel instrument accuracy, unless otherwise determined from plant historical data.

Design Basis Event (DBE). The limiting Anticipated Operational Occurrence (AOO) or an accident, which is analyzed using the analytical limit value for the setpoint to determine the bounding value of a process variable.

Design Limit (DL). The engineering limit or a measured or calculated variable established based on equipment protection or other design base criteria and does not specifically include margin for measurement errors.

Error. The difference between the indication and the ideal value of the measured signal. Errors may be random or systematic (bias, with a displacement from a true value).

Harsh Environment. [[

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Instrument Channel. An arrangement of components (e.g., transmitters, trip units, etc.) as required to generate a single protective signal. Unless otherwise stated, it is assumed that the instrument channel is the same as the entire instrument loop.

Instrument Response Time. Delay in the actuation of a trip function following the time when a measured process variable reaches the actual trip setpoint due to time response characteristics of the instrument channel. Time response requirement is typically determined by instrument characteristics and assumed in the modeling. Time response is not explicitly included in the establishing the instrument setpoint value.

Licensee Event Report (LER). A Licensee Event Report (LER) is filed with the NRC by the holder of an operating license whenever the conditions of 10 CFR 50.73 are met.

Limiting Safety System Settings (LSSS). Limiting safety system settings for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting must be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. (ISA-S67.04.01-2006)

Limiting Trip Setpoint (LTSP). The limiting value for the nominal trip setpoint that ensures the trip or actuation occurs before the AL is reached (see Subsection 4.2.2 for discussion of the uncertainty limits), regardless of the process or environmental conditions affecting the instrumentation.

Based on the definitions, the limiting trip setpoint (LTSP) is interchangeable with the first nominal trip setpoint term ($NTSP_1$) with the required minimum margin to the AL.

Modeling Accuracy. Combination of independent and systematic errors attributed to (typically) a computer model that may be used in safety analysis to predict responses of a plant process or safety variable to postulated plant conditions. Modeling accuracy may consist of modeling bias and/or modeling variability. Modeling bias (B_m) is the result of comparisons of the model to actual plant test data, or other more realistic models when extended to a design basis event, and account for whether conservative or non-conservative methods are used.

Nominal Trip Setpoint (NTSP). A predetermined value for actuation of a final setpoint device to initiate a protective action. (ISA-S67.04.01-2006)

There are three nominal trip setpoints (NTSP) used in GEH methodology. The first nominal trip setpoint is the limiting trip setpoint defined as $NTSP_1$ (and LTSP) in GEH methodology, and is a calculated value. This is the setpoint whose margin to the Analytical Limit (AL) contains all the loop errors [[ ]]. The margin between the AL and $NTSP_1$ is the minimum margin required for safety setpoints. The second nominal trip setpoint $NTSP_2$ is a calculated value with margin to the Allowable Value which accounts for the maximum as-found tolerance as defined in RIS 2006-17. The final nominal trip setpoint ($NTSP_F$) is the actual instrument setting. The $NTSP_F$ trip setpoint value is determined with appropriate margin to the AV for plant operations. $NTSP_F$ must be equal to or more conservative than the LTSP between $NTSP_1$ and $NTSP_2$. The three NTSP values ($NTSP_1$, $NTSP_2$, $NTSP_F$ cannot be less conservative than the Allowable Value.

Normal Environment. The environmental conditions expected during normal plant operation.

Primary Element Accuracy (PEA). Measurement error of a primary element (excluding associated transmitter) that is in contact with a process resulting in some form of interaction. As an example, in an orifice meter, the orifice plate, the adjacent parts of the pipe and the pressure connection comprise the primary element.

Process Measurement Accuracy (PMA). Measurement error due to process effects upon the process variable measurement (e.g., fluid density changes) aside from the primary element and transmitter. It is commonly a bias term (systematic error).

Safety Limit (SL). A limit of an important process variable that is necessary to reasonably protect the integrity of physical barriers that guard against the uncontrolled release of radioactivity. [10 CFR 50.36 (c)(1)(i)(A)].

For Anticipated Operational Occurrences the safety limits are defined in the Technical Specifications. For Special Events and Accidents (which use appropriately selected criteria, (e.g., upset, emergency, etc.) the safety limits are in the safety analyses.

Sensor. The portion of an instrument channel that responds to changes in a plant variable or condition and converts the measured process variable into an electrical signal. A transmitter is equivalent to a sensor.

Steady-State Operating Value. The maximum or minimum value of the process variable anticipated during normal steady-state operation.

Trip Environment. [[

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Trip Module (TM). The portion of the instrument channel that compares the converted process value of the sensor to the trip value and produces a trip signal. The trip module may be digital or analog.

Uncertainty. The amount to which an instrument channel's output is in doubt (or the allowance made for such doubt) due to possible errors, either random or systematic. The uncertainty is generally identified within a probability and confidence level. (See Subsection 4.2.2) (ISA-S67.04.01-2006)

4. SETPOINT METHODOLOGY

One of the primary purposes of instrument setpoint methodology is to establish the basis and criteria for evaluating channel operability as required by the plant Technical Specifications for those instruments having Technical Specification required settings. Various NRC guidance documents address determination of operability [e.g., RG 1.105 (Ref. 2.1.2), RIS 2006-17 (Ref. 2.2.7) and RIS 2005-20 (Ref. 2.2.8)]. The full scope of this determination is not entirely within the scope of this report. However, since operability involves determining whether an instrument is functioning as required to protect its specified safety function as assumed in the plant design basis, the GEH setpoint methodology supports the determination of operability by providing for:

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4.1 SCOPE

The most important setpoints are associated with those functions that are utilized directly or indirectly in the plant safety analyses, and the highest importance is provided to those setpoints that protect the safety limits. These functions are listed in the plant Technical Specifications. Additional types of important instruments are also listed in the Technical Specifications. These setpoint calculations should consider all errors presented in Computational Method (Section 4.2). Additionally, the scope of this document addresses all safety-related automatic protective device settings.

Abbreviated or less rigorous setpoint calculations, or instrument uncertainty analyses, which are not within the scope of this document, may be performed for other functions, such as:

- Instruments, without an automatic protective device setting, used in support of safety-related equipment
- Instruments that are important to plant operation
- Instruments which protect major pieces of equipment against significant damage
- Instruments that provide important alarm indications for post-accident monitoring

- Instrument setpoints whose failure/improper setting could result in personnel or safety hazards. (Examples of these functions are turbine building service water pump protection and automatic trips of the turbine generator).

4.1.1 Group A

Group A includes automatic Instrumentation and Control (I&C) functions that are Limiting Safety System Settings (LSSS) as defined by 10 CFR 50.36. This will include automatic Reactor Protection System (RPS) and Engineered Safety Features (ESF) actuation functions, on which reliance is placed for the achievement or maintenance of safety-related plant functions. They are associated with an established Analytical Limit. These functions actuate systems necessary for the safe shutdown of the plant following an accident or transient and to mitigate the consequences of accidents. Examples include RPS, ESF and Containment Isolation functions.

There are two subcategories of functions included in Group A, as follows:

- A1: Safety Limit (SL)-Related Limiting Safety System Settings (LSSS)
- A2: Non-SL-Related LSSS associated with RPS, ESF actuation, and containment isolation.

4.1.2 Group B

Group B includes those safety-related automatic I&C functions that may not already be addressed within the scope of the LSSS defined above. For Group B functions, the AV calculation is not required. In other respects, the setpoint calculations for Group B are the same as Group A.

4.2 COMPUTATION METHOD

The setpoint methodology Computation Method is based on a statistical, probabilistic approach. This approach is based on Regulatory Guide 1.105 (Ref. 2.1.2), ISA-S67.04.01-2006 (Ref. 2.1.1) and ISA-RP67.04.02-2000 (Ref 2.2.3). [[

]] The Square Root of the Sum of the Squares (SRSS) is the established and accepted technique for combining random and independent uncertainty terms. When uncertainties are combined using SRSS they must be at the same probability/sigma level. In this document uncertainties are combined by SRSS at the 2 sigma level unless otherwise stated.

The determination of a NTSP involves many factors. [[

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4.2.1 Setpoint Relationships

The steps involved in establishing safety system setpoints are summarized in Figure 7-1. It is not drawn to any scale and is used solely to demonstrate the qualitative relationship of the various margins.

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This margin assures that if the setpoint is found at the AV during calibration, it has enough margin to protect the AL. [[

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The AV satisfies both the safety and performance requirements, which are used to define operability of the instrument channel. [[

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The following bulleted items provide a sequence of requirements in the implementation of the setpoint methodology:

- The safety limits (SLs) are based on applicable regulatory and code requirements. These limits provide considerable margin to true public safety limits (e.g., uncontrolled release of radioactivity).
- Analyses are performed to establish protection system setpoints, which assure that appropriate safety limits (SLs) are not exceeded for design basis events (DBE). Trip setpoints used in the analyses are specified as ALs. Significant conservatism is built into the licensing basis analytical models and input assumptions. These models and assumptions have been reviewed and approved by the NRC staff. Instrument response time, transient overshoot, and modeling variability are considered in the analysis or shown to be negligible relative to modeling bias.
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- Instrument component accuracy requirements for each channel, which meet or exceed the uncertainties used in the setpoint determination, are established for each channel. Rated accuracies for the purchased instruments are evaluated to assure that they are consistent with the instrument uncertainties used in the initial determination of the allowable values and nominal trip setpoints. Final calculations of AV and NTSP use the actual vendor performance specified values. For the Drift error, the value for drift for each device is obtained from vendor specification sheets, utility specified drift value, from an analysis of site "As-Found/As-Left" data, or an assumed value that would be replaced when better data is obtained.
- Upon instrument replacement, the instrument component accuracies must be identical to the original equipment. If not, the rated accuracies will have to be reevaluated to assure consistency with the instrument uncertainties in determination of the AV and NTSP, and associated AFT and ALT values.

4.2.2 Uncertainty Limits

Determination of a trip setpoint and its associated allowable value uses tolerance limits for uncertainty terms that are appropriate to the setpoint. The uncertainty limit provides a quantitative statement of the probability and confidence level of a measurement result. Regulatory Guide 1.105 states that the NRC has typically accepted a 95% probability limit for errors such that for the observed distribution of values (empirical data) for a particular error component, 95% of the data points will be bounded by the value selected. The confidence intervals are provided by the design allowances developed by this document. The 95/95-tolerance limit is applied to safety-related automatic actuation functions in Group A and Group B.

4.2.3 Uncertainty Terms

<u>Channel Instrument Accuracy (A_L)</u>. Channel Instrument Accuracy is combination of accuracies of the instrument modules in the loop, and the module accuracies are obtained from module performance specifications. [[

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The design allowance encompasses all instrumentation devices [e.g., sensors, analog to digital (A/D) converters, multiplexing components and temperature compensation] in the channel established for a subject trip function. [[

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[[ ]] (4-1)

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[[ ]] (4-2)

Channel Calibration Error (C_L). This type of error is introduced by the calibrating equipment, calibration standard and calibrating procedures. The value is obtained by calculating the SRSS of the accuracies of the equipment selected to calibrate the actual trip device of an instrument channel, the error allowance for traceable standard equipment used to calibrate the plant calibrating equipment, and allowances for inaccuracies (or as-left tolerances) in the calibration procedures.

Calibration methods for calibration test equipment shall comply with ANSI/NCSL Z540-1-1994 (Ref. 2.2.4, and identified as relevant guidance in BTP HICB-12, Ref. 2.2.1).

Accuracy of the traceable standard equipment (measurement standard) generally does not exceed 25% of the accuracy (based on manufacturer's specification) of the measuring and test equipment being used for the device or loop calibration.

The following table, Table 4-1, lists potential sources of calibration uncertainty as an example of items that should be considered.

Table 4-1. Calibration Equipment List

Device	Calibration Equipment
Transmitter	
Input	Pressure Gauge (Input calibration tool)
	Traceable Standard pressure gauge used to calibrate input device
	Digital Volt Meter (DVM)
	Traceable Standard DVM used to calibrate input device
	Calibration tolerance (procedural error)
Output:	Digital Volt Meter (DVM) (Output calibration tool)
	Traceable Standard DVM used to calibrate output device
	Calibration tolerance (procedural error)

In this section, the total device and channel calibration errors are determined. Only the components that contribute to the calibration error are calculated, and these do not include accuracy and drift errors, which are calculated separately. In these calculations, the random components are individually squared and the square root is taken of the sum of these squared error components. All random errors are calculated at the same sigma value. Generally, calibration errors are always random, but if they have some non-conservative bias components, they should be included.

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]] (4-3)

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Primary Element Accuracy (PEA). PEAs can have random and bias error components. Examples of some PEAs are as follows:

- Temperature element errors are considered PEAs rather than sensor or transmitter errors since temperature elements are removed from service for the purpose of calibration and are typically calibrated in a temperature bath.
- The Neutron Monitoring system sensor errors due to sensitivity and non-linearity are considered part of the PEA calculations.
- For water level instrumentation, the condensing chamber is considered a primary element and the error associated with vessel expansion and resulting movement of the condensing chamber should be accounted for as a PEA.

Process Measurement Accuracy (PMA). PMAs are generally errors caused by the process and are independent of the instrumentation devices. The following are examples of PMAs:

- The effect of normal operating pressure variation on measurement of differential pressure range across a flow primary element is a PMA error (e.g., Main Steam high flow normal operating pressure variation of ± 100 kPa).
- Fluid density variations due to external temperature variations also introduce PMA errors. A pressure sensor calibrated with instrument lines at one temperature that is required to initiate action over a range of instrument line environmental temperatures will introduce a PMA error. PMA error could be zero for reactor water level measurement in the case where the signals have temperature compensation.
- Errors due to APRM tracking and neutron noise are part of the PMA associated with the Neutron Monitoring system.

Channel Instrument Drift (D_L). Channel instrument drift corresponding to a normal environment is used in the nominal trip setpoint calculation. [[

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4.2.4 Allowable Value (AV)

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[[ ]] (4-5)

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[[ ]] (4-6)

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A representation of the Allowable Value is shown in Figure 7-1.

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This factor is conservative relative to the one described in Section 8 of ISA-RP67.04.02 (Reference 2.2.3).

4.2.5 Limiting Trip Setpoint (LTSP)

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[[ ]] (4-7)

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[[ ]] (4-8)

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]] This factor is conservative relative to the one described in Section 8 of ISA-RP67.04.02 (Reference 2.2.3).

4.2.6 Nominal Trip Setpoint Determination

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[[ ]] (4-10)

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4.2.7 (Deleted)

4.2.8 (Deleted)

4.2.9 As-Found Tolerance and As-Left Tolerance Determination

Automatic I&C function setpoints in Groups A and B shall be periodically tested to verify the equipment performs as expected. This may consist of one or more surveillance tests.

The acceptance criteria for the channel calibration of an instrument loop are based on a prediction of the expected performance of the tested instrumentation under the test conditions, and are specified in terms of an acceptable value for the as-found tolerance (AFT). The acceptance criteria are chosen to avoid masking equipment degradation. [[

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[[ ]] (4-11)

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[[ ]] (4-12)

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]] The ALT is a procedural tolerance value that is typically chosen by the plant and documented in the plant calibration procedure.

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[[ ]] (4-13)

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5. DETERMINING UNCERTAINTY LIMITS FROM TEST OR HISTORICAL DATA

Uncertainty values may be determined from test data or historical data in the event that a vendor has test data available (e.g., from qualification testing) but not uncertainty values, or uncertainty values need to be determined from plant drift historical data. Appendix E of ISA-RP67.04.02-2000 (Ref. 2.2.3) identifies methods of treatment for outliers and testing for normal distribution of data, and both Appendices E and J identify useful statistical reference documents.

This method calculates uncertainty values from an established mean of the data, a calculated sample standard deviation, and tolerance factors for the desired uncertainty (e.g., 95/95). Uncertainties may be expressed in engineering units, or in percentages (%) of span or range limit.

Throughout this section, 95/95 confidence/probability limits are used in the examples.

5.1 MEAN, TOLERANCE LIMIT AND TOLERANCE FACTOR

A normal distribution of sample data can be expressed by a tolerance limit:

$$\text{Tolerance Limit} = \overline{X} \pm ks \tag{5-1}$$

where

$\pm$ ks is the 95/95 uncertainty value

$\overline{X}$ is the mean of the sample data

s is the sample standard deviation

k is the tolerance factor at 95/95

Tables for tolerance factor (k) values can be found in general statistics textbooks, typically under "Tolerance and Confidence Intervals". Such a table will provide two-sided normal distribution tolerance factors for various sample sizes, probability limits and confidence levels. A larger number of data points (sample sizes) will decrease the value of tolerance factor.

5.2 SAMPLE STANDARD DEVIATION

Sample standard deviation (s) is calculated from the sample data by the following equation:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{x})^2}{n-1}} \tag{5-2}$$

where

$$x_i = x_1, x_2, \ldots x_n, \text{ Sample data} \tag{5-3}$$

$\overline{X}$ = mean of the sample data

n = number of sample points

There is a distinction between sample standard deviation and population standard deviation, mentioned earlier. Sample standard deviation is calculated from a limited sample drawn from a population of data. Population standard deviation, in contrast, is calculated from the total population of data. Population standard deviation is seldom known because such a large amount of data is required.

6. PREOPERATIONAL TESTING

In order to confirm that instrument setpoints meet the requirements of Plant Technical Specifications, the initial test programs for each unit, as described in the Design Control Document Chapter 14 (Ref. 2.2.5) will require performance of the applicable Surveillance Test Procedures. These procedures will contain tests for confirming setpoint values, required tolerances and correct logic functionality. Successful completions of these tests will confirm compliance with setpoint analyses and Technical Specifications.

7. VERIFICATION TESTING

During the process of verification of the setpoints, there are four possible results (based on the regions shown in Figure 7-1). These results with corresponding surveillance are:

1. The setpoint is found within the as left tolerance defined as ALT. For this case, the results are recorded as required by the plant surveillance procedure and no adjustments are required.
2. The setpoint is outside the ALT but within the as AFT. For this case, the setpoint is to be reset to within the ALT.
3. The setpoint is found conservative to the AV but outside the AFT. For this case, the setpoint is to reset to the $NTSP_F$ (within the ALT), and a channel functionality determination is to be made.
4. The setpoint is found non-conservative to the AV; the channel is inoperable until the setpoint is reset to the $NTSP_F$ (within the ALT), and evaluations necessary to return the channel to service are to be made.

For setpoint functions with one AL, AV and $NTSP_F$, the AV to $NTSP_F$ margin is the AFT.

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Figure 7-1. ESBWR Setpoint Methodology
(not to scale)

Appendix A EXAMPLE CALCULATION – REACTOR VESSEL HIGH PRESSURE

A.1 PURPOSE

The reactor vessel pressure must be maintained within the limits prescribed by the ASME Boiler & Pressure Vessel Code, Section III. If pressure rises to a preset high value, a trip signal to the Reactor Protection System (RPS) will initiate a reactor scram to shut down nuclear heat generation. Reactor scram is initiated by high pressure if other signals have failed to scram the reactor to limit the effect of positive pressure on reactor power and provide assurance that reactor vessel integrity will be maintained.

A.1.1 Trip Logic Description

The reactor vessel steam dome pressure is monitored by four pressure transmitters. There are a total of four identical trip setpoints providing a high pressure trip; (one each for channels A, B, C and D). The trip logic for reactor scram is arranged in two-out-of-four logic.

A.1.2 Loop Diagram and Characteristics

Figure A-1 shows the loop diagram used in this pressure measurement. The involved devices are represented. The instrument loop consists of a pressure transmitter, an analog to digital (A/D) converter and a trip module. Most pressure instruments are made with a single instrument line coming down to the instrument, and measurements are made in units of either gage pressure (kPaG) or absolute pressure (kPaA). The analog output signal from the transmitter is converted to a digital signal in the A/D converter, and trip signal is generated digitally. Since no errors are assigned to digital components, the instrument loop can be considered to have two components, a pressure transmitter and a Trip Module that includes the A/D converter as a potential source of instrument error.

Note that for a pressure transmitter, there may be a head correction adjustment pertaining to instrument line water in the reference leg. The head correction pressure effect is determined via the fluid density applied to the elevation change essentially from the process connection (or condensing chamber) to the pressure-sending device. This is done separately from the setpoint calculation and included in the instrument scaling calculation.

A.1.3 Analytical Limit

The source for analytical limits for this pressure instrument is the safety analysis.

The Design Basis Event (DBE) for the high pressure scram setpoint is the closure of the Main Steam Isolation Valves (MSIVs) with pressure scram. The normal scram path associated with MSIV position switches and high neutron flux are assumed failed.

For this example calculation, the Analytical Limit (AL), as determined in the safety analyses, is as follows:

AL = [[ ]] kPa (A-1)

A.1.4 Setpoint Calculation

The instrument setpoint calculations follow the methodology described in this technical report. The responsible engineer determines the instrument errors to be included in the calculation following this methodology included in the following sections for the example of high pressure scram. The methodology also addresses scaling calculations that are not provided in this example.

A.1.4.1 Process Measurement Accuracy (PMA)

The Process Measurement Accuracy (PMA) is the error due to the process independent of the measurement instrument. [[

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[[ ]] (A-2)

A.1.4.2 Primary Element Accuracy (PEA)

The Primary Element Accuracy (PEA) is the error due to the primary element in contact with the process. [[

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[[ ]]. (A-3)

A.1.4.3 Device and Loop Accuracy

Device accuracy is determined based on the vendor specifications and the environmental/plant parameters in order to obtain the accuracy values [[

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Vendor Accuracy (VA) This is the vendor provided accuracy, which is a combination of the reference basic accuracy, linearity and hysteresis of all the devices in the loop, and [[

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[[ ]]

[[ ]] (A-4)

Temperature Effect (ATE) This is the instrument error due to changes in ambient temperature beyond what is specified for normal operation. [[

]] (A-5)

Static Pressure Zero Effect (SPZE) This is the error in the pressure transmitter instrument zero due to static pressure under operating conditions, when the instrument was zeroed at zero gauge static pressure calibration condition. This error is not considered in gauge or absolute pressure transmitters. It is only applicable to differential pressure transmitters. [[

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[[ ]]

[[ ]] (A-6)

Static Pressure Span Effect (SPSE) This is the error in the pressure transmitter instrument span due to static pressure under operating conditions, when the instrument was spanned at zero gauge static pressure calibration condition. This error is not considered in gauge or absolute transmitters. It is only applicable to differential pressure transmitters. The SPSE has two parts; a systematic error that can be calibrated out and an error that cannot be calibrated out and must be accounted for in the setpoint calculation.

[[ ]]

[[ ]] (A-7)

Overpressure Effect (OPE) This is the error for gauge or absolute pressure transmitters if the static pressure under operating conditions is higher than the specified maximum. This error is not applicable to differential pressure transmitters.

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[[ ]] (A-8)

Radiation Effect (RE) This is the error due to radiation on the instrument. Most pressure instruments (excluding post accident monitoring) are designed to perform their trip functions before harsh radiation conditions are established. Therefore, these errors generally do not need to be considered. However, the environmental data must be evaluated and it must be shown in the calculation that the radiation level for trip conditions is below the threshold for radiation induced error. It is a random error obtained from vendor's functional specifications. [[

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[[ ]]

[[ ]] (A-9)

Power Supply Effect (PSE) This effect must be evaluated for the transmitter. It is usually negligible because the normal voltage source maintains a tight tolerance and the error is relative to the variation in voltage. [[

]] (A-10)

Seismic Effect (SE) This effect is only considered if the device must function after a seismic event and its value is based on instrument qualification data by the vendor. [[

]] (A-11)

Humidity Effects (HE) For pressure transmitters, these effects are not considered since vendor's functional specifications cover a humidity range of 0 to 100% relative humidity.

[[ ]]

[[ ]] (A-12)

Insulation Resistance Effects (IRE) This effect must be considered only for equipment that are expected to perform their safety function in harsh environments.

[[ ]]

[[ ]] (A-13)

[[

]]

[[ ]] (A-14)

[[

]]

[[ ]]

[[ ]] (A-15)

[[

]]

[[ ]] (A-16)

A.1.4.4 Device and Loop Accuracy Calibration Errors

Generally the devices in an instrument loop are calibrated separately and the calibration inputs and outputs are measured by calibration input and output tools. These calibration tools are themselves calibrated by calibration standards that are traced to the National Institute of Standards. The calibration procedure also includes a procedural tolerance within which calibration is acceptable.

[[

]]

For this calculation,

[[

]]

[[

]]

[[ ]] (A-17)

[[

]]

[[ ]] (A-18)

[[ ]]

[[ ]] (A-19)

Deleted Equation A-20)

Deleted Equation (A-21)

A.1.4.5 Device and Loop Drift Errors

Device vendor drift (VD) errors are obtained by taking the vendor specified values and using the method described in this technical report to calculate the time dependent drift for the specified calibration interval. [[

]]

For this example setpoint function the only devices in the loop that must be considered in the drift error calculation are the transmitter and the A/D converter. The calibration interval for the transmitter is specified at the refueling interval or 24 months plus a grace period of 25%, which is equivalent to a total of 30 months. The calibration interval for the A/D converter is 30 months.

[[

]]

[[ ]] (A-22)

[[ ]]

[[ ]] (A-23)

Note that the drift value provided above is only the final result. Details of the derivation of the source of the original errors are outside the scope of this document.

A.1.4.6 Setpoint Calculation

[[

]]

First the AV is determined for the increasing process variable in accordance with Section 4.2.4 of this technical report:

[[ ]] (A-24)

For this example setpoint calculation, the AV is calculated to be:

[[ ]] (A-25)

Next the first Nominal Trip Setpoint ($NTSP_I$), or LTSP as it is also known, is determined for the increasing process variable, following Section 4.2.5 of this technical report:

[[ ]] (A-26)

For this example setpoint calculation, the LTSP is calculated to be

[[ ]](A-27)

A.1.4.7 As-Found and As-Left Tolerance Determination

As documented in Section 4.2.9 of this technical report, [[ ]]

[[ ]] (A-28)

For this example setpoint calculation, [[ ]]:

[[ ]] (A-29)

[[ ]]

[[ ]] (A-30)

[[

]]

The procedural AFT resulting from this example setpoint calculation is then defined as:

[[ ]] (A-31)

Thus for this example setpoint calculation, the as-found and as-left tolerances are:

[[ ]] (A-32)

[[ ]] (A-33)

A.1.4.8 Final Results

The final results of the setpoint calculation, after adjustment, are as follows:

[[ ]] (A-34)

[[ ]] (A-35)

[[ ]] (A-36)

[[ ]] (A-37)

Additional Errors Considered in the Setpoint Analysis

The following additional errors were considered:

[[
]]

[[
]]

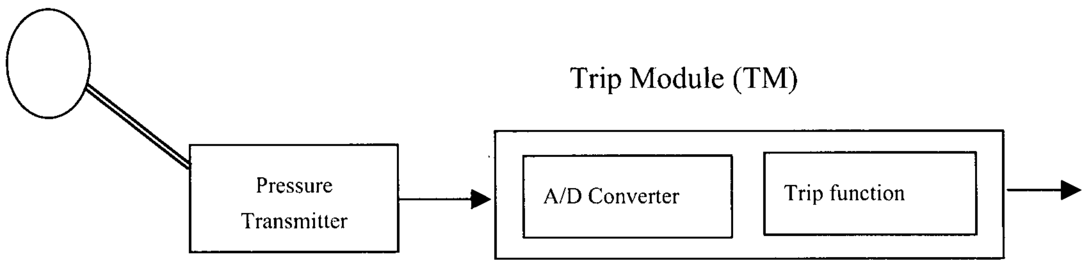

Figure A-1. Typical Pressure Loop Diagram

[[

]]

[[

]]

LAST PAGE

Table 1.6-1

Referenced GE / GEH Reports

Report No.	Title	Section No.
NEDO-33275	*[GE Hitachi Nuclear Energy, "ESBWR Human Factors Engineering Training Development Implementation Plan," NEDO-33275, Class I (Non-proprietary), Revision 4, January 2010.]**	18.10
NEDE-33276P NEDO-33276	*[GE Hitachi Nuclear Energy, "ESBWR Human Factors Engineering Verification and Validation Implementation Plan," NEDE-33276P, Class III (Proprietary), and NEDO-33276, Class I (Non-proprietary), Revision 4, February 2010.]**	18.11
NEDO-33277	*[GE Hitachi Nuclear Energy, "ESBWR Human Factors Engineering Human Performance Monitoring Implementation Plan," NEDO-33277, Class I (Non-proprietary), Revision 4, January 2010.]**	18.13
NEDO-33278	*[GE Hitachi Nuclear Energy, "ESBWR Human Factors Engineering Design Implementation Plan," NEDO-33278, Class I (Non-proprietary), Revision 4, January 2010.]**	18.12
NEDE-33279P NEDO-33279	GE Hitachi Nuclear Energy, "ESBWR Containment Fission Product Removal Evaluation Model," NEDE-33279P, Class III (Proprietary), and NEDO-33279, Class I (Non-proprietary), Revision 3, June 2009.	15.4, 15C
NEDO-33289	GE Hitachi Nuclear Energy, "ESBWR Reliability Assurance Program," NEDO-33289, Class I (Non-proprietary), Revision 2, September 2008.	17.4
NEDE-33295P NEDO-33295	*GE Hitachi Nuclear Energy, "ESBWR Cyber Security Program Plan," NEDE-33295P, Class III (Proprietary), Revision 1, July 2009, and NEDO-33295, Class I (Non-proprietary), Revision 1, July 2009.]**	7.1, 7B
NEDE-33304P NEDO-33304	GE-Hitachi Nuclear Energy, "GEH ESBWR Setpoint ~~Methodology," NEDE-33304P, Class III (Proprietary),~~ and NEDO-33304, Class I (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.	7.1, 7.2, 7.3, ~~7.4, 7.5, 7.8~~ Chapter 16 Sect. 5.5.11

7.8.6 COL Information

None.

7.8.7 References

7.8-1 GE Hitachi Nuclear Energy, "ESBWR I&C Diversity and Defense-In-Depth Report," NEDO-33251, Class I (Non-proprietary), Revision 2, May 2009.

7.8-2 NUREG/CR-6303, "Method for Performing Diversity and Defense-in-Depth Analyses of Reactor Protection Systems, December 1994

7.8-3 [*GE Hitachi Nuclear Energy, "ESBWR - Software Quality Assurance Program Manual," NEDE-33245P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33245, Class I (Non-proprietary), Revision 5, February 2010.*]*

7.8-4 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision ~~3~~4, ~~February~~ May 2010, and NEDO-33304, Class II (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.

References that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2. Prior NRC approval is required to change.

7.5.8 References

7.5-1 GE Nuclear Energy, "GE Nuclear Energy Quality Assurance Program Description," NEDO 11209-04A, Class I (Non-proprietary), Revision 8, March 1989.

7.5-2 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision ~~3~~4, ~~February~~ May 2010, and NEDO-33304, Class II (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.

- Status indication of HP CRD isolation bypass valve position;
- GDCS pool level indication;
- RPV water level indication; and
- Drywell and RPV pressure indication.

The HP CRD isolation bypass function instrumentation located in the drywell is designed to operate in the harsh drywell environment that results from a LOCA. Instrumentation, located outside the drywell, is qualified for the environment in which they must perform their function.

7.4.6 COL Information

None.

7.4.7 References

7.4-1 (Deleted)

7.4-2 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision 34, February May 2010, and NEDO-33304, Class II (Non-proprietary), Revision 34, February May 2010.

7.3-2 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision ~~3~~4, ~~February~~ May 2010, and NEDO-33304, Class II (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.

7.3-3 [*GE Hitachi Nuclear Energy, "ESBWR - Software Management Program Manual," NEDE-33226P, Class III (Proprietary), Revision5, February 2010, and NEDO-33226, Class I (Non-proprietary), Revision 5, February 2010.*]*

7.3-4 [*GE Hitachi Nuclear Energy, "ESBWR - Software Quality Assurance Program Manual," NEDE-33245P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33245, Class I (Non-proprietary), Revision 5, February 2010.*]*

7.3-5 (Deleted)

References that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2. Prior NRC approval is required to change.

BTP HICB-19, Guidance for Evaluation of Defense-in-Depth and Diversity in Digital Computer-Based Instrumentation and Control Systems:

- Conformance: The SPTM function conforms to BTP HICB-19. The implementation of an additional diverse instrumentation and control system is described in Section 7.8.

BTP HICB-21, Guidance on Digital Computer Real-Time Performance:

- Conformance: The SPTM function conforms to BTP HICB-21.

7.2.3.3.6 TMI Action Plan Requirements

In accordance with the SRP for Section 7.2 and with Table 7.1-1, only I.D.3 applies to the SPTM function. This is addressed in Subsection 7.2.3.3.1 for 10 CFR 50.34(f)(2)(v)[I.D.3]. TMI action plan requirements are generically addressed in Table 1A-1 of Appendix 1A.

7.2.3.4 Testing and Inspection Requirements

Proper functioning of analog temperature sensors is verified by channel cross-comparison during the plant normal operation mode. The bulk pool temperatures are continuously compared between divisions and indicated by the PCF.

Each of four SPTM safety-related divisions is testable during plant normal operation to determine the operational availability of the system. Each safety-related SPTM division has the capability for testing, adjustment, and inspection during a plant outage.

7.2.3.5 Instrumentation and Controls Requirements

The I&C requirements related to SPTM are addressed in Subsections 7.2.3.1 and 7.2.3.2.

7.2.4 COL Information

None.

7.2.5 References

7.2-1 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision ~~3~~4, ~~February~~ May 2010, and NEDO-33304, Class II (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.

~~7.2-2 (Deleted)~~

7.2-3 [*GE Hitachi Nuclear Energy, "ESBWR - Software Management Program Manual," NEDE-33226P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33226, Class I (Non-proprietary), Revision 5, February 2010.*]*

7.2-4 [*GE Hitachi Nuclear Energy, "ESBWR - Software Quality Assurance Program Manual)," NEDE-33245P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33245, Class I (Non-proprietary), Revision 5, February 2010.*]*

References that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2. Prior NRC approval is required to change.

7.1-9 GE Hitachi Nuclear Energy, "GEH ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision ~~3~~4, ~~February~~ May 2010, and NEDO-33304, Class II (Non-proprietary), Revision ~~3~~4, ~~February~~ May 2010.

7.1-10 [*GE Hitachi Nuclear Energy, "ESBWR - Software Quality Assurance Program Manual," NEDE-33245P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33245, Class I (Non-Proprietary), Revision 5, February 2010.*]*

7.1-11 (Deleted)

7.1-12 [*GE Hitachi Nuclear Energy, "ESBWR - Software Management Program Manual," NEDE-33226P, Class III (Proprietary), Revision 5, February 2010, and NEDO-33226, Class I (Non-proprietary), Revision 5, February 2010.*]*

7.1-13 (Deleted)

References that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2. Prior NRC approval is required to change.

Enclosure 3

MFN 09-775, Revision 2

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Larry J. Tucker, state as follows:

(1) I am Manager, ESBWR 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.The information sought to be withheld is contained in Enclosure 1 of GEH letter MFN 09-775, Revision 2, Mr. Richard Kingston to Nuclear Regulatory Commission, "Revised Licensing Topical Report NEDE-33304P, GEH ESBWR Setpoint Methodology, Revision 4" dated May 21, 2010. The proprietary information is enclosed within double square brackets with a dotted underline. [[This sentence is an example. {3}]] Figures and large equation objects are enclosed in double brackets. The superscript notation {3} refers to Paragraph (3) of the enclosed 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 License, 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, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 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's 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, or subject to the terms under which it was licensed to GEH. 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 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 contains the process that will be used to qualify batteries to longer duty cycles than previously exist which GEH has developed, and applied to perform this qualification process for the ESBWR.

The development of the testing process 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 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 21st day of May, 2010.

Larry J. Tucker

Larry J. Tucker
GE-Hitachi Nuclear Energy Americas LLC