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Enclosure 2

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"GEH ABWR/ESBWR Setpoint Methodology,"
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Technical Report

GEH ABWR/ESBWR SETPOINT METHODOLOGY

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acknowledgements
(In alphabetical order)

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1.0 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 and other important instrument setpoints for the GEH Advanced Boiling Water Reactor (ABWR), and the ESBWR.

Instrument setpoints are determined by setpoint and safety-related analyses using this methodology, which is based on previously NRC accepted GE Setpoint Methodology, NEDC 31336P-A (Reference 2.2.2), as updated to reflect a graded approach as provided in BTP HICB-12 (Reference 2.2.1) and information contained in Regulatory Information Summary (RIS) 2006-017, "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" (Reference 2.2.6). GEH has many years of experience applying this setpoint methodology to safety-related analyses performed for operating plants.

2.0 APPLICABLE DOCUMENTS

2.1 Codes and Standards

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

2.2 Other Documents

1. Branch Technical Position HICB-12, "Guidance for Establishing and Maintaining Instrument Setpoints," Sept, 1997.
2. NEDC-31336-P-A, "General Electric Instrument Setpoint Methodology," September 1996.
3. ISA-S67.04.02-2000 "Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation"
4. ESBWR Design Control Document, Tier 2, Ch. 14, Initial Test Program, Rev 3
5. ISA-TR67.04.09-2005, Graded Approaches to Setpoint Determination
6. Nuclear Regulatory Commission Regulatory Issues Summary 2006-17, "NRC Staff Position on the Requirements of 10 CFR 50.36, "Technical Specifications," regarding Limiting System Settings During Periodic Testing and Calibration of Instrument Channels"
7. Nuclear Regulatory Commission Regulatory Issues Summary 2005-020, 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"

3.0 DEFINITIONS

Definitions of ISA S67.04.01-2006 (listed in Section 2.1) 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 during instrument surveillance, 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. (ISAS67.04.01-2006)

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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. The channel calibration error without the as-left procedural tolerance is designated as C-tools.

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. There are three instrument accuracies for three different operational modes defined in GEH methodology. The accuracy under trip conditions used for AV and LTSP calculation is A_T, accuracy under calibration conditions used for LER avoidance and AFT calculation is A_C, and the accuracy under normal operating conditions used for spurious trip avoidance calculation is A_N. [[

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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 surveillance test.

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

Limiting Normal Operating Transient. The most severe transient event affecting a process variable during normal operation for which trip initiation is to be avoided and which provides the basis for determining the operational limit.

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 so that the trip or actuation occurs 95% or greater of the time before the AL is reached, 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 (NTSP1) 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 two nominal trip setpoints (NTSP) in GEH methodology. The first nominal trip setpoint is the limiting trip setpoint defined as NTSP1 (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 (PMA, PEA, accuracy under trip conditions, calibration and drift). The margin between the AL and NTSP1 is the minimum margin required for safety setpoints. The final nominal trip setpoint ($NTSP_F$) is the actual instrument setting. The $NTSP_F$ trip setpoint value is based on methodology with appropriate margin to the AV for plant operations. By methodology, $NTSP_F$ must be equal to or more conservative than the LTSP.

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

Operational Limit. The operational value of a process variable established to allow trip avoidance margin for the limiting normal operating transient.

Performance Test. A test that evaluates the performance of equipment against a set of criteria. The results of the test are used to support an operability determination. (ISAS67.04.01-2006)

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. [10CFR50.36 (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.

Spurious Trip Avoidance (STA). The test performed to assure that the instrument setpoint will not cause spurious trips during normal plant operation.

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. (ISA S67.04.01-2006)

4.0 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 2006-017 (Ref. 2.2.6) and RIS 2005-020 (Ref. 2.2.7)]. 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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The operability considerations inherent in the assumptions regarding AFT include:

a. At the beginning of each calibration interval, resetting an instrumentation channel setpoint to a value that is within the ALT of the associated $NTSP_F$

b. For Graded Approach Group A functions, when the as-found channel setpoint is outside the applicable AFT, evaluations are performed to consider whether the instrumentation channel is functioning as required (i.e., within the performance assumptions of the applicable setpoint calculations).

4.1 Graded Categories

A graded approach for calculating setpoints will be used for the GEH ABWR/ESBWR. The philosophy for this approach is based upon Section 4 of ISA-S67.04.01, (listed in Section 2.1), which allows for various levels of rigor to be applied in setpoint determination methodology based on importance to safety, and BTP 7-12, ISA-RP67.04.02-2000 and ISA TR67.04.09-2005 (listed in Section 2.2) which include guidelines for a graded approach.

The graded approach to establishing setpoints utilizes different levels of technical rigor (i.e., probability and confidence) for various setpoints based upon the level of safety significance of the instrument function. This approach is fundamentally dependent on the analytical basis of each independent function. In order to apply the graded approach, it is necessary to identify the level of safety significance that is associated with each function.

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 Computation Method (Section 4.2).

Abbreviated or less rigorous setpoint calculations may be performed for other functions, such as:

- Instruments 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).

For functions not evaluated in the safety analyses there is no analytical limit (AL) but instead there may be a design limit (DL) that is based on other important requirements (such as equipment protection). For these functions, the AV and NTSP will be calculated the same as if the DL was the AL. For some functions with a DL instead of an AL, calculation of an Allowable Value will still be required. Some of the instrument setpoints may also be determined based on the methods described in the Engineering Judgment Method (Section 4.3), as discussed later. Instrument setpoints with minimal importance to plant safety may be set based on the methods in these sections.

Categories A through C are defined below and correspond to the various levels of rigor of the Computational Method in establishing instrument nominal trip setpoints (NTSPs) and allowable values (AVs). Category D is defined below and corresponds to the Engineering Judgment Method of establishing the instrument setpoints..

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 RPS and ESF actuation functions, on which reliance is placed for the achievement or maintenance of the nuclear safety function. 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 Reactor Protection system (RPS), Engineered Safety Features (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)

  Includes Safety Limit (SL) related LSSS listed in a document controlled under 10 CFR 50.59.

- A2: Non-SL-Related LSSS associated with RPS, ESF actuation, and containment isolation.

  Includes non-SL related LSSS listed in a document controlled under 10 CFR 50.59.

4.1.2 Group B

Group B includes those automatic I&C functions and equipment that are secondary to functions accomplished by Group A functions or that support those functions in the achievement or maintenance of a safety function. In addition, Group B includes permanently installed instrumentation utilized to verify Technical Specification Surveillance Requirement acceptance criteria explicitly assumed in the safety analyses, unless adequate margin is justified. Based on the presence of Group A required accident mitigation functions, the degrees of probability and confidence applied to the calculated settings of the Group B functions need not be as high as that of Group A. Based on the Group A system's setpoint function to provide the required accident mitigation function, the supporting Group B setpoint may be of lower integrity. Examples include those automatic I&C functions related to Technical Specification limiting conditions that are not included in Group A.

4.1.3 Group C

Group C includes those automatic I&C functions that have an auxiliary or indirect role in safety functions. Group C includes those functions that have some safety significance but are not assigned to Groups A or B. These functions may allow for early automatic or manual operator response to an accident but are not the primary mitigation capability.

Group C also includes instrumentation that is required to support the credited availability of nonsafety-related/risk significant systems as defined in the Probabilistic Risk Analysis (PRA). For the ESBWR, the Regulatory Treatment of Non-Safety Systems (RTNSS) process covers these systems.

Examples include alarms to alert the operator to abnormal operation of safety systems.

Group C functions will include:

- Functions with setpoints that start, stop, modulate or provide control actions (not including alarms) in systems that mitigate transients accidents and special events. In this context, mitigation includes functions in which the safety consequences (e.g., offsite doses, approach to safety limits) of the event are impacted by the setpoint.
- Alarms which alert the operator to the approach to a TS LCO, which are related to operator action specifically credited in the safety analysis report, and which alert the operator that a safety system is not currently achieving or is incapable of achieving a safety function. Example – Standby Liquid Control Tank Level low water level alarm is intended to indicate the approach to a TS LCO. Therefore the setpoint is a Group C setpoint.
- Functions with setpoints that are identified as risk significant;

  Example: Feedwater Runback Logic initiation setpoints for the ESBWR supplements ATWS event mitigation
- Remote Shutdown (RSD) Panel indications. This insures that the minimum set of instrumentation required for safe shutdown are covered by RG 1.105 calculations. It also insures that in the special event in which only RSD indication is available, i.e., where only limited cross-checks are available instrument accuracy is quantified.

4.1.4 Group D

Functions other than those addressed in Group A, B, and C above that are not safety-related, or risk significant, and thus have limited safety significance, are included as Group D functions. Group D includes those automatic I&C functions that have limited safety significance and include most nonsafety-related functions. This group includes functions associated with systems where limits are not stated or established by the design basis or safety analyses or where engineering judgment based on common industry practice or manufacturers guidance has been shown to be appropriate.

BWROG EPG/SAG action levels are not RG 1.105 setpoints, unless they perform another function that puts them in Category A, B or C. For example, Post Accident Monitoring (PAM) parameters will be Group B for those parameters evaluated as risk significant. The BWROG EPG/SAG symptom based procedures use nominal instrument readings except for specific parameters as described in the EPGs.

4.1.5 Additional considerations

1. If a setpoint meets the definition of more than one category, it is assigned to the one with the most safety significance (and the most rigorous calculation requirement).
2. The classification is based on the function of the setpoint, and not the safety classification of the instrument and hardware that execute the function (e.g., a setpoint implemented in safety-related equipment may be Group D, or a setpoint implemented in nonsafety-related equipment may be Group B).
3. In cases when use of the high confidence level instrument uncertainty does not provide an Allowable Value with acceptable margin, additional analyses are performed, to show that the safety limits or consequences are not violated with a given Allowable Value. In this way it's possible to demonstrate that the combination of instrument accuracy, and analysis margin provide the required high confidence that the safety limits or consequences are not violated.

4.1.6 Setpoint Documentation

The setpoints for functions in all Groups will be listed in a setpoint list database. The basis for the grouping of functions and the calculations for Categories A, B and C will be documented in Setpoint Calculation documents, as addressed in the following paragraphs. The basis of setpoints for Group D will be subject to normal engineering verification as described below:

The graded approach to ESBWR/ABWR automatic I&C function setpoints consists of these four elements:

1. A defined classification scheme.
2. A definition of the variations in the rigor and conservatism of the instrument channel uncertainty used to establish the setpoint(s) in each Group.
3. Classification of each automatic I&C function into one of the classification groups.
4. Consistency with applicable regulatory requirements and industry standards, including Reg. Guide 1.105, HICB-12 and ISA 67.04.

The four Groups of automatic I&C functions (Groups A, B, C, & D) applied in the ESBWR and ABWR project vary in safety importance. The basis for assigning functions to different groups, and the differences in the process of determining the associated setpoints and associated level of rigor follows.

4.1.6.1 Group A

The setpoint calculation will provide the required high probability that the setpoint will prevent its associated analytical limit from being exceeded. In most cases this will be achieved by using loop accuracy calculations based on 95% probability and high confidence (see section 4.2). In some cases the required confidence level will be provided by a combination of the instrument data confidence level and additional conservatisms which provide assurance that analytical limits will not be exceeded.

4.1.6.2 Group B

Given that Group B functions do not directly protect Safety Limits, and the associated lesser safety significance, the setpoint methodology can employ drift accuracy with lesser degrees of probability and confidence, than are used in the determination of Group A functions. The basis for less rigor is that Group A setpoints cover all the plant Limiting Safety System Settings (LSSS), which will assure no safety or analytical limits are exceeded. Also, for Group B setpoints and interlocks without listed functions in ESBWR and ABWR Technical Specifications, the LER Avoidance Test and the Spurious Trip Avoidance Test are not required. In other respects the setpoint calculations are the same as Group A.

4.1.6.3 Group C

Based on the existence of the Group A & B functions which provide more safety significant protective functions, the setpoint methodology can employ drift accuracy with lesser degrees of probability and confidence for Group C setpoints, than are used in the determination of Group A and B setpoints. Also, no Allowable Value, LER Avoidance Test, and Spurious Trip Avoidance Test calculations are performed for these functions. In other respects the setpoint methodology calculations are the same as Group A & B. Risk significant instrumentation is required for equipment not directly credited in the safety analysis, but does support "defense in depth." Increased uncertainty in the associated setpoints could lead to a delay in system actuation. This would have minimal impact on plant safety since these systems are not credited for DBE mitigation.

4.1.6.4 Group D

Group D functions do not contain any SR or risk significant instrumentation. Increased uncertainty in the associated instrumentation will have no impact on plant safety. Setpoint methodology (described by the computation method in section 4.2) may be applied to Group D functions, but in most cases the less rigorous engineering judgment method in section 4.3 is justified and may be applied. Determination of these setpoints is covered by the ESBWR and ABWR GEH project design process.

4.2 Computation Method

The setpoint methodology Computation Method is based on a statistical, probabilistic approach. This approach is consistent with Regulatory Guide 1.105 (listed in Section 2.1) ISA-S67.04.01-2006 (listed in Section 2.1) and ISA-RP67.04.02-2000 (listed in Section 2.2). [[

]] The Square Root of the Sum of the Squares (SRSS) is the established and accepted technique for combining random and independent uncertainty terms.

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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The margin between the final NTSP and the normal Steady-State Operating Value allows for appropriate channel and modeling accuracies. Where normal steady-state operation involves a range of values, the more limiting value is used. This margin assures that the probability of unwarranted or spurious system trips is acceptably low.

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 trip setpoint and its associated allowable value uses tolerance limits for uncertainty terms that are appropriate for the grade assigned 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. Based on a normal error distribution, this corresponds to a 2 sigma value (1.96). By establishing that the 95% confidence intervals are bounded by the design allowances developed by this NEDE for the highest group of setpoints, the results produced by the GEH setpoint methodology included in this document can be established with a high degree of confidence, as noted in the NRC Safety Evaluation Report for Reference 2.2.2.

BTP HICB-12 (listed in Section 2.2) allows less rigorous tolerance limits for drift uncertainty terms in determination of trip setpoints that have a lower level of safety significance (lower graded categories). The uncertainty limits may be provided by a vendor or may be determined from test or historical data (Section 5).

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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Channel Calibration Accuracy (C_L). This type of error is introduced by the calibrating equipment, calibration standard and calibrating procedures. The value is obtained by calculating the Square Root of the Sum of the Squares (SRSS) of the accuracies of the equipment selected to calibrate the actual monitoring and 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 (listed in Section 2.2 and identified as relevant guidance in BTP HICB-12, also listed in Section 2.2).

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 Stnd pressure gauge used to calibrate above device
	Digital Volt Meter (DVM)
	Traceable Stnd DVM used to calibrate such device
	Calibration tolerance (procedural error)
Output:	Digital Volt Meter (DVM) (Output calibration tool)
	Traceable Stnd DVM used to calibrate above 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 component of the errors is squared and the square root is taken of the sum of the squares. 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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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, LER avoidance, and spurious trip avoidance calculations. [[

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4.2.4 Allowable Value (AV)

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

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]] This factor for a single sided distribution is described in Reference 2.2.2, section 1.2.3.2 as accepted by the associated NRC Safety Evaluation Report. This factor is also described in section 8 of ISA-RP67.04.02 (listed in Section 2.2).

4.2.5 Limiting Trip Setpoint (LTSP)

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]] This correction for a single sided distribution is described in Reference 2.2.2, section 1.2.3.2 as accepted by the associated NRC Safety Evaluation Report. This correction is also described in section 8 of ISA-RP67.04.02 (listed in Section 2.2).

4.2.6 Nominal Trip Setpoint Determination

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4.2.7 LER Avoidance Test

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]] These probabilities are generally available in Standard Normal Distribution tables in statistics textbooks or references.

[[

]]

4.2.8 Spurious Trip Avoidance Test

In order to evaluate the impact of the nominal trip setpoint on plant availability, the following test can be applied in those cases where sufficient information is available. [[

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[[ ]] (4-11)

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[[ ]] (4-12)

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[[ ]] (4-13)

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[[ ]] (4-14)

[[ ]] (4-15)

(See the definition of Modeling Accuracy in Section 3 for definitions of modeling terms.)

[[

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[[

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4.2.9 As-Found Tolerance and As-Left Tolerance Determination

Safety-related and other important setpoints shall be periodically tested to verify the equipment performs as expected. This may consist of one or more verification tests.

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

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[[ ]]

[[

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[[ ]]

[[

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[[ ]] (4-16)

[[
]]

[[ ]] (4-17)

[[

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

[[ ]] (4-18)

[[ ]]

4.3 Engineering Judgment Method

The engineering judgment method (Figure 7-2) will be applied when the computation method is not practical, and the design limit is not established by accident analysis (AL is not applicable). The uncertainty limits are also not applicable or practical. A two-zone concept is used to determine nominal trip setpoint, as shown in Figure 7-2. The zones specify a range within which the trip value is adequate for its intended function and the range where there would be a violation of the design limit. The acceptable trip value zone is a portion of the instrumentation trip range that will have its midpoint at the nominal trip setpoint, and it should be wide enough to allow for normal instrumentation drift. Violation of acceptable trip value zone occurs when the trip value drifts into the portion of the instrumentation trip range beyond the calibration tolerance upper value. The larger acceptable design limit zone should be established so that when the maximum error has occurred, sufficient margin remains between the nominal trip setpoint and the design limit [not the same as Design Basis Analytical Limit (AL)].

Some setpoints have non-critical functions or are intended to provide trip functions related to gross changes in the process variable, for regulatory and/or operational requirements. Historical values determined to be acceptable for previous plants can only be used if the governing conditions for the intended application are confirmed to be no worse than those associated with past applications. One way of establishing the nominal setpoint is to establish the differential between the nominal setpoint and the design limit as the maximum drift permitted between surveillance intervals.

5.0 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 corresponding to the grade assigned to the setpoint, or uncertainty values need to be determined from plant drift historical data. Appendix E of ISA-S67.04.02-2000 (listed in Section 2.2) 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. Other limits can be used as appropriate for the grade assigned to the setpoint and the uncertainty term being considered.

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

$x_i = x_1, x_2, \ldots x_n$, Sample data (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.

6.0 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 Documents (listed in Section 2.2) 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.

7.0 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 A_{LC}. 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 (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 (within the ALT), and evaluations necessary to return the channel to service are be made.

For graded Group A, the AV to $NTSP_F$ margin is the AFT. Therefore the case represented by item 3 above does not occur for graded Group A.

[[

STEADY STATE OPERATING VALUE

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Figure 7-1. GEH Setpoint Methodology

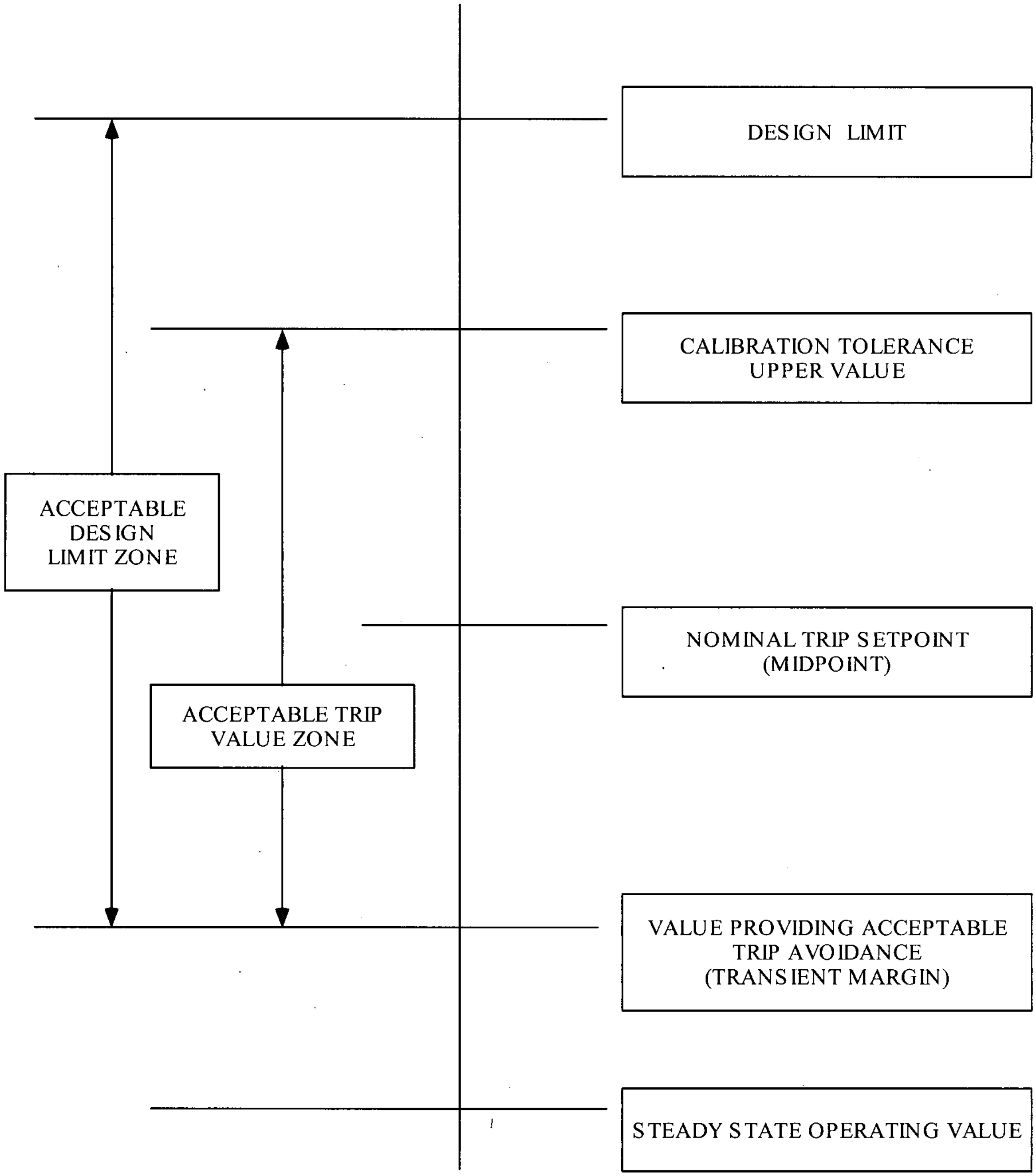

Figure 7-2. Engineering Judgment Method

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 which 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:

$$AL = [[\qquad\qquad]]\ \text{kPa} \qquad (A\text{-}1)$$

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 which 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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[[

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[[

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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 [[

]]

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 [[

]]

[[ ]]

[[ ]] (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. [[

]]

[[ ]]

[[ ]] (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 which 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. [[
]]

[[ ]]

[[ ]] (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)

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[[ ]] (A-14)

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[[ ]]

[[ ]] (A-15)

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[[ ]] (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 which are traced to the National Institute of Standards. The calibration procedure also includes a procedural tolerance within which calibration is acceptable.

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[[ ]] (A-17)

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[[ ]] (A-18)

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[[ ]] (A-19)

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[[ ]] (A-20)

[[ ]]

[[ ]] (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 18 months plus a grace period of 25% which is equivalent to a total of 22.5 months. The calibration interval for the A/D converter is 22.5 months.

[[

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[[ ]] (A-22)

[[ ]]

[[ ]] (A-23)

Note that the drift values are provided as results only, without derivation of the source of the original errors.

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 ($NTSP_1$) 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)

Next, the LER avoidance Test is performed in accordance with Section 4.2.7 of this technical report. [[ ]]

[[ ]] (A-28)

[[ ]] (A-29)

[[ ]] (A-30)

Note that the value provided for A_{LC}^2 is a result only, without derivation of the source of the error.

Next, the Spurious Trip Avoidance (STA) test is performed in accordance with Section 4.2.8 of this technical report. [[

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For this example setpoint calculation the results are as follows.

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[[ ]] (A-31)

For this example

[[ ]] (A-32)

[[

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[[ ]] (A-33)

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[[ ]] (A-34)

For this example setpoint calculation, the operational limit (X_T) is.

[[ ]] (A-35)

[[ ]]

[[ ]] (A-36)

[[

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[[ ]]

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

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

[[ ]] (A-37)

[[ ]] (A-38)

For this example setpoint calculation, [[ ]]:

[[ ]] (A-39)

The actual AFT for this example setpoint calculation is:

[[ ]] (A-40)

[[ ]]

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

[[ ]] (A-41)

[[ ]] (A-42)

A.1.4.8 Final Results

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

[[ ]] (A-43)

[[ ]] (A-44)

[[ ]] (A-45)

[[ ]] (A-46)

Additional Errors Considered in the Setpoint Analysis

The following additional errors were considered:

[[
]]

[[

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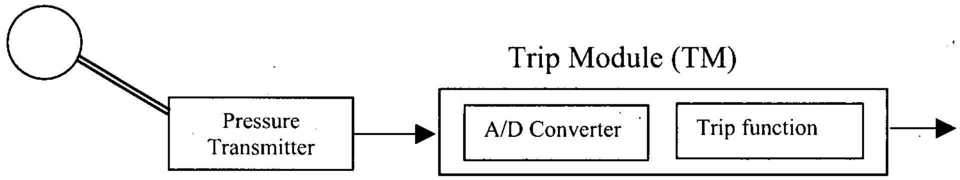

Figure A-1 - Typical Pressure Loop Diagram

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MFN 07-535

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 07-535, Mr. James C. Kinsey to U.S. Nuclear Regulatory Commission, dated October 23, 2007, entitled *ESBWR Instrumentation Setpoint Methodology -- Supplemental Response to RAI 7.2 36, Supplement 1."* The proprietary information in Enclosure 1, which is entitled *GE-Hitachi Nuclear Energy, "GEH ABWR/ESBWR Setpoint Methodology," NEDE-33304P, Revision 0, October 2007, Class III – 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, 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 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 methods, techniques, information, procedures, and assumptions related to its instrumentation setpoint methodology. The information is consistent in its scope of application with information in NEDC 31336P-A, September 1996, General Electric Instrument Setpoint Methodology, 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 23rd day of October 2007.

David H. Hinds
GE-Hitachi Nuclear Energy Americas LLC