21st Annual Conference of the Canadian Nuclear Society
Toronto, Ontario, Canada / June 11-14, 2000

Regulatory Positions on Safety Related Setpoints and Instrumentation Uncertainty of Wolsong Units

- Focused on Calibration / Drift Problem -

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Abstract

This paper presents the regulatory positions on Special Safety Systems Instrumentation Uncertainty for Trip Setpoint and Allowable Values that were developed using the experience gained from Wolsong Units 2,3 &4. The equipment diversity method for the defense against common mode failure is applied to the transmitters of shutdown system (SDS) 2. However the Units experienced an unexpected drift problem with which the performance did not meet the Technical Specification (Tech Spec) Surveillance Requirements (SR). Discussed are the background, status and corrective actions for the drift problem. It is an instrument uncertainty methodology that the designer of safety system should have shown when the drift problem occurred. For deeper understanding of the problem, we present the background of Tech Spec SR for setpoints in Korean PWR and in CANDU reactors. The Setpoint Verification Test and Calibration Test shall be achieved by recording sufficient as-found data to determine the setpoint in terms of the measured process variables prior to any adjustment.

We considered the problem using Canadian calibration practices and the as-found/ as-left method for drift surveillance. When an as-found value measured is between an Allowable Value and MAPS value in Setpoint Verification Test and Calibration Test on a single channel, plant operation is acceptable with one affected channel, only if the other channels are checked and reviewed according to the Tech Spec. Finally we present performance and diversity issues. The regulatory view for performance & diversity is that diversity should be applied to reduce common mode failure and enhance reliability. The diverse components can be used provided that there is a reasonable assurance for overall benefit. Equipment diversity should not be justified unless the performance of components of the SDS 2 is equivalent to that of the SDS 1 or is shown within the as-found limit criteria specified by designers. It is recommended that a consistency should be maintained between in-situ calibration procedures and instrument uncertainty methodology.

Key Words: Drift, Calibration, As-Found. As-Left, Diversity, Setpoint, Uncertainty, Technical Specification

1. INTRODUCTION

In June1998, inspections for Wolsong Units 1, 2, 3 & 4 showed that the Setpoint Verification Tests procedure did not meet the Technical Specification (Tech Spec) surveillance requirement (SR) to confirm the Allowable value in the Tech Spec: reference [1]. According to the Tech Spec, the Channel Functional Test (CFT) is required for setpoint verification every week. CFT focus on a bistables or an analog Alarm Units only for SDS 1 and 2 [2]. Requirements of R-8 and CAN3-N290.1-8 Section 4.4.9 [3] of the on-line test facility for Trip Setpoint Verification Tests (SVT) are not fully met by Alarm Unit module racks in an analogue loop in Emergency Core Cooling System (ECCS) and Containment systems.

In August 1999, an inspector found an unexpected drift problem, out of Allowable values in SDS 2 steam generator level trip transmitters (SGLTs) after only two years of operation. Not only did half the as-found values of the twelve SGLTs not meet the requirement of Tech Spec, but also some were out of the analysis values. Thus the specified calibration intervals in Tech Spec are no longer valid due to the unexpected drift problem.

2. Drift Problems Identified by Calibration Test in Wolsong Units

2.1 Background for SGLTs' Problem

In April 1997, the setpoint curves for Steam Generator Low Level (SGLL) of Setback System of Reactor Regulating System were changed. The Changes of the setpoint curves for SDS1&2 were implemented by the compensated calibration method for SDS 1&2 transmitters. It was a fast damping time of SDS 2 SG Level Transmitters (LTs) that made SDS 2 trip when the Load Rejection Test was performed in the Commissioning Stage just after changing the setpoint curves and recalibration of SDS 1&2 SG LTs. The investigation found that the SGLTs' damping time is not sufficient to damp the instantaneous spurious level signal. Because a new SGs' down-comer effect causes a sudden differential pressure change, the plant staff solved the damping time problem for SGLT with a capacitor-resistor filter. In 1998, the installation of the passive filter for SDS2 Wolsong Unit 2 was completed.

The calibration frequencies of Wolsong Units 2,3 & 4 for Special Safety Systems in the Tech Spec[1] are 3 years or 4 years depending on the number of channels or loops of Heat Transfer System. In December 1998, during the first outage of Wolsong Unit 2, the calibration test intervals were no longer valid in some channels that the I & C plant staff calibrated all the channel. At that time, the drift problem of some SDS 2 transmitters of Wolsong Unit 2 was not fully understood both by plant staff and the regulatory body because it was hard to get the calibration data.

2.2 Status of Drift Problem

In August 1999, the as-found data was fully available from Wolsong Units 2,3 &4. An extended inspection showed that the drift problem prevailed in Wolsong 2, 3 and 4 (Table 1). Even if the Allowable Values for each SDS 2 transmitter in Tech Spec were not specified, the drift magnitudes were beyond the total loop error- Allowable Values in Tech Spec. The worst case were Wolsong Unit 4 SGLTs, which were out of the Allowable Values when the weekly on-power spread checks were performed for the first time after a few months' operation.

	W 2	W 3	W4	Remarks
Outage 1998	9	-	-	12 SGLTs per Unit
Outage 1999	8	8	6 / 5	Outage/ On-power

Table 1. The numbers of SGLTs of SDS 2 beyond the Tech Spec Allowable values

2.3 Corrective Actions Taken

The various remedial actions [4] or trial attempts to resolve the problem on a short term basis have been formalized among utility, NSSS designers and transmitters vendors to date such that;

- Weekly spread checks between SDS 1&2 SGLTs
- Adjustment of the existing calibration frequencies in Tech Spec,
- Re-calculation of instrumentation uncertainty components for allowable values,
- Confirmation of the uncertainty calculation in DMs of Special Safety Systems ,
- Discussion of the definition for Minimum Allowable Performance (MAPS) and Allowable Value,
- Vendor's re-evaluation of overpressure effect or other effects in transmitters' drift
- Interim analysis of safety impact on SG trip coverage with proposed new analysis values and
- Trial modification of in-site calibration procedures to evaluate static pressure effect unique in SDS differential transmitter.

The existing Canadian practices for Wolsong SDS 2 are challenging due to the unexpected drift rate. The present Tech Spec surveillance requirements seem impossible to meet without changing the transmitters or changing the setpoint of SDS 2 SGLL trip. If the concerned signal out of the Allowable Value is found during the weekly in-situ spread check, the re-calibration should be performed within a week.

2.4 Regulatory Considerations

Inspection by KINS found that the setpoints for the SDS 2 instrumentation might allow the Wolsong units to operate outside the limiting conditions of operation specified in the safety analysis.

Before the plant staff decided the final solution for them, the KINS staff had temporarily concluded that the problems should be solved in such ways that;

- The existing uncertainty calculations in DM of Special Safety System instrumentation should be replaced as practically as possible in order to meet the Tech Spec by a so-called, "uncertainty methodology" with a separate "uncertainty calculation" such as rigorous documentation recommended by ISA S-67.04-1994[4].

3. SETPOINT SURVEILLANCE REQUIREMENTS IN KOREAN TECH SPEC

3.1 Background Tech Spec SR for setpoint in Korean PWR

In addition, the Technical Specification Surveillance Requirements (SR) for setpoints of the Westinghouse and CE Type in Korea are identical except Wolsong Units. Including the Wolsong Units Tech Spec, the concept for setpoint relationship is the same as shown in Figure 1[4]. The new KORI Unit 1 setpoint study for Protection System Instrumentation replaced the old one. The instrument uncertainty & setpoint methodology [5] and instrument uncertainty & setpoint calculation [6] were updated according to the latest ISA S- 67.04. The setpoint calculations for Kori Unit 1, Yongkwang Units 3,4 and Ulchin Units 3,4 are identical due to the same designer's work as follows. The Allowable Value, which is calculated excluding the measurement channel - transducers and I/E module - uncertainty, is checked on a monthly or quarterly CFT depending on each plant's SR frequency in the PWR Tech Spec. The uncertainty calculation, for example, of Kori Unit 1 includes measurement channel (transmitter) uncertainty, I/E module uncertainties and ALM module uncertainties. It was utilized in the in-situ calibration procedure.

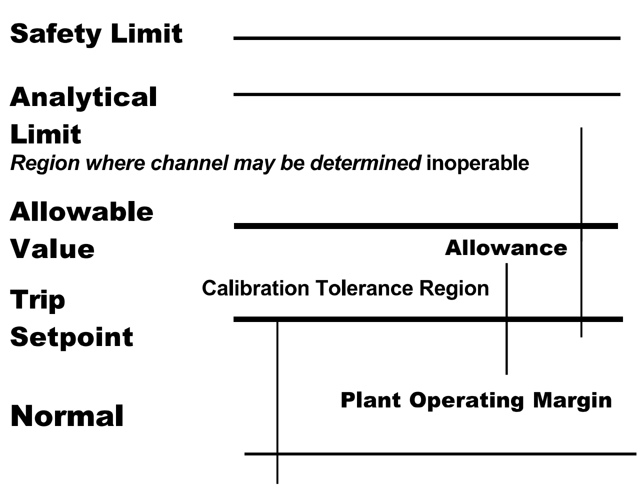

Figure 1: Nuclear safety related setpoint relationship [4, 7]

3.2 The Background of Tech Spec SR for Setpoint in CANDU

Following the Korean regulation, the designer wrote the Tech Spec for Wolsong Units 2,3 & 4 using the same format as the existing Korean nuclear power plants did. However the Canadian plants still maintain the contents and concepts for " Operating Policies and Principles." The section of Design Manual for SDS 1 & 2 for allowance of errors and uncertainties specified the instrumentation uncertainties for each trip setpoint [2, 8]. The frequency, the method and the value for checking the setpoint of CANDU reactor are different from that of PWR. The performance test of transmitters in CANDU in power operation is possible, while in PWR it is impossible during power operation. However the test in CANDU does not confirm the setpoints because of the difficulty in injecting an accurate input signal to the transmitters.

3.3. The Prospect of Tech Spec SR and in situ Calibration.

In Korea, the plant calibration procedures should be incorporated with the uncertainty methodology and setpoint calculation. A regulatory inspection identified an example not consistent between the procedure and the methodology. Thus plant staff has taken various remedial actions since then. Whether the setpoint calculation for Kori Units 2,3 & 4 and Yongkwang Units 1 &2 fully comply with new Westinghouse Setpoint Methodology [9] is not confirmed. In December 1999, the Tech Spec change submitted for Improved Thermal Design of Kori Unit and the regulatory body has reviewed since then. In conjunction with the proposal for CE and Westinghouse Improved Standard Technical Specification [10,11], the setpoint methodology will be thoroughly studied by the Korean Utility. The new standardized Tech Spec for Wolsong Units 2,3 & 4 was submitted in December 1999 and the regulatory body is now reviewing the details of Limiting Safety System Settings (LSSS). The utility is supposed to study the uncertainty methodology sooner or later by regulatory request.

3.4. The Korean regulatory concern for as-found and as-left techniques

The ISA S 67.04 outlines the setpoint maintenance techniques as similar to those developed due to Korean regulatory concerns. Formal documentation is necessary to support the investigation and documentation of any occurrence where a limit is exceeded and to follow the Tech Spec or a setpoint calculation that specifies each allowable value or limits for each instrument or group of instrument as practical.

The SVT and the Calibration Test shall be achieved by recording sufficient as-found data to determine the setpoint in terms of the measured or derived process variables prior to any adjustment. As-found data shall be the data taken during the first traverse in the direction of concern during the test.

- If as-found data indicates that no instrument adjustment is necessary, documentation of the testing and as-found data is all that is required.
- If there is a need for adjustment, documentation of the as-found and as-left data is required.
- It is necessary to keep records in order to check and evaluate the difference between the as-left value in previous calibration test and the as-found value before adjustment.
- If as-found data indicates that an allowable value for each instrument or instrument group as measured was exceeded, appropriate action shall be taken. This action shall include investigation to determine the cause of the finding, evaluation of operability, and appropriate corrective action to prevent re-occurrence.

4. CONSIDERATION OF WOLSONG DRIFT PROBLEMS

4.1 Consideration on Canadian Calibration Practices for as-found limits

The requirements of an on-line test facility for the SVT of the trip parameters in Programmable Digital Comparators (PDC) are unclear so there are no SVT for them in the Wolsong Units' Tech Spec. And the SVTs for instrumentation of the ECCS and Containment System does not fully meet the Tech Spec surveillance requirements in Korea. The loop error for SVT and Calibration Test is not specified in any design documents, too

The drift check procedure with the as-found/ as-left technique or limiting drift value for determining further operability should have been specified in the uncertainty calculation for calibration test criteria and channel functional test criteria. The on-line signal validation technique from transducers would be a novel solution for reducing the calibration efforts so that effort could be concentrate on concerned transducers that showed a bad correlation. The idea for cross-calibration or signal validation technique can be found in the literatures [12]. It is said that the on-line trip monitor computer on Darlington NGS could be one of the modern cross-calibration techniques; however this computer is not designed for Wolsong Units 2,3 & 4.

4.2 MAPS and Allowable Value

The Minimum Allowable Performance Standards (MAPS) are defined in the section 4.1.6 of R-8 [3] such that;

- If any component of a shutdown system is found to be inoperable, or impaired below its MAPS, that component and its associated equipment shall immediately be put in a safe condition.

This requirement is implemented in Tech Spec of the Special Safety Systems of Wolsong Units. MAPS can be understood as the analytical limits. There used to be a misunderstanding in the application for the Tech Spec definition between MAPS in CANADA-AECB R-8 [3] and the Allow Value in US-NRC Regulatory Position 4 of RG 1.105[5]. The next section is an interpretation of these using two components, i.e. a transducer and an Alarm Unit module rack.

4.3. Discussion of drift SR

When the as-found value measured in SVT and Calibration Test exists between an Allowable Value and an analysis value, plant operation or a transition from the Guaranteed Shutdown State is acceptable with an affected channel being declared inoperable, only if the channels are checked and reviewed according to the Tech Spec.

The Wolsong 2,3 & 4 Tech Spec provision already specifies the total Allowable Value for initiating ACTION for declaring inoperability. "Region where channel may be determined inoperable" in figure 1 should be interpreted as Tech Spec description: SR & Limiting Conditions for Operation (LCO) and the Bases for LSSS. The plant staff should review channel operability and declare if the drift in Allowable Value is confirmed according to the Tech Spec.

The NRC Regulatory Position 4 of RG 1.105 [5] states in a same manner such that;

- The Allowable Value is the limiting value that the trip setpoint can have when tested periodically, beyond which the instrument channel is consider inoperable and corrective action must be taken in accordance with the Tech Spec.

It should be noted that the conservative direction of as-found limits for Setpoint Verification Test of Alarm Unit module rack and that for Calibration Test of transducer are opposite. For example, the pressure transmitter as-found limit for the High Reactor Building Pressure has a negative sign or decreasing magnitude but the alarm module rack setpoint as-found limit has a positive sign or increasing magnitude. This one-side conservatism should have been incorporated in the two independent Allowable Values in the instrument uncertainty study for one transducer and connected alarm unit module rack drift.

The weekly on-power spread transmitter's signal check between SDS 1&2 SGLTs is a temporary remedial measure for monitoring the drift rate. The limit for spread check should be carefully specified because other uncertainty factors are included on an average value measured and calculated. Both side errors should be checked in order to decide the operability of the concerned transducers. In this case, the total loop Allowable Values beyond the specified transducers' drift limit would be a maximum value for initiating a re-calibration. The drift rate would be another criteria for the transducers' operability.

5. PERFORMANCE AND DIVERSITY ISSUES

5.1. Performance Requirements for the instrument in the Standards

There are several definitions for the performance criteria of the instrument depending on its purpose. Dynamic and steady state performance are two criteria. The capability of an instrument in the operating environmental conditions should be considered when assessing performance through the environmental qualification steps. The minimum functional performance requirements for protection system include the followings in the IEEE 279-1971 [13]:

- System response times & system accuracies;
- Ranges (normal, abnormal, and accident conditions) of the magnitudes and rates of the change of sensed variables to be accommodated until proper conclusion of the protective action is assured

Error defined in ISA S-37.1 [14] is preferred in specifications and other specific descriptions of transducer performance. As a performance specification, accuracy shall be assumed to mean Accuracy Rating of the device, when used at the reference operating conditions. Accuracy Rating in the ISA S-51.1 [15] is included in Reproducibility. So the term system accuracies in [13] should be replaced with reproducibility due to omitting the drift effect and the design should take into account of drift in the performance of instrument. The relationship of terms used in the calibration test in [15] is summarized as below.

- Reproducibility = accuracy rating + drift
- Accuracy rating = conformity or linearity + hysteresis + dead-band + repeatability

The term 'Measurement Accuracy' in FSAR 7 and 16 and Design Manual (DM) of Wolsong Units 2,3 & 4 is defined as estimated errors applicable measurement, which is 2σ(standard deviation). The Measurement Error is interpreted the same as the total loop error or 'allowance' in the figure 1. The Measured Accuracy defined in the ISA S-51.1 is typically expressed in terms of the measured variable, percent of scale length or percent of actual output reading in both sides i.e. ± .

5.2 Calibration Standards & Drift

A drift is an inevitable phenomenon if we use analogue instrumentation. The reproducibility including drift for a period is a main concern for an instrument. A drift is defined in the ISA S-51.1 and ISA S-37.1 in the same way as follows. Stability is defined in ISA S-37.1 for transducers only.

- Drift – An undesired change in output over a period time, in which change is not a function of Measurand. Where, Measurand is a physical quantity, property or condition, which is measured. The term Measurand is preferred to 'input', 'parameter to be measured', 'physical phenomenon' and ' variable.
- Stability – The ability of tansducer to retain its performance characteristic for a relatively long period of time.

To Calibrate is defined in the ISA S-51.1 as the action to ascertain outputs of a device corresponding to a series of values of quantity which the device is to measure, receive or transmit.

- Calibration - A test during which known values of Measurand are applied to the transducer and corresponding output reading are recorded under specified condition.

Two Standards do not explicitly utilize the as-found/ as-left technique in the calibration test. However the reproducibility is the same concept for the as-found/ as-left technique. Methods for Calibration Tolerance are introduced in the Standard ISA S-67.04. If the method of Calibration Test or SVT verifies all attributes of Accuracy Rating and the Calibration Tolerance is less than or equal to the Accuracy Rating, then the Calibration Tolerance does not need to be included in the total instrument channel uncertainty i.e. total loop error. A method for verification of measured accuracy, hysteresis & dead-band and repeatability is demonstrated in ISA S-51.4. Also the Accuracy Rating of the Measurement & Test Equipment (M& TE) is specified to be accurate to less than one tenth with respect to the instrument being tested as follows.

- When the accuracy rating of the M & TE is one tenth or less than that of the instrument under test, the accuracy rating of the M & TE may be ignored.
- When the accuracy rating of the M & TE is one third or less but greater than one tenth that of the instrument under test, the accuracy rating of the M & TE shall be taken into account.

The statement M & TE Accuracy Rating in ISA S-51.1 is comparable to IEEE 498 standard [16]. The IEEE Standard sets forth the requirements for a calibration program to control and verify the accuracy of M & TE and Reference Standard used in the safety system of a nuclear facility. This standard is withdrawn in Branch Technical Position HICB-12 of the Standard Review Plan, but is still a valid review guideline [17]. The rationale of 4 : 1 higher accuracy requirement for M & TE than the instrument being calibrated is based on the IEEE Std 498 requirement.

5.3 Brief Historical Review of Regulation on Drift problems in US plants

Drift also has been one of the main topics in US Licensee Event Reports (LERs) since the first version of Regulatory Guide (RG) 1.105 was published in 1975. In 1974, the NRC issued a Standardized Tech Spec, which has a new concept; the Allowable Value. Exceeding the Allowable Value in a single channel was a reportable event i.e. LER. The Allowable Value meant only an allowance for bistable module rack at that time. In 1976, RG 1.105 Rev.1 defined a new Allowable Value allowed for a Drift. In 1983, the NRC issued a revised 10CFE 50.36 'Technical Specification' [18], which did not require reporting a LER in case of single channel inoperability.

The first version of ISA S-67.04 [4] did not used to mention the drift relationship with Measurand. The drift is sometimes assumed as a linear function of time not for interpolation but for exploration,. It is not generally accepted in the US-NRC as indicated in the concerns in RG 1.105 with Generic Letter (GL) 91-04 [19] for reviewing the extended surveillance intervals. The drift issues are highlighted in the increased calibration interval related GL 91-04. Followings are the concerns identified in the GL 91-04. It is informative for the Wolsong drift problem.

- Confirm that the instrument drift as determined by as-found/ as left calibration data has not exceeded specified limits for a calibration interval.
- Confirm that the value of drift for each instrument type and application have been determined with a high probability and a high degree of confidence.
- Provide a summary of the methodology and assumptions used to determine the rate of instrument drift with time based upon historical plant calibration data.
- Confirm that the magnitude of instrument drift has been determined for a bounding calibration interval of 30 months for each instrument type and application.
- Confirm that a comparison of the projected instrument drift errors has been made with the values of drift used in the setpoint analysis.
- Confirm that the projected instrument errors caused by drift are acceptable for control of plant parameters to affect a safe shutdown with associated instrumentation.
- Confirm that all the conditions and assumptions of the setpoint and safety analysis have been checked and are appropriately reflected in the acceptance criteria of plant surveillance procedures for channel checks, channel functional tests, and channel calibrations.

Based on the survey for LERs by AMS [20], the survey confirmed the validation of existing Tech Spec Surveillance. Research [21] showed that only the heat and pressure cycling conditions resulted in any measurable degradation in limited sampled transmitters. The search of LERs [20] showed setpoint drift and calibration problems in about 5% of process instrument systems predominantly including pressure, level, and flow transmitters. Revision 10CFR 50.36 resulted in an 50% decrease in the number of LER from those reported 1984. Thus fewer LER were submitted after 1983 solely to report problems with a small number of instruments only when the safety function fails. The average failure for pressure instrumentation can be calculated 1.9 failure per US plant per year as shown in the Table 2. :

- 1.9 ≈ 1,866 LERs ÷ 100 plants ÷ 10 years

5.5 Diversity and Reliability in the IAEA Design Standards

IAEA Code for protection system design provides the general design criteria for system & component reliability. It describes several design measures that may be used to achieve and maintain the required reliability commensurate with the importance of the safety functions to be performed within three echelons of defense in depth – redundancy, single failure criterion, diversity, independence, fail safe design, auxiliary services, common cause failure, equipment outages. The following design methods are considered for diversity design criteria in the IAEA design code [22].

- Using the principle of diversity to reduce the potential for certain common cause failures can enhance the reliability of some systems.

Table 2. LERs Statistic

Total LERs 1980 to Oct. 1992					40 000
Pressure Sensing System Failure				6,04%	
1. Pressure Instumention Failure			4,67%		
1.1 Aged- Related		36%			
1.1.1 Drift. Calibrarion	27%				
1.1.2 Worn,Broken, Bent	22%				
1.1.3 Water Spray, Flow Blockage	19%				
1.1.4 Vibration, Fatigue	5%				
1.1.5 Errosion/ Corrosion	2%				
1.2. Personnel Error		31%			
1.2.1 Testing/ Surveillance	26%				
1.2.2 Desing Erros	20%				
1.2.3 Maitenance/ Operation	22%				
1.2.4 Intallaltion/ Fabrication	13%				
1.2.5 Administrtive	8%				
1.2.6 Construction	2%				
1.2.7 Others/ Unknown	5%				
1.3 Other causes		33%			
2. Sensing Line Failure			1,37%		

- Diversity is applied to redundant systems or components that perform the same safety function by incorporating different attributes into the systems or components.
- If diversity is applied, care shall be exercised to ensure that any diversity used actually achieves the desired increase in reliability in the implemented design.
- If diverse components or systems are used, there should be a reasonable assurance that such additions are of overall benefit, taking into account the disadvantages such as the extra complication in operating, maintenance and test procedures or the consequent use of equipment of lower reliability.

The IAEA Safety Guide for Protection System [23] specifies the design basis or detailed design principles in order to ensure that the protection system performance requirements and reliability goals are attained. To establish certain minimum levels of system capability, a number of recognized design practices shall be implemented in the system design. The principle of diversity can be used in the protection system, the safety actuation systems and the safety system support features, to cope with potential failures, e.g. certain common cause failures, or uncertainties in design or design analysis. In the design of the safety systems, the postulated failure causes should be carefully examined to determine where the principle of diversity should be effectively used. Diversity is generally classified into Functional diversity and Equipment diversity. Specially being applied to Wolsong Units 2,3 &4 SDS 2, the equipment diversity means that either similar equipment from different suppliers or equipment employing different principles of operations is used in the system.

In any application care must be exercised to ensure that diversity is in fact achieved in the implemented design. The designer should remain alert to areas of potential commonality in the application of diversity, such as materials, components, similar manufacturing processes, or subtle similarities in operating principles or common support features. Diversity may be of some benefit in all portions of the safety systems but generally the largest gains are achieved in particular areas as follows:

- Functional diversity by the sensing of two different variables.
- If carefully applied, equipment diversity offers protection against design, manufacturing and construction deficiencies as well as reducing the potential of cascading influences from other systems.
- A combination of the above.

IAEA Safety Series for Single Failure Criterion specified the common cause failures and the defense against them. Quality, segregation and diversity are of fundamental importance in the defense against common cause failures. In addition to quality, there is a need for adequate diversity in human activities, environment and hardware. The overall defensive strategy can be shown in Fig. 2

- Equipment diversity implies the use of different kinds of components in redundant trains.
- Human diversity may be applied by using separate teams for the design, manufacture, operation and maintenance of redundant items.

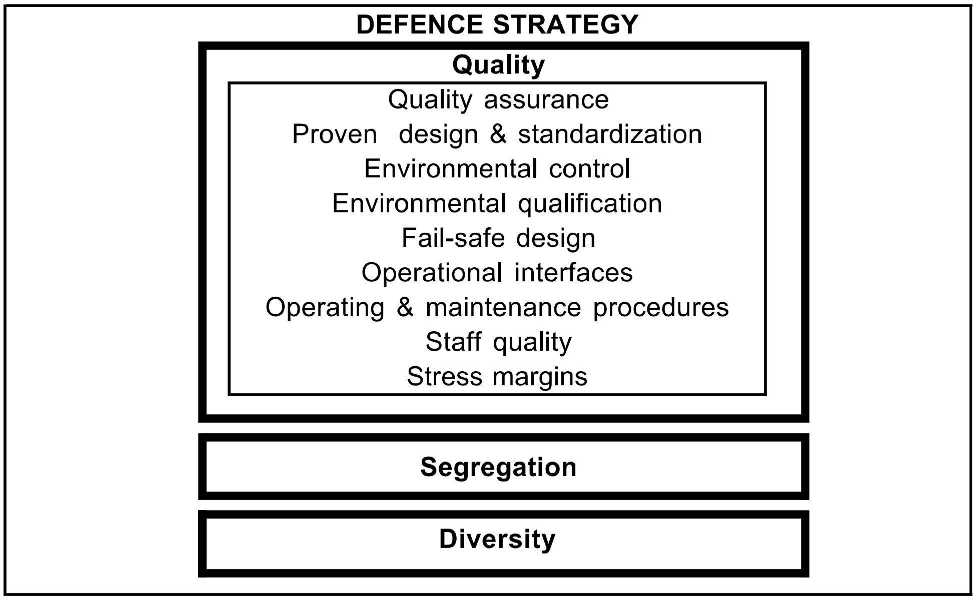

Figure 2. Common Cause Defense Strategy Structure

5.6 Regulatory View for Performance & Diversity

The equipments of SDS 2 are different from that of SDS 1: manufacturers and measuring principles. However the transmitters have an unexpected drift problem in which the performance did not meet the Tech Spec SR. FSAR 7.2.1.1.3.4 describes the reliability; SDS 1 &2 shall have unavailability for each trip parameter of no more than 10^{-3} years per year. For design purpose, the division of allowed unavailability is as follows:

- Trip logic 1×10^{-4}
- Trip parameters 1×10^{-4}

Meeting the requirements for the reliability goal, the degradation of performance with respect to the unexpected drift of transmitters cannot be tolerated without any compensation of the drift problem. Equipment diversity should not be justified unless the performance of components of the SDS 2 is equivalent to that of the SDS 1 or is shown within the as-found limit criteria specified by designers.

6. Conclusion

The Following are the future considerations for the drift problem on the SG Level Transmitters.

- To confirm the reason why the change of setpoint in PDC software did not consider in the interim analysis of safety impact on SG trip coverage.
- To confirm the plan for utilizing a trip monitor computer such as Darlington one.
- To confirm the statistical proof of using __(standard deviation) data with a weighting factor.

The regulatory positions for the problem are summarized as;

- The existing uncertainty calculations should be confirmed with an 'uncertainty methodology'.
- The performance shown in environmental qualification documents or drift rate should be within the as-found limit criteria according to the uncertainty methodology decided,

- The equipment diversity should not be justified unless the performance of components of the SDS 2 is equivalent to that of the SDS 1 or is shown within the as-found limit criteria specified by designers.
- New facts and uncertainty calculation data submitted in the proposed documents should be supported by environmental qualification test reports according to the standards.

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