Setpoint Methodology for Safety-Related Instrumentation

Revision 2

Non-Proprietary

JANUARY 2018

REVISION HISTORY

Revision	Date	Page	Description
0	November 2014	All	First Issue
1	February 2017	2 (2.1)	Described clearly the relationship between the periodic test error band and the draft trip setpoint and added the effect on the draft trip setpoint, allowable value, and trip setpoint when the PPS cabinet periodic test error band is zero. (RAI 301-8280, Question 07.01-41)
		9 (2.5.4)	Described the basis for a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-50)
		14 (5)	Editorial Change : Insertion of acronym
		A5 (App.A)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		B5 (App.B)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		C6,C7 (App.C)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		D4 (App.D)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		E5 (App.E)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		F4 (App.F)	Editorial Change : Correction of typo
		F4 (App.F)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		G4 (App.G)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)

Revision	Date	Page	Description
		H4 (App.H)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		I3 (App.I)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		J4 (App.J)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		K4 (App.K)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		L4 (App.L)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		M5 (App.M)	Described clearly the purpose of a margin between the allowable value and the trip setpoint (RAI 301-8280, Question 07.01-41)
		N4 (App.N)	Editorial Change : Insertion of acronym
2	January 2018	ALL	1. Used the comprehensive term of the Safety-Related Instrumentation instead of individual terms of the PPS and DPS. 2. Changed the APC-S to the signal conditioning device.
		1 (1.2)	1. Deleted Appendices B through N. 2. Deleted a sentence related to the change of the setpoint calculation process. (RAI 301-8280, Question 07.01-41, Rev.1)
		2~4 (2.1, Figure 1)	1. Deleted descriptions regarding specific PPS and ESFAS functions. 2. Distinguished clearly the TSP and the DTSP. 3. Described clearly the relationship among the TSP, DTSP, AV, and PTE band. (RAI 301-8280, Question 07.01-41, Rev.1)
		3, 6 (2.2, 2.4)	Described clearly the relationship among the TSP, DTSP, AV, and PTE band. (RAI 301-8280, Question 07.01-41, Rev.1)
		7~9 (2.4)	Moved assumptions to Appendix B. (RAI 301-8280, Question 07.01-41, Rev.1)

Revision	Date	Page	Description
		6 (2.4.1)	Described clearly the scope of LSSS. (RAI 34-7870, Question 07.01-5)
		7 (2.5)	1. Added the description related to the documentation. 2. Deleted the description of rate-limited variable setpoint. 3. Deleted the description of response time covered by APR1400-Z-J-NR-14013-P. (RAI 301-8280, Question 07.01-41, Rev.1)
		8 (3.1)	Added the description that the response time analysis is addressed in APR1400-Z-J-NR-14013-P. (RAI 301-8280, Question 07.01-41, Rev.1)
		8 (3.2)	1. Described the information related to the NTSP, AV, AFT and ALT in TS 5.5.19. 2. Deleted the description of rate-limited variable setpoint calibration. (RAI 301-8280, Question 07.01-41, Rev.1)
		9 (4)	Incorporated latest references. (RAI 301-8280, Question 07.01-41, Rev.1)
		10~11 (5)	Deleted unused definitions. (RAI 301-8280, Question 07.01-41, Rev.1)
		A1~A5 (App.A)	1. Described “typical sample” in the appendix. 2. Deleted the description of response time covered by APR1400-Z-J-NR-14013-P. 3. Distinguished clearly the TSP and the DTSP. (RAI 301-8280, Question 07.01-41, Rev.1)
		B1 (App.B)	1. Moved assumptions to a new appendix. 2. Deleted all the appendices except for appendix A of a typical sample. (RAI 301-8280, Question 07.01-41, Rev.1)

ABSTRACT

This technical report describes the setpoint determination methodology applied to the safety-related instrumentation for the APR1400.

The methodology described in this technical report has been established to ensure that the PPS and DPS setpoints are consistent with the assumptions made in the safety analysis and conform to current setpoint-related requirements of industry standard, ANSI/ISA-S67.04-1994, which is endorsed by US NRC Regulatory Guide 1.105 Rev. 3, NUREG- 0800 Brach Technical Position (BTP) 7-12, and US NRC Regulatory Issue Summary (RIS) 2006-17.

The detailed setpoint calculation processes for the safety-related instrumentation are described in Appendix A of this document and may change according to the plant-specific data. The uncertainty methodology and application for instrumentation for the APR1400 are addressed in a separate technical report, APR1400-Z-J-NR-14004-P, which is referenced by this technical report. The setpoint determination methodology used for the core protection calculator system (CPCS) for APR1400, which is not covered by this technical report is documented in a separate technical report, APR1400-F-C-NR-14001-P, “CPC Setpoint Analysis Methodology for APR1400”.

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ACRONYMS AND ABBREVIATIONS

AC	accident condition
AL	analytical limit
ANSI	American National Standards Institute
AV	allowable value
BTP	branch technical position
CFR	code of federal regulations
CPC	core protection calculator
CU	cabinet uncertainty
COLSS	core operating limit supervisory system
DBE	design basis event
DCD	design control document
DNBR	departure from nucleate boiling ratio
DTSP	draft trip setpoint
ESF	Engineered safety features
HE	harsh environment
ISA	Instrument Society of America
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
LPD	local power density
LSSS	limiting safety system setting
MCU	measurement channel uncertainty
NHE	non harsh environment
PTE	periodic test error
RIS	regulatory issue summary
SRP	standard review plan
SRSS	square-root-sum–of-squares
TS	technical specifications
TSP	trip setpoint
WCN	worst case normal

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1 INTRODUCTION

1.1 Purpose

This report describes the general setpoint calculation methodology for the safety-related instrumentation for the APR1400. This methodology has been established to ensure that the setpoints for the safety-related instrumentation are consistent with the assumptions made in the safety analysis and conform to current licensing requirements and industry standards.

1.2 Scope

This report describes the setpoint methodology used in calculating setpoints for the safety-related instrumentation. This method satisfies current setpoint-related requirements of industry standard ANSI/ISA-S67.04-1994 (Reference 4.1), which is endorsed by USNRC regulatory guide 1.105 Rev. 3 (Reference 4.2), and BTP 7-12 (Reference 4.5), and RIS 2006-17 (Reference 4.6).

Section 2.0 describes the present methodology of setpoint determination. A general explanation of setpoint determination is given for the design control document (DCD) Sections 7.2 and 7.3, and technical specifications (TS). This section provides more detailed discussion of determining setpoints for the safety-related instrumentation.

Section 3.0 describes the assumptions regarding equipment calibration and periodic test procedures used in the setpoint calculations.

Appendix A provides the setpoint calculation process for the safety-related instrumentation.

The uncertainty methodology and application for instrumentation for the APR1400 are specifically described in Reference 4.7.

Departure from nucleate boiling ratio (DNBR) and local power density (LPD) setpoint calculation for the CPCS is provided in the Reference 4.9.

2 SETPOINT METHODOLOGY

2.1 Basic Description

Protective action is initiated when a process value exceeds a predetermined setpoint value, which is the trip setpoint (TSP). This TSP is established such that during design basis events (DBEs) the analytical limit (AL) is not exceeded. ALs are established such that safety limits (SLs) are not reached. SLs assure that unacceptable consequences do not occur during the DBE.

The relationship between nuclear safety-related setpoints is illustrated in Figure 1.

The draft trip setpoint (DTSP) is a more conservative value than the AL by the amount of the total instrument channel uncertainty. The DTSP is synonymous with “limiting trip setpoint” as used in Reference 4.6. This uncertainty is the combination of all identified uncertainty elements. The allowable value (AV) is less conservative than the DTSP by the amount of the periodic test error. This uncertainty, already included conservatively in the DTSP, accommodates the expected measurable equipment drift that could occur in a specified calibration interval. The final TSP is a more conservative value than the DTSP by an amount of margin determined by engineering judgment to reduce the possibility that a periodic test result exceeds the AV. The final TSP is synonymous with “nominal trip setpoint (NTSP)” as used in Reference 4.6.

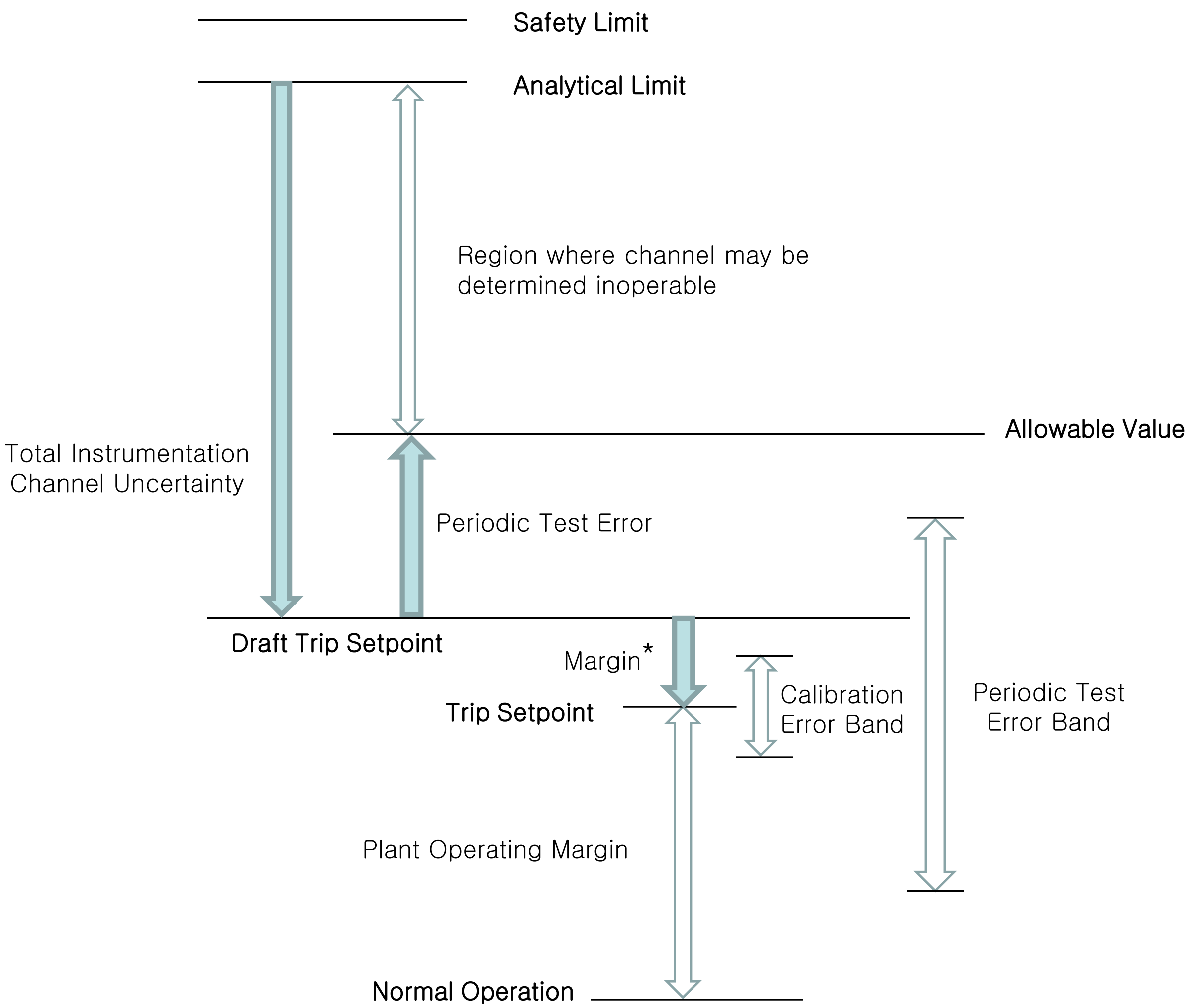
The total instrument channel uncertainty between the AL and the DTSP includes all uncertainty factors existing on the safety-related instrumentation channel signal conditioning device, and safety system cabinet. The total instrument channel uncertainty is generally determined by the algebraic summation of the termination and splicing effect, the static pressure effect, the reference leg error, the dynamic flow error, and the square-root-sum-of-squares (SRSS) combination of the reference accuracy, the drift, the temperature effect, the power supply effect, the radiation effect, the seismic effect, and the measurement test error. The detailed method to combine all uncertainty factors to calculate the total instrument channel uncertainty is described in Section 2.3.3.

The calibration error band shown in Figure 1 is the as-left tolerance (ALT) for the SRSS combination of the reference accuracy, the power supply effect, and the measurement test error of the transmitter, signal conditioning device, and the safety system cabinet. The transmitter and the signal conditioning device errors after calibration are each individually verified to be within their respective calibration error bands.

The periodic test error band shown in Figure 1 is the as-found tolerance (AFT) for the SRSS combination of the reference accuracy, the drift, the temperature effect, the power supply effect, the radiation effect, and the measurement test error of the transmitter, signal conditioning device and the safety system cabinet. The periodic test results for the transmitter and the signal conditioning device are individually verified to be within their respective periodic test error bands. The uncertainty factors to determine the band are selected from those used to determine the total instrument channel uncertainty.

If the instrument reading is within the calibration error band (ALT), the channel is operable and no calibration is required. If the instrument reading is outside the ALT, but within the periodic test error band (AFT), the channel is operable but degraded. Recalibration is required. If the instrument reading is outside the periodic test error band, but within total periodic test error band, the channel is operable, but the evaluation is needed. Recalibration is required. If the instrument reading is outside the total periodic test error band, but within AV, the channel is operable but the evaluation for proper functionally is required.

Also, recalibration is needed. If the instrument reading is outside the AV, the channel is inoperable. Recalibration is required and must be evaluated for returning channel to an operable status.



* Margin will be determined by engineering judgment.

Figure 1 Nuclear safety-related setpoint relationships for rising trip

The remainder of Section 2.0 discusses in more detail the specific components of the setpoint methodology. The uncertainties addressed in this document do not include all uncertainty factors described in Section 4.3.1 of ISA S67.04, Part I.

2.2 Analytical Limit

ALs are the limits of a measured or calculated variables required to ensure that the three primary reactor safety limits are not violated. These limits are: pressurizer pressure not to exceed 2750 psia, DNBR greater than or equal to 1.29, and LPD not to exceed 21.0 kilowatts per foot at a 95/95

probability/confidence level. If protective action is initiated at or before the AL, the integrity of the physical barriers that guard against the uncontrolled release of radioactivity will be maintained.

TSPs, in turn, ensure initiation of protective action at or before reaching the analytical limit. This results in acceptable consequences for safety related DBEs. TSPs also ensure that performance related DBEs can be accommodated without protective action.

Some events analyzed in the safety analysis result in a more severe environment for protection system equipment than other events. As a result, the expected total equipment uncertainties can be event-specific and a trip parameter can have an AL for each design basis event. The remaining parameters, except for three functions having safety limits, have their own design limits that are acceptance criteria for corresponding ALs. The final ALs used in the safety analysis are then used in the setpoint calculation to determine TSPs and AVs, which are described in subsequent sections of this report.

2.3 Equipment Errors

2.3.1 General

Good engineering practice and current setpoint requirements dictate that all factors that can affect the operation of equipment be considered in the setpoint calculation. In this setpoint methodology, uncertainty components are determined separately and combined by a statistically valid method to arrive at a total instrument channel uncertainty. Those uncertainties that are both random and independent are combined by the square-root-sum–of-squares (SRSS) technique, a standard method of combining random uncertainties. Those uncertainties that are non-random and dependent are combined by algebraic summation.

For means of setpoint calculation, the safety system is divided into two major regions. The first region is the measurement channel portion of the instrument loop and it consists of the sensor, transmitter, power supply, and signal processing equipment - all equipment up to the safety system cabinet. This region is susceptible to four individual errors. These individual elements are specific to plant and equipment.

- Measurement Channel Calibration Error
- Measurement Channel Periodic Test Error
- Measurement Channel Worst Case Normal Error
- Measurement Channel Accident Condition Error

The second region is the safety system cabinet itself, which is susceptible to three errors. These individual elements are specific to plant and equipment.

- Safety System Cabinet Calibration Error
- Safety System Cabinet Periodic Test Error
- Safety System Cabinet Worst Case Normal Error

2.3.2 Individual Errors

2.3.2.1 Measurement Channel Calibration Error

The measurement channel calibration error accounts for the uncertainties introduced in the transmitter and/or the signal conditioning device during the calibration process that must be accommodated if the instrumentation is required for protective action immediately after calibration. The measurement channel calibration error is determined from tests and from the information supplied by the manufacturer. The measurement channel calibration error band uses the SRSS combination of the reference accuracy, power supply effect, and measurement test error. The combination method for each trip parameter is described in appendices.

2.3.2.2 Measurement Channel Periodic Test Error

The measurement channel periodic test error for the transmitter and/or the signal conditioning device accounts for the expected, measurable process equipment drift that might accumulate in the maximum allowable calibration interval that is 25% greater than the interval required by the TS. The measurement channel periodic test error band uses the SRSS combination of the reference accuracy, drift, temperature effect, power supply effect, radiation effect, and measurement test error. In this case the measurement test error is taken, twice in the calibration of periodic test error because it must be reapplied at the end of the test interval. The specific combination method for each trip parameter is described in appendices.

2.3.2.3 Measurement Channel Worst Case Normal Error

This error accounts for the maximum expected uncertainty in the measurement channel caused by the environmental extremes, drift and background radiation expected during normal plant operation. The specific combination method for each trip parameter is described in appendices.

2.3.2.4 Measurement Channel Accident Condition Error

During certain design basis events, combinations of atmospheric changes and seismic events are considered to occur simultaneously. Event specific environmental effects on the measure channel equipment can introduce: temperature effects, pressure errors, reference leg heating errors, seismic errors, and radiation errors. The environment postulated in the DCD Sections 7.2 and 7.3 for a specific event determines which environmental errors are combined to calculate the accident environment error for that event. The specific combination method for each parameter is described in appendices. This environment is assumed to be maintained up to the time of reactor trip or ESF actuation. Consequently, the errors associated with a steam line break, feedwater line break and loss of coolant accident can be different and depend on the event temperature and radiation exposure.

2.3.2.5 Safety System Cabinet Calibration Error

The safety system cabinet calibration error accounts for the uncertainties introduced in the safety system cabinet during the calibration process that must be accommodated if the instrumentation is required for protective action immediately after calibration. This error is determined for the specific equipment installed in the safety system cabinet from the information supplied by the manufacturer.

2.3.2.6 Safety System Cabinet Periodic Test Error

The safety system cabinet periodic test error accounts for the expected drift of the safety system cabinet equipment between the periodic channel functional test. The following factors contribute to uncertainty components: setting and checking the setpoint, the difference between safety system cabinet setting and checking environments, and anticipated drift of the safety system cabinet equipment. The maximum interval used is 25% greater than the interval required by the TS. These component errors, which are calculated from manufacturer's information and from tests, are combined to determine the safety system Cabinet Periodic Test Error.

2.3.2.7 Safety System Cabinet Worst Case Normal Error

This error accounts for the safety system cabinet uncertainty caused by the non-containment environmental extremes expected during normal plant operation. The specific combination method for the PPS cabinet worst case normal for each trip parameter error is described in appendices.

2.3.3 Total Instrument Channel Uncertainty

After the individual error components have been determined, they are combined to arrive at a total instrument channel uncertainty, which is used in calculating the TSP. Each individual uncertainty consists of both random (±) and non-random (having a known sign) components. Random uncertainties are combined by the SRSS technique. These are then added algebraically to the non-random uncertainties. The total instrument channel uncertainty is the maximum error that could occur at any time during the periodic surveillance interval for the limiting event for which the function is required to operate. Event-specific total instrument channel uncertainties are calculated for each function, and are used to determine the TSPs.

2.3.3.1 Total Channel Worst Case Normal Error

This error accounts for the total channel uncertainty caused by the environmental extremes expected during normal plant operation. The specific combination method for the total channel worst case normal error is described in appendices.

2.3.3.2 Total Channel Accident Condition Error

This error accounts for the total uncertainty caused by the limiting DBE environment. The specific combination method for the total channel accident condition error is described in appendices.

2.4 Setpoint Determination

2.4.1 Limiting Safety System Setting (LSSS)

Where an LSSS 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 (Reference 4.3). LSSS for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions.

The LSSS, which is maintained in the TS, establishes the AV. The TSP is described in the DCD Sections 7.2 and 7.3 and the AV is required part of the TS.

2.4.2 Trip Setpoint

The DTSP is established to ensure the safety limit by adding/subtracting, in the conservative direction, the event-specific total instrument channel uncertainty to the corresponding AL. The TSP is established by adding/subtracting, in the conservative direction, additional margin for more assurance.

2.4.3 Allowable Value

The AV is less conservative than the DTSP, by the amount of the periodic test error. This uncertainty accommodates the maximum anticipated drift of the transmitter, signal conditioning device, and safety system cabinet between calibrations. The TS requires that, if upon checking a setpoint, the value set in the PPS is less conservative than the AV, the channel must be declared inoperable until the PPS setpoint is reevaluated to a conservative value.

The errors of the transmitter and the signal conditioning device are verified by a channel calibration test during every refueling period. The periodic test for the safety related cabinet is performed during operation for the channel functional test in accordance with Technical Specification.

2.5 Documentation

The description of the setpoint methodology and procedures used in determining setpoints, including information sources, scope, assumptions, interface reviews, and statistical methods will be addressed in the setpoint calculation documents.

3 EQUIPMENT CALIBRATION

3.1 Basic Description

The setpoint methodology determines TSPs and AVs for the PPS trip parameters. When the setpoint calculation is made, it is assumed the equipment will be maintained and will operate in accordance with TS requirements. These requirements cover measurement channel environment, PPS cabinet environment, frequency of calibration and testing, the LSSS setpoint data, and equipment response time limits. The response time analysis is specifically addressed in Reference 4.8. Assumptions and requirements used in the setpoint calculations in these areas form the basis for the PPS operational requirements of the plant TS.

Other assumptions, about the actual operation of the PPS equipment, are not explicitly stated in the TS. Items such as required accuracy (as a function of temperature) of the instruments to be achieved during calibration are supplied to the plant owner as an output of the setpoint calculation results. This information is then incorporated into plant calibration and testing procedures.

This system ensures the equipment is operated in a manner such that the setpoint calculation remains valid. The equipment will then perform conservatively with respect to the safety analysis.

3.2 Technical Specifications

The majority of assumptions are documented in the plant TS. RPS assumptions are entered in TS sections 3.3.1, 3.3.2, 3.3.4, B 3.3.1, B 3.3.2, and B 3.3.4, "Limiting Conditions for Operations", and "Surveillance Requirements". ESFAS assumptions are entered in the corresponding TS sections 3.3.5, 3.3.6, B 3.3.5, and B 3.3.6. Requirements that correspond to setpoint assumptions in these sections include:

1. the frequency of calibrations and the types of testing and calibration

2. the frequency of instrument response time verification and the maximum acceptable response times during testing

The NTSP, AV, AFT, and ALT are stated in TS section 5.5.19, “Setpoint Control Program.”

3.3 Safety-Related Instrumentation Calibration and Testing Data Guidelines

The channel functional test should be performed on the PPS cabinet as stated in the TS in order to verify that the TSP is within the AV.

4 REFERENCES

1. ANSI/ISA-S67.04-1994, "Setpoints for Nuclear Safety-Related Instrumentation.", September 1994

2. US NRC Regulatory Guide 1.105, Rev.03, "Setpoints for Safety-Related Instrumentation," December 1999

3. US NRC 10 CFR 50.36, "Technical Specifications."

4. NUREG-0737, Position 5, "Containment Isolation Dependability," October, 1980

5. NUREG-0800, SRP BTP 7-12, Rev.05, "Guideline on Establishing and Maintaining Instrument Setpoints," March 2007.

6. USNRC Regulatory Issue Summary RIS 2006-17, "NRC Staff Position on the Requirements of 10 CFR 50.36, "Technical Specifications," regarding Limiting Safety System Settings during Periodic Testing and Calibration of Instrument Channels," August, 2006.

7. APR1400-Z-J-NR-14004-P, Rev.02, "Uncertainty Methodology and Application for Instrumentation," January 2018.

8. APR1400-Z-J-NR-14013-P, Rev.02, "Response Time Analysis of Safety I&C System," January 2018.

9. APR1400-F-C-NR-14001-P, Rev.02, "CPC Setpoint Analysis Methodology for APR1400," November 2017.

5 DEFINITIONS

Analytical Limit (AL)

Limit of a measured or calculated variable established by the safety analysis to ensure that a safety limit is not exceeded.

Allowable Value (AV)

A limiting value that the trip setpoint may have when tested periodically, beyond which appropriate action shall be taken.

Calibration Error (CE)

The as-left error of a device or loop due to the potential inaccuracy of test equipment used during calibration.

The calibration error is synonymous with “as-left limit” as used in Reference 4.1 and “setting tolerance” as used in Reference 4.6.

Design Basis Event (DBE)

Postulated events used in the design to establish the acceptable performance requirements for the structures, systems, and components.

Limiting Safety System Setting (LSSS)

Settings for automatic protective devices related to those variables having significant safety functions.

The LSSS, which is maintained in the TS, establishes the AV. The LSSS is selected such that fission product physical barriers will not be penetrated or damaged beyond acceptable limits during DBEs.

Periodic Test Error (PTE)

The as-found error that must be taken into account when the equipment is checked at the end of the periodic surveillance interval in the normal operating environment.

The periodic test error is synonymous with “as-found limit” as used in Reference 4.1.

Safety Limit

Limits on process variables found necessary to protect the integrity of the fission product physical barriers that guard against the uncontrolled release of radioactivity.

Total Instrument Channel Uncertainty

The total instrument channel uncertainty is the combination of all errors that must be taken into account for event-specific environment such as worst case normal and accident condition.

Trip Setpoint (TSP)

A predetermined value for actuation of the final setpoint device to initiate a protective action.

The TSP is the least conservative value that may be set into the protective equipment and still be consistent with the analytical limit assumptions.

APPENDIX A

PRESSURIZER PRESSURE - HIGH

TRIP SETPOINT CALCULATION

(Typical Sample)

I. SAFETY ANALYSIS VALUES

A. Analytical Limit (AL) : AL1 Non Harsh Environment (NHE)

: AL2 Harsh Environment (HE)

II. SAFETY SYSTEM CABINET UNCERTAINTIES (CU)

A. Measurement Test Error

B. Termination Unit Reference Accuracy

C. Termination Unit Temperature Effect

D. Termination Unit Drift

E. Analog Input (A/I) Reference Accuracy

F. Analog Input (A/I) Temperature Effect

G. Analog Input (A/I) Drift

H. Processor Module Reference Accuracy

I. Processor Module Temperature Effect

J. Processor Module Drift

CALIBRATION ERROR

[ ]TS

[

.

]TS

APPENDIX A

PRESSURIZER PRESSURE - HIGH

TRIP SETPOINT CALCULATION

(Typical Sample)

PERIODIC TEST ERROR

[

.

] TS

WORST CASE NORMAL (WCN) ERROR

[ ] TS

III. MEASUREMENT CHANNEL UNCERTAINTIES (MCU)

A. Transmitter Reference Accuracy

B. Transmitter Drift

C. Transmitter Temperature Effects :

1. Normal

2. Accident Condition

D. Transmitter Power Supply Effect

E. Transmitter Radiation Effect :

1. Background

2. Accident Condition

F. Transmitter Seismic Effect

G. Transmitter Measurement, Test Error

H. Signal Conditioning Device Reference Accuracy

I. Signal Conditioning Device Drift

J. Signal Conditioning Device Temperature Effect

K. Signal Conditioning Device Power Supply Effect

L. Signal Conditioning Device Seismic Effect

APPENDIX A

PRESSURIZER PRESSURE - HIGH

TRIP SETPOINT CALCULATION

(Typical Sample)

M. Signal Conditioning Device Measurement, Test Error

N. Termination, Splicing Effects

TRANSMITTER CALIBRATION ERROR

[ ] TS

TRANSMITTER PERIODIC TEST ERROR

[ ] TS

SIGNAL CONDITIONING DEVICE CALIBRATION ERROR

[ ] TS

SIGNAL CONDITIONING DEVICE PERIODIC TEST ERROR

[ ] TS

MEASUREMENT CHANNEL CALIBRATION ERROR

[ ] TS

MEASUREMENT CHANNEL PERIODIC TEST ERROR

[ ] TS

APPENDIX A

PRESSURIZER PRESSURE - HIGH

TRIP SETPOINT CALCULATION

(Typical Sample)

MEASUREMENT CHANNEL WORST CASE NORMAL (WCN) ERROR

[ ]TS

MEASUREMENT CHANNEL ACCIDENT CONDITION (AC) ERROR

[ ]TS

IV. TOTAL CHANNEL WORST CASE NORMAL (WCN) ERROR WITH SEISMIC

Combine:

PPS Cabinet WCN Error : CU(WCN)

Measurement Channel WCN Error : MCU(WCN)

[ ]TS

V. TOTAL CHANNEL ACCIDENT CONDITION (AC) ERROR

Combine:

PPS Cabinet WCN Error : CU(WCN)

Measurement Channel AC Error : MCU(AC)

[ ]TS

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Draft Trip Setpoint = Analytical Limit (AL1) - Total Channel WCN Error

APPENDIX A

PRESSURIZER PRESSURE - HIGH

TRIP SETPOINT CALCULATION

(Typical Sample)

= DTSP1

Draft Trip Setpoint = Analytical Limit (AL2) - Total Channel AC Error

= DTSP2

Allowable Value = DTSP1 or DTSP2 + SRSS (Transmitter, Signal Conditioning Device, Safety System PTE)

More conservative trip setpoint should be selected to calculate allowable value.

Final Trip Setpoint = DTSP1 or DTSP2 - Margin

To reduce the possibility that a periodic test result exceeds the allowable value, the final trip setpoint is margin from the calculated allowable value.

The pretrip setpoint may be determined by engineering judgment.

APPENDIX B

ASSUMPTIONS

I. Calibration and Testing Equipment

The equipment used to calibrate and test the process instrumentation will have an accuracy that is five (5) times better than the accuracy of the process instrumentation being calibrated or tested.

II. Calibration and Testing Interval

The safety system cabinet will be tested on interval that does not exceed 39 days. The transmitter and signal conditioning device will be calibrated on an interval that does not exceed 22.5 months.

III. Nuclear Instrumentation Calibration Interval

Nuclear instrumentation calibration interval will not exceed 3,000 hours

IV. Nuclear Instrumentation Calorimetric Calibration

The uncertainty associated with calculating the secondary calorimetric power and adjusting the linear power signal to accord with the calorimetric calculation will not exceed +/- 4.0% of full power.

NOTE: Any changes to the core operating limit supervisory system (COLSS) can also change the secondary calorimetric power calculation error.

V. Measurement Test Error

Measurement test error is taken twice in the calculation of periodic test error because it must be reapplied at the end of the test interval.