Indian Point 3
Nuclear Power Plant
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Buchanan, New York 10511
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NewYorkPower Authority

Robert J. Barrett
Site Executive Officer

September 8, 2000
IPN-00-066

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: Indian Point 3 Nuclear Power Plant
Docket No. 50-286
Proposed Improved Technical Specifications
Reply to NRC Request for Additional Information

REFERENCE: 1. NRC letter, "Request for Additional Information Regarding Improved Standard Technical Specifications--Indian Point Nuclear Generating Unit No. 3 (TAC No. MA5529)," G. Wunder to J. Knubel, dated August 17, 2000.

Dear Sir:

This is to transmit the Authority's responses to the NRC Requests for Additional Information, (Reference 1) regarding Beyond Scope Review topics for the proposed Improved Technical Specification, Section 3.3, Instrumentation. These responses are consistent with the telephone conference of August 24, 2000 between Indian Point 3 personnel and NRC staff. The responses to the questions are provided in Attachment I. Attachment II is a setpoint calculation as requested in question 5.

The Authority is making no new commitments in this letter. If you have any questions, please contact Mr. Ken Peters,

Very truly yours,

Robert J. Barrett
Site Executive Officer
Indian Point 3 Nuclear Power Plant

cc: next page

A001

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REPLY TO NRC RAIs REGARDING PROPOSED ITS SECTION 3.3, INSTRUMENTATION

Q1: NUREG-1431, Standard Technical Specifications, Surveillance Requirement (SR) 3.3.1.16 and SR 3.3.2.10 require that Reactor Trip System (RTS) and Engineered Safety Features Actuation System (ESFAS) response times are verified to be within limits typically on a refueling time period staggered test bases. The licensee has proposed a NOTE for SR 3.3.1.10 and SR 3.3.1.16 which states that the channel calibration surveillance shall "include verification that the time constants are adjusted to the prescribed values." Discuss why the proposed Improved Technical Specifications (ITS) described in Table 3.3.1-1, Items 11 (Undervoltage Reactor Coolant Pumps (RCPs)) and Item 12 (Underfrequency RCPs) and Table 3.3.2-1, Item 5.d (Loss of Offsite Power-Non SI Blackout Sequence Signal for Indian Point (IP3) omitted the performance of the subject sensor-to-actuation device time response surveillance.

Answer: The STS surveillances for RTS and ESFAS response time testing were not adopted because the IP3 licensing basis does not require response time testing, most likely due to the vintage of the plant. The initial operating license for IP3 was issued in 1975.

Q2: NUREG -1431, Standard Technical Specifications, requires that the allowable values of an upper and lower time delay be specified for the loss of power diesel generator start relays for the loss of voltage and degraded voltage functions. The upper time delay is used to prevent unnecessary separation from the offsite power source as a result of motor starting and other transients. The second time delay determines how long the plant will operate at the degraded voltage level. Explain why the proposed ITS changes (i.e., SR 3.3.5.2) do not include the requirement for upper and lower time delays.

Answer: The time delay settings proposed for the IP3 ITS are the same as the values in the existing Technical Specifications (CTS Table 3.5-1, item 7). These settings were established in Technical Specification Amendment 54 as described in the NRC Safety Evaluation dated April 9, 1985. Therefore, the difference between STS and the proposed IP3 ITS is justified by current licensing basis. By specifying a maximum time delay (i.e., 45 seconds for non-SI conditions and 10 seconds for SI conditions) assurance is provided that electrical equipment will not be damaged by a low voltage power supply. However, the IP3 Technical Specifications do not specify a minimum time delay (referred to as 'upper time delay' in the question). The NRC Safety Evaluation for Amendment 54 found this acceptable.

Q3: Note 1 of Table 3.5-3 in the current IP3 Technical Specifications states that "If the 138 k.V and 13.8kV sources of offsite power are available and the conditions of column 3 or 4 (total number of degraded voltage channels operable) cannot be met within 72 hours then the requirements of 3.7.c.1 or 2 shall be met." IP3 Technical Specification 3.7.c.1 requires a plant shutdown within 30 hours. The proposed ITS changes described by SR 3.3.5.2 implies that one degraded voltage channel can remain inoperable until the plant drops below Mode 4. One channel could experience an incipient failure mode (setpoint

drift/improper calibration) while the other channel is tripped under Limiting Condition for Operation 3.3.5.B which would result in the loss of the degraded voltage function. The licensee is requested to address the technical adequacy of the proposed change for safe plant operation.

Answer: The IP3 ITS does not propose a technical change to the CTS requirements regarding the degraded voltage relays. CTS Table 3.5-3 (Function 4.b and Note 2) states that if one channel becomes inoperable, it must be placed in trip. This requirement is maintained in the proposed ITS as 3.3.5 Condition B. An administrative change is noted in DOC A.6 to explain that since CTS does not specify a completion time for this action, a one-hour completion time is reasonable to use in ITS. Placing the channel in trip satisfies the condition of CTS Table 3.5-3, columns 3 and 4. CTS Table 3.5-3 Note 1 provides a 72-hour restoration time if columns 3 or 4 are not satisfied. After 72-hours, the shutdown requirements of CTS 3.7.C.1 are imposed (hot shutdown in 6 hours and cold shutdown in 36 hours). The equivalent of this requirement is maintained in the proposed ITS as 3.3.5 Condition C, by imposing the Required Actions and Completion Time of ITS 3.8.1 Condition B for an inoperable Diesel Generator (DG). ITS allows 72 hours to restore the DG or plant shutdown in required (Mode 3 in 6 hours and Mode 5 in 36 hours).

Note that the IP3 design does not provide for single failure protection of the degraded voltage function at the instrument level. The degraded voltage function is based on a two-out-of-two logic. With one channel in trip, the actuation logic becomes one-out-of-one. This configuration is acceptable because single failure protection is provided at the bus level. IP3 has three independent safety buses each powered by its own DG. Any two DGs are capable of supplying the required safeguards loads.

Q4: By letter dated February 3, 1994, the licensee stated that the loop accuracy/setpoint calculations show that the existing degraded voltage trip setting or allowable values does not provide sufficient margin to accommodate postulated uncertainties for a 30-month period. Provide degraded voltage setpoint calculations showing all uncertainties used to establish the proposed allowable values in SR 3.3.5.2.b and SR 3.3.5.2.c. Verify that voltages just above the setpoints are adequate to allow all equipment to start and operate properly at all voltage levels down to and including the 120 volt levels.

Answer: Revision 0 of the IP3 ITS incorrectly identified an allowable value of $\geq$ 421 volts for the degraded voltage relays. Revision 1 of the IP3 ITS is being corrected to adopt the CTS value of $\geq$ 414 volts. Therefore there is no change being proposed as part of the conversion to ITS. Note that the basis for the CTS value was described in NYPA letters to NRC; IPN-84-035 dated August 31, 1984 and IPN-84-049, dated October 31, 1984.

Q5: Provide the RCP undervoltage setpoint calculations showing all uncertainties used to establish the proposed allowable values in the ITS SR 3.3.1.11.

Answer: The undervoltage setpoint calculation is provided in Attachment II to this letter. The calculation results are reported in voltage units (78.63 Vac), while the ITS uses percent (68.37%). The conversion is made as follows:

78.63 Vac [(7200/120) / 6900] = 68.37 %
where: 7200/120 is the potential transformer multiplication factor, and
6900 is the bus full voltage

The allowable value is shown as 'n/a' in Table 3.3.1-1 of the proposed ITS because the term 'allowable value' implies that the setting is based on a safety analysis analytical limit and there is no analytical limit for this parameter at IP3. The proposed ITS Bases will contain the following explanation:

"The IP3 Complete Loss of Reactor Coolant Flow Event analysis assumes that the reactor coolant pump UV trip occurs at time zero; hence no trip setpoint is explicitly modeled. Therefore, no Allowable Value applies to this function. The UV relay is adjusted for a nominal trip setpoint of 75% of the 6900 Vac bus voltage."

ATTACHMENT II TO IPN-00-066

NEW YORK POWER AUTHORITY
CALCULATION IP3-CALC-RPC-00291, REVISION 1
6.9kV UNDERVOLTAGE AND UNDERFREQUENCY INSTRUMENT LOOP ACCURACY/UNCERTAINTY CALCULATION
(24 MONTH REFUELING CYCLE)

NEW YORK POWER AUTHORITY
INDIAN POINT 3 NUCLEAR POWER PLANT
DOCKET NO. 50-286
DPR-64

Nuclear Engineering
CALCULATION CONTROL SHEET

Nuclear Plant: IP3 [X] JAF [ ]

CALC. NO. IP3-CALC-RPC-00291 REVISION 1

CALCULATION IS: PRELIMINARY ___ FINAL X

	NAME	SIGNATURE	DATE
PREPARER:	Joseph M. Ashcraft	Joseph M. Ashcraft (A)	2/12/98
CHECKER:	Brad Landry	B. Landry	2/12/98
(DESIGN) VERIFIED/NA	Salvatore D'Auria	S. D'Auria	2/17/98
APPROVED:	Sam Petrosi	S. Petrosi	2/18/98

ORIGINATOR: NYPA [X] OR OTHER [ ]

FOR INFORMATION ONLY

SYSTEM NO./NAME: Reactor Protection and Control (RPC)

TITLE: 6.9kV Undervoltage and Underfrequency Instrument Loop Accuracy / Uncertainty Calculation (24-Month Refueling Cycle)

QA CATEGORY I DISCIPLINE: I&C STRUCTURE: ___

MODIFICATION NO. / TASK NO.: ___ DBD REF. NO.: IP3-DBD-312

PROBLEM/OBJECTIVE/METHOD:

This calculation is being developed in support of the Authority's application for 24-month refueling cycle. As such, the calculation will demonstrate that the Undervoltage and Underfrequency Relay trips will occur within the Analytical Limit (AL) considering additional instrument drift or uncertainties due to extension of the operating cycle from 18-months ± 25% to 24-months ± 25%. (Ref. 3.5.2)

This calculation has been performed in accordance with DCM-2, Preparation and Control of Calculations and Analyses. The calculation is developed, and includes the latest drift analysis (Ref. 3.3.3) values for 30-month surveillance extension.

SYSTEM: RPC

QA CAT: CAT I

FILE #: 44-A-0116

COMP. PRINTOUT LOC: ___

RECEIVED
FEB 24 1998
By ___

DESIGN BASIS / ASSUMPTIONS:

The 6.9kV bus undervoltage and underfrequency trip circuits provide protection against a loss of Reactor Coolant Flow incident. (Section 14.1.6 of Ref. 3.2.3)

See Section 2.0 of this calculation for "Assumptions" and Section 3.0 for "Design Basis".

SUMMARY / CONCLUSIONS:

This calculation demonstrates that the performance of the Undervoltage, Undervoltage Time Delay and Underfrequency Relays; The existing Trip Setpoints for the Undervoltage Time Delay and Underfrequency Relays and the calculated Setpoint for the Undervoltage Relays provide sufficient margin to insure that channel trip will occur within the Analytical Limit (AL), for an extended twenty-four (24) month ± 25% operating cycle. A setpoint change to 91.00 VAC is required for the Undervoltage Relays.

THIS CALC SUPERSEDES OR VOIDS CALC NO.: IP3-CALC-RPC-00291, Rev. 0

DISTRIBUTION: C = CONTROLLED, I = INFO

NAME	DEPARTMENT	LOCATION	C	I
S. Petrosi	IDEE	IP3	C	
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S. Manzione	I&C	IP3	C	
B. Decker	OPERATIONS	IP3		I
T. Orlando	PERFORMANCE	IP3	C	

COMPONENTS

MAJOR EQUIPMENT	PIPE NO.	VALVE NO.	SUPT. NO.	INST. NO.	PENE. NO.
RPS (LOV) Undervoltage Relay				27-1A 27-2A 27-3A 27-4A	
RPS (LOV) Undervoltage Time Delay Relay				27-1-62A 27-2-62A 27-3-62A 27-4-62A	
RPS (w/TDR) Underfrequency Relay				81-1 81-2 81-3 81-4	

RELATED DOCUMENTS

See Section 3.0 of this calculation.

RELATED DRAWINGS

See Section 3.0 of this calculation.

SECURITY: (Y/N) N COMPUTER PRINTOUT: (Y/N) N

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1.0 PURPOSE

This calculation is performed to quantify measurement uncertainties of the Undervoltage Trip Setpoint, Undervoltage Time Delay and Underfrequency Relays and evaluate the impact of those uncertainties on Technical Specification (Tech. Spec.) limits. This calculation will verify that the Undervoltage, Undervoltage Time Delay and Underfrequency Relay trips will occur within the Analytical Limit (AL), and provide accuracy sufficient to support Tech. Spec. requirements, extended to a surveillance interval of 24 Months with a ± 25% grace period. Revision 0 of this calculation supported the Undervoltage Time Delay and Underfrequency Relays surveillance extension based on the consideration of relay drift limits statistically derived from Reference 3.5.1, at a 95 percent probability / 95 percent confidence level (95/95) from historical calibration data. This revision (Rev. 1) supports the Undervoltage and Undervoltage Time Delay Relays, 95/95 drift limits derived from Reference 3.5.2.

This calculation uses only normal plant environmental conditions for the Undervoltage and Underfrequency relays, as the instrumentation is not subjected to adverse environmental conditions. (Ref. 3.2.3)

The Underfrequency and Loss of Reactor Coolant Flow parameters are utilized as input into the Safety Analysis.

2.0 ASSUMPTIONS AND CONDITIONS OF CALCULATIONS

2.1 This calculation does not consider the effects of a design basis seismic event on the Undervoltage and Underfrequency relays. The Undervoltage and Underfrequency relays setting accuracy can not be warranted until a component calibration check is performed should a seismic event occur.

2.2 No margin is initially considered in determining the Undervoltage and Underfrequency relay limits. This calculation evaluates the impact of uncertainty on Tech. Spec. Undervoltage and Underfrequency relay requirements.

2.3 Deleted.

2.4 Instruments outside Containment, except in the Control Room, will be assumed to be calibrated at a minimum ambient temperature of 68 °F, unless otherwise noted.

2.5 The Safety Analysis assumes a time delay from the time of loss of voltage to the initiation of control rod motion. For the purpose of this calculation, one-half (1/2) of this total time delay will be assumed as the Analytical Limit for the Undervoltage time delay relay trip setpoint. (See Section 8.2)

2.6 The maximum trip time for the Reactor Coolant Pump breakers is assumed to be 9 cycles (150 ms). This time is from the moment the trip coil is energized, to opening of the auxiliary contacts. This value is conservative, given that Westinghouse has verified that 75DH500 Breakers typically trip within 8 cycles. (Ref. 3.1.9)

2.7 Unless otherwise stated, vendor rated Reference Accuracy (RA) specification includes the combined effects of repeatability, linearity, and hysteresis.

2.8 Under normal operating conditions it is assumed the Humidity Effects (HE) are routinely calibrated out on a periodic basis, are not cumulative and therefore are considered to be negligible.

2.9 Normal Radiation Effects (RE) are calibrated out on a periodic basis, are not cumulative, and therefore are considered to be negligible.

2.10 The relays are located in a mild environment, Turbine Building 15' elevation. The Turbine Hall and Heater Bay has outside air entering the turbine building through fixed and variable louvers, and awning sashes along the west wall. Ventilation air in the Turbine Hall is warmed by heat lost from equipment. The fan house is ventilated by a thermostatically controlled louvers. The louvers are set to open and close at 95°F and 90°F. The UV & UF Reactor Trip functions are required when the Reactor Trip Breakers are closed. Normal Plant Startup would have the Reactor Coolant System at Normal Operating Temperature & Normal Operating Pressure (NOT/NOP), This means that the Secondary System is in

service, hence the Turbine Building is warm. Therefore, it is assumed that the temperature ranges from 65°F to 95°F. (Page 5 & 25 of Ref. 3.1.8)

2.11 The effects of normal vibration (or a minor seismic event that does not cause an unusual event) on a component are assumes to be routinely calibrated out on a periodic basis, are not cumulative and therefore are considered to be negligible.

2.12 Under normal operating conditions, the effects caused by insulation resistance leakage are assumed to be negligible.

2.13 Measuring and Test Equipment (M&TE) is assumed to have an accuracy greater than or equal to the requirements of IC-AD-2, Calibration and Control of M&TE. This assumption includes MTE reading error and / or reference standard error. Relative to the magnitude of other channel uncertainties; the inaccuracies contributed to M&TE uncertainty by the reference standards used to calibrate the MTE are assumed to be negligible. (Ref. 3.4.1)

- A Doble FT-2, ± 1 least significant digit, for all ranges. For msec range (0 - 99.9), the least significant digit would be 0.1 msec. This calculation uses 0.10% to evaluate uncertainty. (Ref. 3.6.7)
- A Fluke 8810A DVM, 4½ digit, (or equivalent) on the two volt scale is 0.03% of reading + 2 digits, for all ranges. This calculation conservatively uses 0.04% to evaluate uncertainty. (Refs. 3.6.8 & 3.6.9)
- A Visicorder, 5-interval timing system is ± 0.10%. This calculation uses 0.10% to evaluate uncertainty. (Ref. 3.6.10)

2.14 There is no temperature rating for the Underfrequency time delay portion of the relay. It is conservative to assume this is equal to the Underfrequency relay temperature effect, because both functions are supplied in the same device.

2.15 It is assumed that loop components are calibrated consistent with the method specified in the IP3 calibration procedure.

2.16 Static Pressure (SP) effects are not applicable to purely electronic or electrical components.

2.17 Sensor drift will be monitored in the Drift Monitoring Program to ensure the values in this calculation remain bounding. (Ref. 3.1.20)

3.0 REFERENCES

3.1 General

3.1.1 U.S. NRC, Regulatory Guide 1.105, Instrument Setpoints for Safety-Related Systems, 2/86

3.1.2 ISA-S67.04, Part I, Setpoints for Nuclear Safety-Related Instrumentation. 9/94

* 3.1.3 ISA RP67.04, Part II Recommended Practice, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation, 9/94

* 3.1.4 IES-3, Instrument Loop Accuracy and Setpoint Calculations, Rev. 1

3.1.5 DCM-2, Preparation and Control of Calculations and Analyses, Rev. 7

* 3.1.6 Plant Equipment Database (PEDB) cut sheets, tag numbers;

LOV Relay	27-1-A, 27-2-A, 27-3-A and 27-4-A
LOV TDR	27-1-62A, 27-2-62A, 27-3-62A and 27-4-62A
UF Relay	81-1, 81-2, 81-3 and 81-4

3.1.7 System Description, No. 27.1, Electrical Systems, Rev. 0

* 3.1.8 System Description, No. 11.0, Ventilation System, Rev. 0

3.1.9 Notes of telephone conversation, between G. Durniak/NYPA and W. Adamsky/Westinghouse, concerning trip response time of 75DH500 breakers, Shop Order 25-Y-6757, 10/20/92

3.1.10 Proto-Power Telecommunications, Test reports, and Protective Relay Data Sheets, 10/6/92

3.1.11 JB-D&A84-101, Letter from J. Bashian to G. Laszlo / L. Burnett, Degraded Grid Voltage Studies Report, Phase III, Report No. RPT-EDA-84-08 (DSR No. 169370), 10/29/84

3.1.12 Memo from G.D. Rockefeller to J. Tamburri, Settings for L&P Underfrequency and Undervoltage Relays, 1/7/74

3.1.13 Memo from G. D. Rockefeller to J. Tamburri, Temporary Settings for L&P Undervoltage Relays, 7/25/75

*Used as Design Input

3.1.14 Memo from G.D. Rockefeller to J. Tamburri, Relay Settings for Reactor Undervoltage Trip, 10/29/76

3.1.15 Memo from H. Calhoun / ABB to G. Durniak / NYPA, CV-7, SV, KF Relay Data. 1/10/92

* 3.1.16 NYPA Response Letter to NRC, from W. Cahill to R. Reid, (DSR No. 37486), 8/29/77

3.1.17 Deleted

3.1.18 IEEE Transactions on Power Apparatus and Systems, Volume PAS-95, No. 1, Determination of Frequency Decay Rates, 2/76

* 3.1.19 Notes of telephone conversation, between G. Durniak / NYPA and W. Elmore /ABB, Westinghouse Type KF Relay Power Supply Uncertainty, 5/21/92

3.1.20 IC-AD-34, Drift Monitoring Program, Rev. 1

* 3.1.21 Design Basis Document, IP3-DBD-312, Reactor Protection System / Engineered Safeguards System (RPS/ESS), Rev. 0

3.2 IP3 Updated Final Safety Analysis Report (FSAR), 12/95

3.2.1 Chapter 16, Section 16.3.3, Seismic Testing of Instrument and Control Equipment

3.2.2 Chapter 8, Section 8.2.2, Station Distribution System

3.2.3 Chapter 14, Safety Analysis

* 3.2.4 Chapter 15, Technical Specification and Bases for Indian Point Nuclear Generating Unit Number 3, (Volumes 1 and 2) through Amendment No. 176

3.3 Drawings

3.3.1 Main Three Line Diagrams;
9321-F-30113, Sht. 1, Rev. 25
9321-F-30113, Sht. 2, Rev. 3
9321-F-30113, Sht. 3, Rev. 0

* 3.3.2 Elementary Wiring Diagrams;
500B971, Sht. 15, Rev. 9
500B971, Sht. 16, Rev. 6
500B971, Sht. 17, Rev. 5
500B971, Sht. 18, Rev. 6
500B971, Sht. 19, Rev. 6
500B971, Sht. 20, Rev. 4

* 3.3.3 Equipment Arrangement Drawings;
9321-F-70053, Equipment Arrangement, Turbine Building, Rev. 15

3.3.4 617F643, 6900V One Line Diagram, Rev. 8

3.3.5 617F645, Main One Line Diagram, Rev. 14

* 3.3.6 Reactor Protection System Schematics;
113E301, Sht. 2, Rev. 9
113E301, Sht. 9, Rev. 8
113E301, Sht. 11, Rev. 18

3.3.7 Schematic Diagrams;
9321-LL-31133, Sht. 7, Rev. 9
9321-LL-31133, Sht. 8, Rev. 8
9321-LL-31133, Sht. 9, Rev. 12
9321-LL-31133, Sht. 10, Rev. 9

3.4 Calibration Procedures

3.4.1 IC-AD-2, Calibration and Control of Measuring and Test Equipment, Rev. 12

* 3.4.2 AP-19, Surveillance Test Program, Rev. 21

* 3.4.3 AP-17, Calibration of M&TE, Rev. 5

* 3.4.4 3PC-R5A, 6.9kV Undervoltage Relay Calibration and Agastat Time Response, Rev. 14

* 3.4.5 3PC-R5B, 6.9kV Underfrequency Relays Calibration, Rev. 11

3.4.6 Deleted

*Used as Design Input

* 3.4.7 3PT-R91, Reactor Trip and Bypass Breaker Response Time and Trip Verification, Rev. 9

3.5 Drift Reports

* 3.5.1 Report, IP3-RPT-RPC-00357, Instrument Drift Analysis for RPS, 11/10/92

* 3.5.2 Report, IP3-UNSPEC-02662 (Westinghouse Letter INT-97-701), Surveillance Interval Extension Project: RCP 6.9kV Undervoltage Relay and Agastat Time Delay Relay Sensor Drift, 10/24/97

3.6 Product Literature

3.6.1 Deleted

* 3.6.2 I. L. 41-503L, Westinghouse KF Underfrequency Relay Instructions, Tech Manual WE-49, 1/74

* 3.6.3 Agastat 2100 Series Timing Relay, Amerace Corp. Industrial Catalog, 12/89

* 3.6.4 ABB/Westinghouse Instrument Transformer Reference, Voltage Transformers, Type VOY and VOZ, (ABB File No. 42-000 H90)

* 3.6.5 I. L. 41-766.1K, Westinghouse Instruction, Type SV Relay, 12/86

* 3.6.6 I.L.41-753.1K, Westinghouse MG-6 Relay Instruction Manual, 12/88

* 3.6.7 Operating Manual, Doble, Model FT2 Power System Timer, 1/82

* 3.6.8 Specification Sheet, Fluke Digital Multimeters & Voltmeters, Model 8810A, 1994

3.6.9 Specification Sheet, Fluke Bench / Portable Multimeters & Voltmeters, Model 8050A, 1994

* 3.6.10 Product Information, Honeywell Visicorder, Model 1858

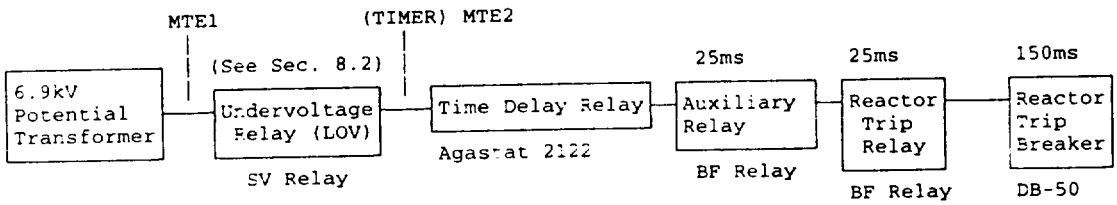
4.0 LOOP FUNCTION

A loss of reactor coolant flow incident can result from a fault in the Reactor Coolant Pumps power supply.

The 6.9kV low voltage and low frequency trip circuits provide a part of the necessary protection against a loss of reactor coolant flow incident.

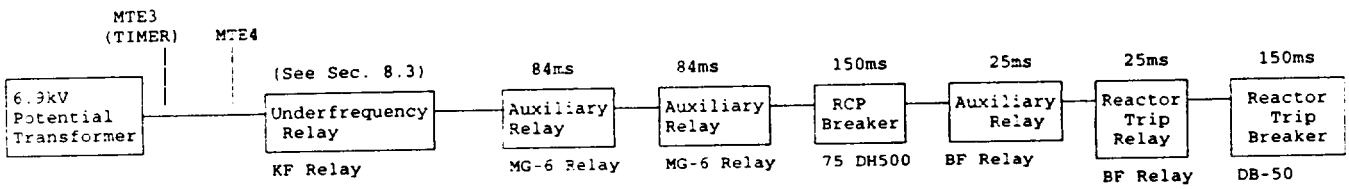
(Sect. 14.1.6 of Ref. 3.2.3)

5.0 LOOP (BLOCK) DIAGRAM



The diagram above is similar for four (4) loops, as follows; (Ref. 3.3.2)

BUS	UNDERVOLTAGE (LOV) RELAY	TIME DELAY RELAY	AUXILIARY RELAY	REACTOR TRIP RELAY	REACTOR TRIP BREAKER
1 2 3 4	27-1A 27-2A 27-3A 27-4A	27-1-62A 27-2-62A 27-3-62A 27-4-62A	27-1-X-1-X 27-2-X-1-X 27-3-X-1-X 27-4-X-1-X	RT13, RT14 (Trains A & B)	52/RT, 52/BY (Trains A & B)



The diagram above is similar for four (4) loops, as follows; (Ref. 3.3.2)

BUS	UNDER FREQUENCY RELAY	AUXILIARY RELAY	AUX. RELAY	RCP Breaker	AUX. RELAY	REACTOR TRIP RELAY	REACTOR TRIP BREAKER
1 2 3 4	81-1 81-2 81-3 81-4	81-1-X1 81-2-X1 81-3-X1 81-4-X1	81T, 81T2	52/RPC31 52/RPC32 52/RPC33 52/RPC34	52/RPC-31X 52/RPC-32X 52/RPC-33X 52/RPC-34X	RT13, RT14 (Trains A & B)	52/RT, 52/BY (Trains A & B)

5.1 Input Table

LOOP COMPONENTS

(Ref. 3.1.6)

TAG	SYSTEM	BUILDING	BUS	MODEL
27-1A 27-2A 27-3A 27-4A	ED	TB ELEV. 15	1 2 3 4	WESTINGHOUSE TYPE SV
27-1-62A 27-2-62A 27-3-62A 27-4-62A	ED	TB ELEV. 15	1 2 3 4	AGASTAT 2122DH39Y (Sht. 20 of Ref. 3.3.2)
81-1 81-2 81-3 81-4	ED	TB ELEV. 15	1 2 3 4	WESTINGHOUSE TYPE KF

6.0 LOOP UNCERTAINTY EQUATIONS

6.1 Instrument Channel Uncertainty (CU)

The instrument channel uncertainty can be calculated with a single loop equation containing all potential uncertainty values, or by a series of related term equations. The specific channel calculation will coincide with the channel's layout from process measurement to final output module or modules. Random channel uncertainties may be combined using Square-Root Sum-of-Squares (SRSS) method. Any positive (B^+) or negative (B^-) bias associated with the instrument channel uncertainty is combined algebraically.

The typical equation for linear CU will have the following form;

$$CU = \pm \sqrt{PM^2 + PE^2 + e_1^2 + e_2 + e...^2 + e_n^2} + IRE^2 \pm B \qquad \text{(Ref. 3.1.4)}$$

Where;

PM	=	Random uncertainties that exist in the channel's basic Process Measurement.
PE	=	Random uncertainties that exist in the channel's Primary Element or; any system element that quantitatively converts the measured variable energy into a form suitable for measurement.
e_n	=	Random uncertainties that are associated with any module or; assembly of interconnected components that constitutes an identifiable device, instrument, or piece of equipment.
IRE	=	Insulation Resistance Effect leakage allowance in percent of span; resulting from high humidity and temperature subsequent to an accident.
B	=	An uncertainty of the process that consistently has the same algebraic sign and is expressed as an estimated limit of error.

6.2 Module Uncertainties (e_n)

The random individual module uncertainties are also a statistical combination of uncertainties. Depending on the type of module, it's location, and the specific factors that can affect it's accuracy, the determination of the (e_n) will vary. Random module uncertainties may be combined using Square-Root Sum-of-Squares (SRSS) method. Any positive (B^+) or negative (B^-) bias associated with the instrument channel uncertainty is combined algebraically.

The typical equation for e_n will have the following form;

$$e = \pm\sqrt{RA^2 + DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

However, using plant historical data (i.e. AF - AL values) as the basis for DR, RA will be deleted as it is included in this data. Therefore; (Ref. 3.1.4)

$$e = \pm\sqrt{DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Where;

RA	=	Module Reference Accuracy specified by the manufacturer
DR	=	Drift of the module specified over a specific time period
TE	=	Temperature Effect for the module; the effect of ambient temperature variations on module accuracy; the TE may be an accident TE, or normal operating TE as required
RE	=	Radiation Effect for the module; the effect of radiation exposure on module accuracy; the RE may be an accident RE, or time of trip RE as required
SE	=	Seismic Effect or vibration effect for the module; the effect of seismic or operational vibration on module accuracy
HE	=	Humidity Effect for the module; the effect of changes in ambient humidity on module accuracy resulting form a design base event
SP	=	Static Pressure effect for the module; the effect of changes in process static pressure on module accuracy
PS	=	Power Supply effects for the module; the effect any change in voltage or frequency may have in the module accuracy
MTE	=	Measuring and Test Equipment effect for the module; this accounts for the uncertainties in the equipment utilized for calibration of the module
ALT	=	The range of the measured parameter that an instrument can be left at without adjustment during calibration
B	=	An uncertainty of the process that consistently has the same algebraic sign and is expressed as an estimated limit of error

6.3 As-Found Tolerance (AFT)

The As-Found Tolerance values determine the expected measurable performance of the loop components over the calibrated interval.

The typical equation for AFT will have the following form;

$$\mathbf{AFT} = \pm\sqrt{RA^2 + DR^2 + ALT^2}$$

For the same reason as stated in Section 6.2;

$$\mathbf{AFT} = \pm\sqrt{DR^2 + ALT^2}$$

6.4 Trip Setpoint (TS)

The predetermined value for actuation of the final actuation device to initiate protective action may be determined by adding or subtracting CU and margin to a predetermined limit; Analytical Limit (AL) or the Nominal Process Limit (NPL). Addition or subtraction is based on the conservative direction of the process variable with respect to the applicable limit. For process variables decreasing toward a limit, CU and margin are added to the limit. For process variables increasing toward a limit, CU and margin are subtracted from the limit.

The typical equation for TS will have the following form;

TS = AL or NPL ± [CU + margin]

Where;

TS = Trip Setpoint

AL = Analytical Limit - the limit of a measured or calculated variable established by the safety analysis to ensure that a Safety Limit (SL) is not exceeded

NPL = Nominal Process Limit - The limit of a measured or calculated variable established by system or equipment operational requirements, performance expectations and/or historical operational data to ensure that a system or equipment operational limit is not exceeded

Margin = The amount chosen, if operationally supportable, for conservatism of the trip setpoint, see Assumption 2.2

6.5 The following uncertainty terms are taken to be either negligible, not applicable, or included in other terms:

6.5.1 Undervoltage Relay (27-1A, 2A, 3A and 4A)

6.5.1.1 Per Assumption 2.9, RE - Module radiation effect is considered negligible.

6.5.1.2 Per Assumptions 2.1& 2.11, SE - Module seismic effect is considered negligible.

6.5.1.3 Per Assumption 2.8, HE - Module humidity effect is considered negligible.

6.5.1.4 Per Assumption 2.16, SP - Module Static Pressure effect is not applicable.

6.5.2 Undervoltage Time Delay Relay (27-1-62A, 2-62A, 3-62A and 4-62A)

6.5.2.1 Per Assumption 2.9, RE - Module radiation effect is considered negligible.

6.5.2.2 Per Assumptions 2.1& 2.11, SE - Module seismic effect is considered negligible.

6.5.2.3 Per Assumption 2.8, HE - Module humidity effect is considered negligible.

6.5.2.4 Per Assumption 2.16, SP - Module Static Pressure effect is not applicable.

6.5.3 Underfrequency Relay (81-1, 81-2, 81-3 and 81-4)

6.5.3.1 Per Assumption 2.9, RE - Module radiation effect is considered negligible.

6.5.3.2 Per Assumptions 2.1& 2.11, SE - Module seismic effect is considered negligible.

6.5.3.3 Per Assumption 2.8, HE - Module humidity effect is considered negligible.

6.5.3.4 Per Assumption 2.16, SP - Module Static Pressure effect is not applicable.

7.0 DETERMINE CHANNEL UNCERTAINTY (CU)

7.1 Process Measurement Uncertainty (PM)

Process Measurement Uncertainty is considered negligible for a voltage or frequency measurement, and not applicable for a time delay.
Therefore;

PM = ± 0. 00 VAC

7.2 Primary Element Uncertainties (PE)

Westinghouse 6.9kV Potential Transformers are typically ANSI 0.3 Accuracy Class. (Ref. 3.6.4)

This corresponds to ± 0.30% x 120.00 VAC (Secondary) = ± 0.36 VAC.
Therefore;

PE = ± 0.36 VAC

7.3 Insulation Resistance Effect (IRE)

Both the Undervoltage (LOV) and Underfrequency Relays in 6.9kV Switchgear 31 and 32 are located in the Turbine Building, Elevation 15', which is a mild environment. (Ref. 3.3.3 & Assum. 2.12)
Therefore;

IRE = ±0.00 VAC

7.4 Undervoltage (LOV) Relay Trip Setpoint Uncertainty (e_1)

Given the following Undervoltage (LOV) Relay uncertainties:

7.4.1 Reference Accuracy (RA_1)

Vendor Reference Accuracy is not given for the SV-7 relays. (Ref. 3.6.5)
However, per Section 6.2, RA is not included.

RA_1 = ± 0. 00 VAC

7.4.2 Drift (DR_1)

Per Ref. 3.5.2, DR for 30-months is expected to be ± 10.90, +1.10 VAC.

DR_1 = ± 10.90, + 1.10 VAC

7.4.3 Temperature Effect (TE_1)

Vendor Temperature Effect is not given for the SV series relays. The only reference to temperature is in the Installation section of the Instruction, which states that these relays should be mounted in a location free from dirt, moisture, excessive vibration and heat. For conservatism, the TE for the Undervoltage Time Delay will be used, as it is located in close proximity to the Undervoltage Trip relay. It should be noted that this conservatism is generous, because the Time Delay Relay is composed of elastomers, which are susceptible to Temperature effects, whereas the SV series relays are not. (Ref. 3.6.5)

Per Assumption 2.10 and Sub-section 7.5.3, TE = ± 3.00% of setting.

TE_1 = (± 3.00% x 86.25 VAC)
TE_1 = ± 2.59 VAC

This calculation will use ± 2.73 VAC reflect anticipated setpoint change.

TE_1 = ± 2.73 VAC

7.4.4 Measuring & Test Equipment (MTE_1)

A Digital Volt Meter (DVM) Fluke 8810A (or Equivalent) is used to calibrate the Undervoltage relay. (Ref. 3.4.4)

Converting the MTE DVM uncertainty to VAC;

MTE_1 = (± 0.04% x 115.00 VAC) (Assum. 2.13)
MTE_1 = ± 0.046 VAC

Therefore;

MTE_1 = ± 0.05 VAC

7.4.5 Power Supply Effect (PS_1)

The undervoltage relays are powered from the potential transformers on the 6.9kV bus. Therefore, any PS effects are included in Section 7.2.

PS_1 = 0.00 VAC

7.4.6 As-Left Tolerance (ALT_1)

The As-Left Tolerance for the Undervoltage Relays is shown to be +3.00, -0.00 VAC. (Ref. 3.4.4)

Therefore;

ALT_1 = +3.00, -0.00 VAC

7.4.7 Module Uncertainty (e_1)

From Section 6.2 the general form of the device uncertainty equation is;

$$e = \pm\sqrt{DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2 + R^2} \pm B$$

Removing the uncertainties listed in Section 6.5.1 as negligible, or not applicable;

$$e_1 = \pm\sqrt{DR^2 + TE^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Substituting;

$$e_1 = +\sqrt{10.90^2 + 2.73 + 0.05^2 + 0.00^2 + 3.00^2} + 1.10$$

$$e_1 = -\sqrt{+10.90^2 + 2.73 + 0.05^2}$$

e_1 = + 12.73 VAC, - 11.24 VAC

7.5 Undervoltage (LOV) Time Delay Relay Uncertainty (e_2)

Given the following Undervoltage (LOV) Relay Time Delay uncertainties;

7.5.1 Reference Accuracy (RA_2)

The Vendors Repeat Accuracy is given as ± 5.00% at 25°C.
However, per Section 6.2, RA is not included. (Page 11 of Ref. 3.6.3)

RA_2 = ± 0. 00% of Setting

7.5.2 Drift (DR_2)

Per Ref. 3.5.2, DR for 30-months is expected to be ± 36.40, -2.00 msec.

$$\frac{\pm 36.40\ msec}{500.00\ msec} = \pm 7.28\%$$

$$\frac{-2.00\ msec}{500.00\ msec} = -\ 0.40\%$$

DR_2 = ± 7.28, - 0.40% of Setting

7.5.3 Temperature Effect (TE_2)

The relays are located in a mild environment. The temperature ranges from 65 to 95°F (18.33 to 35.00°C). (Assumption 2.10)

The vendor specified average time delay between -55.00°C and 85.00°C will be within ± 20.00% of the average at 25.00°C, with a proportionally reduced effect at lesser extremes. (Page 11 of Ref. 3.6.3)

This represents a temperature change of 80.00°C below and 60.00°C above 25.00°C.

The calibration performed at a minimum ambient temperature of 68.00°F (20.00°C) per Assumption 2.4.

Therefore,

18.33-25.00°C = 6.67°C ,for the cooling off case
35.00-25.00°C =10.00°C ,for the heating up case

For the cooling off case;

20% x 6.67°C / 80°C = 0.42% of setting

For the heating up case;

20% x 10.00°C / 60°C = 3.00% of setting

TE_2 = ± 3.00% of Setting

7.5.4 Measuring and Test Equipment (MTE_2)

A Doble FT2, Visicorder, or Equivalent, is used to calibrate the Undervoltage Time Delay Relay. (Ref. 3.4.4)
Therefore; (Assum. 2.13)

MTE_2 = ± 0.10% of Setting

7.5.5 Power Supply Effect (PS_2)

The preset time delay period for an Agastat Series 2122 (off-delay) pneumatic relay begins as soon as the coil is de-energized. No power is required during the timing period. (Page 11 of Ref. 3.6.3)

$PS_2 = \pm 0.00\%$ of Setting

7.5.6 As-Left Tolerance (ALT_2)

The Calibration Procedure Tolerance for the Undervoltage time delay relays is shown to be ± 25.00 milliseconds for a setting of 500.00 milliseconds. (Ref. 3.4.4)

$$\frac{25.00\ msec}{500.00\ msec} = \pm\ 5.00\%$$

$ALT_2 = \pm 5.00\%$ of Setting

7.5.7 Module Uncertainty (e_2)

From Section 6.2, the general form of the device uncertainty equation is;

$$e = \pm\sqrt{DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Removing the uncertainties listed in Section 6.5.2 as negligible, or not applicable;

$$e_2 = \pm\sqrt{DR^2 + TE^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Substituting;

$$e_2 = \pm\sqrt{7.28^2 + 3.00^2 + 0.00^2 + 0.10^2 + 5.00^2} - 0.40$$

$e_2 = +9.33, -9.73\%$ of Setting

7.6 Underfrequency Relay Uncertainty, Time Delay (e_3)

Given the following Underfrequency Relay time delay uncertainties;

7.6.1 Reference Accuracy (RA_3)

The Vendor Reference Accuracy is not given for the Underfrequency Relay time delay. (Ref. 3.6.2)

However, per Section 6.2, RA is not included.

$RA_3 = \pm 0.00\%$ of Setting

7.6.2 Drift (DR_3)

Vendor drift data is not available for the underfrequency relays time delay. (Ref. 3.6.2)

However, the Instrument Drift Analysis for RPS (Ref. 3.5.1) provides an evaluation of relay performance, based on a statistical study of actual As-Found and As-Left values. The Maximum Expected Drift for a 30-month period (MED30) for the relays is shown to be within ± 19.32% of Setting.

MED30 represents the combined uncertainty due to RA and DR effects as a minimum.

DR_3 = ± 19.32% of Setting

7.6.3 Temperature Effect (TE_3)

Per Assumption 2.14 and Section 7.7.3, TE = ± 0.18% of setting.

TE_3 = ± 0.18% of Setting

7.6.4 Measuring and Test Equipment (MTE_3)

A Visicorder (or Equivalent) is used to calibrate the Undervoltage Time Delay relay. (Ref. 3.4.5 & Assum. 2.13)

Therefore;

MTE_3 = ± 0.10% of Setting

7.6.5 Power Supply Effect (PS_3)

Per conversation with ABB, the power supply uncertainty for a KF Type relay with a DC timer is negligible. (Ref. 3.1.19)

PS_3 = ± 0.00% of Setting

7.6.6 As-Left Tolerance (ALT_3)

The Calibration Procedure Tolerance for the Underfrequency relays time delay is shown to be -0.016 Seconds. (Ref. 3.4.5)

$$\frac{-0.016}{0.10} = -16.00\%$$

ALT_3 = +0.00, -16.00% of Setting

7.6.7 Module Uncertainty (e_3)

From Section 6.2, the general form of the device uncertainty equation is;

$$e = \pm\sqrt{DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Removing the uncertainties listed in Section 6.5.3 as negligible, or not applicable;

$$e_3 = \pm\sqrt{DR^2 + TE^2 + MTE^2 + PS^2 + ALT^2} \pm B$$

Substituting;

$$e_3 = +\sqrt{19.32^2 + 0.18^2 + 0.10^2 + 0.00^2 + 0.00^2}$$

$$e_3 = -\sqrt{19.32^2 + 0.18^2 + 0.10^2 + 0.00^2 + 16.00^2}$$

e_3 = + 19.32, - 25.09% of Setting

7.7 Underfrequency Relay Trip Setpoint Uncertainty (e_4)

Given the following Underfrequency Relay uncertainties;

7.7.1 Reference Accuracy (RA_4)
The vendor reference accuracy is not given for the Underfrequency Relays. (Ref. 3.6.2)

However, per Section 6.2, RA is not included.

RA_4 = ± 0. 00% of Setting

7.7.2 Drift (DR_4)

Vendor drift data is not available for the underfrequency relays. However, the Instrument Drift Analysis for RPS (Ref. 3.5.1) provides an evaluation of relay performance, based on a statistical study of actual As-Found and As-Left values. The Maximum Expected Drift for a 30-month period (MED30) for the relays is shown to be within ± 0.46% of Setting. MED30 represents the combined uncertainty due to RA and DR effects as a minimum.

DR_4 = ± 0.46% of Setting

7.7.3 Temperature Effect (TE_4)

The Temperature Effect is shown to be within ± 0.10 Hz from -86.00°F (-30.00°C) to 158.00°F (70.00°C). (Fig. 6 of Ref. 3.6.2)

This is equivalent to;

$$\frac{0.10}{55.00} = \pm 0.18\% \text{ of Setting (Max.)}$$ (Sect. 8.4)

It is conservative to assume that the equipment operates to the ends of the temperature range.

TE_4 = ± 0.18% of Setting

7.7.4 Measuring and Test Equipment (MTE_4)

A Visicorder (or Equivalent) is used to calibrate the Undervoltage Time Delay relay. (Ref. 3.4.5)

Therefore; (Assum. 2.13)

MTE_4 = ± 0.10% of Setting

7.7.5 Power Supply Effect (PS_4)

For an AC impressed voltage as low as 60.00 VAC (from the Potential Transformer), the minimum trip frequency is shown to be within -0.10 Hz for a Setting of 55.00 Hz. (Sect. 8.4 and Fig. 7 of Ref. 3.6.2)

$$\frac{-0.10}{55.00} = -0.18\% \text{ of Setting (Max.)}$$ (Sect. 8.4)

This will cause the relay to trip later for a decreasing variable (frequency). Therefore, this represents a positive bias on a loop basis, equivalent to;

PS_4 = + 0.18% of Setting (bias)

7.7.6 As-Left Tolerance (ALT_4)

The Calibration Procedure Tolerance for the underfrequency relays is shown to be + 0.10 Hz. (Ref. 3.4.5)

$$\frac{+0.10}{55.00} = +0.18\% \text{ of Setting}$$ (Sect. 8.4)

ALT_4 = + 0.18, -0.00 % of Setting

7.7.7 Rate of Change Effect

In addition to the effects itemized above, the vendor also provides the change in trip frequency due to the rate of change in bus frequency. The Safety Analysis assumes the Rate of Change in bus frequency to be 10.00 Hz/Sec. (Page 14.1-42 of Ref. 3.2.3)

The change in trip frequency at contact closure for a rate of change in frequency of 10.00 Hz/Sec. is shown to be -2.00 Hz, for a 6 cycle delay setting.

(Fig. 5 of Ref. 3.6.2)

This change causes the relay to trip later for a decreasing variable. Therefore, this represents a positive bias on a loop basis, equivalent to:

$$\frac{2.00}{55.00} = +3.64\% \ (Max.)$$

B = + 3.64% of Setting (bias) (Sect. 8.4)

7.7.8 Module Uncertainty (e_4)

From Section 6.2, the general form of the device uncertainty equation is;

$$e = \pm\sqrt{DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2 + ALT^2} \pm B$$

Removing the uncertainties listed in Section 6.5.3 as negligible, or not applicable;

$$e_4 = \pm\sqrt{DR^2 + TE^2 + MTE^2 + ALT^2} \pm B$$

Substituting;

$$e_4 = +\sqrt{0.46^2 + 0.18^2 + 0.10^2 + 0.18^2} + 0.18 + 3.64$$

$$e_4 = -\sqrt{0.46^2 + 0.18^2 + 0.10^2 + 0.00^2}$$

e_4 = + 4.36, - 0.50% of Setting

7.8 Calculate Channel Uncertainty (CU)

General equation for CU is provided in Section 6.1, reduced to applicable terms for each channel, as developed below. Channel configuration is shown in Section 5.0.

$$CU = \pm\sqrt{PM^2 + PE^2 + e_1^2 + e_2 + e...^2 + e_n^2} + IRE^2 \pm B \qquad \text{(Ref. 3.1.4)}$$

Where;

PM -	Random uncertainties that exist in the channel's basic Process Measurement
PE -	Random uncertainties that exist in the channel's Primary Element or; any system element that quantitatively converts the measured variable energy into a form suitable for measurement
e_n -	Random uncertainties that are associated with any module or; assembly of interconnected components that constitutes an identifiable device, instrument, or piece of equipment
IRE -	Insulation Resistance Effect leakage allowance in percent of span; resulting from high humidity and temperature subsequent to an accident
B -	An uncertainty of the process that consistently has the same algebraic sign and is expressed as an estimated limit of error

7.8.1 Undervoltage (LOV) Relays; 27-1A, 27-2A, 27-3A and 27-4A

PM	There are no Process Measurement uncertainties identified for this loop
PE	Per Sub-Section 7.2
e_1	Per Sub-Section 7.4
IRE	Per Sub-Section 7.3
B	There are no Bias uncertainties identified for this loop

Deleting negligible and not applicable terms results in:

$$CU_{e1} = \pm\sqrt{PE^2 + e_1^2}$$

$$CU_{e1} = +\sqrt{0.36^2 + 12.73^2} \qquad \text{(Sects. 7.2 \& 7.4)}$$

$$CU_{e1} = -\sqrt{0.36^2 + 11.24^2} \qquad \text{(Sects. 7.2 \& 7.4)}$$

CU_{e1} = + 12.74, - 11.24 VAC

7.8.2 Undervoltage (LOV) Time Delay Relays; 27-1-62A, 27-2-62A, 27-3-62A and 27-4-62A

PM	There are no Process Measurement uncertainties identified for this loop
PE	There are no Process Element uncertainties identified for this loop
e_2	Per Sub-Section 7.5
IRE	Per Sub-Section 7.3
B	There are no Bias uncertainties identified for this loop

Deleting negligible and not applicable terms results in;

$$CU_{e2} = \pm\sqrt{e_2^2}$$

$$CU_{e2} = +\sqrt{9.33^2} \qquad \text{(Sect. 7.5)}$$

$$CU_{e2} = -\sqrt{9.73^2} \qquad \text{(Sect. 7.5)}$$

CU_{e2} = + 9.33, - 9.73% of Setting

7.8.3 Underfrequency Time Delay Relays: 81-1, 81-2, 81-3 and 81-4

PM	There are no Process Measurement uncertainties identified for this loop
PE	There are no Process Element uncertainties identified for this loop
e_3	Per Sub-Section 7.6
IRE	Per Sub-Section 7.3
B	There are no Bias uncertainties identified for this loop

Deleting negligible and not applicable terms results in;

$$CU_{e3} = \pm\sqrt{e_3^2}$$

$$CU_{e3} = +\sqrt{19.32^2} \qquad \text{(Sect. 7.6)}$$

$$CU_{e3} = -\sqrt{25.09^2} \qquad \text{(Sect. 7.6)}$$

CU_{e3} = + 19.32, - 25.09% of Setting

7.8.4 Underfrequency Relays; 81-1, 81-2, 81-3 and 81-4

PM	There are no Process Measurement uncertainties identified for this loop
PE	There are no Process Element uncertainties identified for this loop
e_4	Per Sub-Section 7.7
IRE	Per Sub-Section 7.3
B	There are no Bias uncertainties identified for this loop

Deleting negligible and not applicable terms results in;

$$CU_{e4} = \pm\sqrt{e_4^2}$$

$$CU_{e4} = +\sqrt{4.36^2}$$

$$CU_{e4} = -\sqrt{0.50^2}$$

CU_{e4} = + 4.36, - 0.50% of Setting

7.9 Calculate As-Found Tolerance (AFT)

The As-Found Tolerances determine the expected measurable performance of the loop components over the calibration interval. Components are assumed to be calibrated as individual devices. For the purpose of this calculation;

$$AFT = \pm\sqrt{DR^2 + ALT^2}$$ (Sect. 6.3)

7.9.1 Undervoltage (LOV) Relays; 27-1A, 27-2A, 27-3A and 27-4A

$$AFT_1 = \pm\sqrt{DR_1^2 + ALT_1^2}$$ (Sect. 7.4)

DR_1	ALT_1	AFT_1
+ 12.00, - 10.90 VAC	+ 3.00, - 0.00 VAC	+ 12.37, - 10.90 VAC

7.9.2 Undervoltage (LOV) Time Delay Relays; 27-1-62A, 27-2-62A, 27-3-62A and 27-4-62A

$$AFT_2 = \pm\sqrt{DR_2^2 + ALT_2^2}$$ (Sect. 7.5)

DR_2	ALT_2	AFT_2
+ 7.28, - 7.68%	± 5.00%	+ 8.83, -9.16%

7.9.3 Underfrequency Time Delay Relays; 81-1, 81-2, 81-3 and 81-4

$$AFT_3 = \pm\sqrt{DR_3^2 + ALT_3^2}$$ (Sect. 7.6)

DR_3	ALT_3	AFT_3
± 19.32%	+ 0.00, - 16.00%	+19.32% -25.09%

7.9.4 Underfrequency Relays; 81-1, 81-2, 81-3 and 81-4

$$AFT_4 = \pm\sqrt{DR_4^2 + ALT_4^2}$$ (Sect. 7.7)

DR_4	ALT_4	AFT_4
± 0.46%	+ 0.18, 0.00%	+ 0.49, -0.46%

8.0 ANALYTICAL LIMIT (AL)

8.1 Undervoltage (LOV)

SV Type instantaneous undervoltage relays on each of the four 6.9kV Buses provide an undervoltage trip upon loss of bus voltage.
The basis for the 6.9kV Undervoltage trip setpoint is to provide adequate reactor protection in anticipation of a primary system loss of flow, while maintaining coordination with phase and ground fault protection on the 6.9kV buses in order to prevent unnecessary reactor trips. (Response 1.e of Ref. 3.1.16)

The limiting trip point assumed in the safety analysis is 68% of Nominal Voltage. The Potential Transformer (PT) ratio is 7200 / 120 (Ref. 3.3.2).

Therefore, the Analytical Limit at the output of the PT is equivalent to:

$$0.68 \times 6900 \text{ VAC} \times 120 / 7200 = 78.20 \text{ VAC}$$

$$\mathbf{AL_1 = 78.20 \text{ VAC}}$$

8.2 Undervoltage (LOV) Time Delay

An Agastat Timer is associated with each SV Type undervoltage relay. A time delay is provided to minimize unnecessary unit trips due to transient undervoltage conditions. (Ref. 3.1.14)
Many stability studies show that a setting of 70% voltage with a 1.00 Second delay can result in false trips. A setting of 65 to 70% voltage with a 2.00 Second delay would eliminate nearly all of the potential hazards of false tripping. (Page 35 of Ref. 3.1.18)

However, the Safety Analysis assumes a time delay (maximum) of 1.20 Seconds from the time of loss of power to the initiation of control rod motion. (Page 14.1-42 of Ref. 3.2.3)

As shown in the block diagram (Sect. 5.0) this maximum time delay must be reduced by the response times of the SV Type relay, the interposing relays, and the reactor trip breaker. However, a drop out time for the SV Type relays is not available from Westinghouse / ABB.

Therefore, per Assumption 2.5, one-half (1/2) of the maximum time delay will be used as the Analytical Limit for the time delay relays. The remaining half is assumed to be the total time required for actuation of the SV Type relay, two interposing relays and the Reactor Trip Breaker. This is conservative given that each of these components operate an order of magnitude faster than the specified time delay.

Therefore,

$$AL = \frac{1.20}{2.00} = 0.60 \text{ Sec.}$$

AL_2 = 0.60 Sec.

8.3 Underfrequency Time Delay Relay

As described on Page 34 of Ref. 3.1.18, an underfrequency setpoint of 55.00 Hz would require a time delay of at least 1.50 Seconds to avoid a spurious trip for a typical power system disturbance.

However, the Safety Analysis assumes a time delay (Max.) of 1.25 Seconds from the moment the underfrequency trip setpoint is reached, to the initiation of control rod motion. (Page 14.1-4 and 14.1-42 of Ref. 3.2.3)

As shown in the block diagram (Sect. 5.0) this maximum time delay must be reduced by the response times of the interposing relays, and the reactor trip breaker, as follows:

DEVICE	RESPONSE TIME	REFERENCE
Westinghouse MG-6 Type Relay	5 cycles (~84 ms)	3.6.6, 3.3.2
Westinghouse BF Type Relay	25 ms (max.) Drop-out	3.3.6
Westinghouse 75DH 500 Breaker	150 ms (max.)	3.3.7 & Assum. 2.6
Reactor Trip Breaker	150 ms (max.)	3.4.7

The maximum time delay for the underfrequency relay is therefore;
1250 ms - (84 ms - 84 ms - 150 ms - 25 ms - 25 ms - 150 ms) = 732 ms
Therefore,

AL_3 = 0.70 Sec. (Rounded down to the nearest tenth second.)

8.4 Underfrequency Relay

A 55.00 Hz Trip Setpoint was assumed in the Safety Analysis. (Page 14.1-42 of Ref. 3.2.3)
Therefore,

AL_4 = 55.00 Hz

9.0 DETERMINE SETPOINTS (TS)

Channel Uncertainty (CU) is combined with the Analytical Limit in an appropriate direction, in order to determine the Trip Setpoint (TS), as shown below.

9.1 Undervoltage (LOV) Trip Setpoint

The Undervoltage (LOV) Trip Setpoint AL is 78.20 VAC. The positive value of CU is used for a decreasing variable, to insure that the relay will trip above the Analytical limit.

TS = AL ± [CU + margin] (Ref. 3.1.4)
= 78.20 + (12.74) (Section 7.8.1 & 8.1)
= 90.94 VAC

TS_1 = 91.00 VAC (Rounded up to the nearest tenth)

9.2 Undervoltage (LOV) Time Delay Relay Setpoint

The Undervoltage (LOV) Time Delay AL is 0.60 Seconds. The negative value of CU is used for an increasing variable to insure that channel trip occurs below the Analytical Limit.

TS = AL ± [CU + margin] (Ref. 3.1.4)

$$= 0.60 - (0.0973)TS \quad \text{(Sects. 7.8.2 \& 8.2)}$$

$$= \frac{0.60}{(1.00 + 0.0973)}$$

$$= 0.5468 \ Sec.$$

TS_2 = 0.54 Sec. (Rounded down to the nearest hundredth second)

9.3 Underfrequency Relay/Time Delay Setpoint

The Underfrequency Relay / Time Delay AL is 0.70 Sec. The negative value of CU is used for an increasing process variable (time).

(Para. 7.2 of Ref. 3.1.3)

TS = AL ± [CU + margin] (Ref. 3.1.4)

$= 0.70 - (0.2509)TS$ (Sects. 7.8.3 & 8.3)

$= \frac{0.70}{(1.00 + 0.2509)}$

$= 0.5596\ Sec.$

TS_3 = 0.55 Sec. (Rounded down to the nearest hundredth second)

9.4 Underfrequency Trip Setpoint

The AL is 55.00 Hz. The positive valve of CU is used for a decreasing process variable (frequency).

TS = AL ± [CU + margin] (Ref. 3.1.4)

$= 55.00 + (0.0436)TS$ (Sects. 7.8.4 & 8.4)

$= \frac{55.00}{(1.00 - 0.0436)}$

$= 57.5073\ Hz$

TS_4 = 57.50 Hz

10.0 DETERMINE ALLOWABLE VALUE (AV)

The Allowable Value (AV) can be determined as follows; (Ref. 3.1.3 & 3.1.4):

$$AV = TS \pm CU_{CAL}$$

$$CU_{CAL} = + \sqrt{AFT_{e1}^2 + AFT_{e2}^2 + AFT_{m}^2} \quad ,$$

Where;

TS	=	Trip Setpoint
CU_{CAL}	=	The Channel Uncertainty (CU) as seen during calibration. Therefore, uncertainties due to a harsh environment, process measurement, or primary element are not considered. For conservatism, only DR, and ALT uncertainties are considered in computing the individual component AFT values. RA is not considered since it has been removed from the computation of e values (Sections 6.2 and 6.3) based on historical As-Found / As-Left drift values.

CU_{CAL} will be calculated using the Square Root Sum of Squares (SRSS) method which is consistent with the method used for the determination of the trip setpoint. Therefore, a check calculation is not required. (Ref. 3.1.3)

10.1 AV for the Undervoltage (LOV) Setpoint;

$$CU_{1CAL} = \sqrt{AFT_1^2}$$

$$= + 12.37, - 10.90 \text{ VAC}$$ (Sect. 7.9.1)

$$AV_1 = TS_1 - CU_{1CAL}$$
$$= 91.00 - (12.37)$$
$$= 78.63 \text{ VAC}$$

AV_1 = 78.63 VAC

10.2 AV for the Undervoltage (LOV) Time Delay Setpoint;

$$CU_{2CAL} = \sqrt{AFT_2^2}$$

$$= +8.83, -9.16\% \text{ of Setting}$$ (Sect. 7.9.2)

$$AV_2 = TS_2 + CU_{2CAL}$$

$$= 0.54 + (0.0916 \times 0.54) = 0.5895$$

AV_2 = 0.58 Sec. (rounded down to nearest hundredth)

10.3 AV for the Underfrequency Time Delay Setpoint;

$$CU_{3CAL} = + \sqrt{AFT_3^2}$$

$$= +19.32, -25.09\% \text{ of Setting}$$ (Sect. 7.9.3)

$$AV_3 = TS_3 + CU_{3CAL}$$
$$= 0.55 + (0.2509 \times 0.55)$$
$$= 0.6880 \text{ Sec.}$$

AV_3 = 0.68 Sec. (rounded down to nearest hundredth)

10.4 AV for the Underfrequency Trip Setpoint;

$$CU_{4CAL} = \pm \sqrt{AFT_4^2}$$

$$= \pm 0.49\% \text{ of Setting}$$ (Sect. 7.9.4)

$$AV_4 = TS_4 \pm CU_{4CAL}$$
$$= 57.50 - (0.0049 \times 57.50) = 57.2183 \text{ Hz}$$

AV_4 = 57.22 Hz (rounded up to nearest hundredth)

11.0 SUMMARY

11.1 Undervoltage (LOV) Trip Setpoint;

	CALCULATED	EXISTING
Trip Setpoint (TS)	91.00 VAC (Sect. 9.1)	86.25 VAC (Ref. 3.4.4)
Limiting Safety System Setting		80.50 VAC (Ref. 3.2.4, Note 2)
Allowable Value (AV)	78.63 VAC (Sect. 10.1, Note 1)	
Analytical Limit (AL)	78.20 VAC (Sect. 8.1)	

11.2 Undervoltage (LOV) Time Delay Relay;

	CALCULATED	EXISTING
Analytical Limit (AL)	0.60 Sec. (Sect. 8.2)	
Allowable Value (AV)	0.58 Sec. (Sect. 10.2, Note 1)	
Limiting Safety System Setting		N/A (Note 3)
Trip Setpoint (TS)	0.54 Sec. (Sect. 9.2)	0.50 Sec. (Ref. 3.4.4)

11.3 Underfrequency Time Delay;

	CALCULATED	EXISTING
Analytical Limit (AL)	0.70 Sec. (Sect. 8.3)	
Allowable Value (AV)	0.68 Sec. (Sect. 10.3, Note 1)	
Limiting Safety System Setting		N/A (Note 3)
Trip Setpoint (TS)	0.55 Sec. (Sect. 9.3)	0.10 Sec. (Ref. 3.4.5)

11.4 Underfrequency Trip Set Point;

	CALCULATED	EXISTING
Trip Setpoint (TS)	57.50 Hz (Sect. 9.4)	57.50 Hz (Ref. 3.4.5)
Limiting Safety System Setting		57.20 Hz (Ref. 3.2.4)
Allowable Value (AV)	57.22 Hz (Sect. 10.4, Note 1)	
Analytical Limit (AL)	55.00 Hz (Sect. 8.4)	

Notes:

1. The calculated Allowable Valve (AV) represents the limiting As-Found condition for the instrument loop.

2. 70% x 6900 VAC x 120 / 7200 = 80.50 VAC (Page 2.3-3 of Ref. 3.2.4)

3. A Limiting Safety System Setting for Time Delay is not specified in the existing Technical Specification (Page 2.3-3 of Ref. 3.2.4).

11.5 Undervoltage Relays;

The calculated Setpoint provides sufficient margin to insure that channel trip will occur within the Analytical Limit (AL), for an extended twenty-four (24) month ± 25% operating cycle. A setpoint change to 91.00 VAC is required.

11.6 Undervoltage Time Delay and Underfrequency Relays;

The existing Setpoints provide sufficient margin to insure that channel trip will occur within the Analytical Limit (AL), for an extended twenty-four (24) month ± 25% operating cycle. No setpoint changes are required.

11.7 Technical Specification - Allowable Values;

Undervoltage and Underfrequency trip setpoints and time delay allowable values are specified in this Sub-section, and shall be utilized in the Improved Technical Specification (ITS).

12.0 ATTACHMENTS

None.

Section 7.0											
UV		**bias**	**UV Time Delay**		**bias**	**UF Time Delay**		**bias**	**UF**		**bias**
PE=	0.36										
RA =	0.00		RA =	0.00		RA =	0.00		RA =	0.00	
DR =	10.90	1.10	DR =	7.28	-0.40	DR =	19.32		DR =	0.46	
TE =	2.73		TE =	3.00		TE =	0.18		TE =	0.18	
MTE =	0.05		MTE =	0.10		MTE =	0.10		MTE =	0.10	
PS =	0.00		PS =	0.00		PS =	0.00		PS =	0.00	0.18
ALT =	3.00	0.00	ALT =	5.00		ALT =	0.00	-16.00	ALT =	0.18	
B=											3.64
e1 =	12.73	-11.24	**e2 =**	9.33	-9.73	**e3 =**	19.32	-25.09	**e4 =**	4.36	-0.50
CU e1 =	12.74	-11.24	**CU e2 =**	9.33	-9.73	**CU e3 =**	19.32	-25.09	**CU e4 =**	4.36	-0.50
AFT1 =	12.37	-10.90	**AFT2 =**	8.83	-9.16	**AFT3 =**	19.32	-25.09	**AFT4 =**	0.49	-0.46
Section 9.0											
AL1 =	78.20	VAC	**AL2 =**	0.60	sec.	**AL3 =**	0.70	sec.	**AL4 =**	55.00	Hz
TS1 =	90.935	VAC	TS2 =	0.547	sec.	TS3 =	0.560	sec.	TS4 =	57.504	Hz
TS1 Used =	**91.00**	VAC	**TS2 Used =**	**0.54**	sec.	**TS3 Used =**	**0.55**	sec.	**TS4 Used =**	**57.50**	Hz
Section 10.0											
AV1 =	78.631	VAC	AV2 =	0.589	sec.	AV3 =	0.688	sec.	AV4 =	57.216	Hz
AV1 Used =	**78.63**	VAC	**AV2 Used =**	**0.58**	sec.	**AV3 Used =**	**0.68**	sec.	**AV4 Used =**	**57.22**	Hz

ROUNDING

	LOV	LOV-TD	UF-TD	UF
Process Variable	Down	Up	Up	Down
CU Intrest	Pos.	Neg.	Neg.	Pos.
Trip Setpoint	Up	Down	Down	Up
Allowable Value	Up	Down	Down	Up

Verification of:

Document Title: 6.9kV Undervoltage and Underfrequency Instrument Uncertainty Calculation

(24-Month Refueling Cycle)

Document Number: IP3-CALC-RPC-0291, Revision 1

Subject: Surveillance Interval Extension Project

Modification/Task Number (if applicable): N/A

QA Category: CAT I

Review Required	Discipline	Review Complete (initial of reviewer)
	ELECTRICAL	
	MECHANICAL	
X	INSTRUMENT & CONTROL	
	CIVIL/ STRUCTURAL	
	FIRE PROTECTION	
	SIMULATOR	

IDENTIFICATION:	DISCIPLINE:
Document Title: 6.9kV Undervoltage and Underfrequency Instrument Uncertainty Calculation Doc. Number: IP3-CALC-RPC-00291 Doc. Revision: 1 QA Category: I	[ ] ELEC [X] I&C [ ] MECH [ ] Fire Pro. [ ] C/S [ ] Simulator [ ] Other_____ (specify)

METHOD OF VERIFICATION:

[X] Design Review [ ] Alternate Calculations [ ] Qualification Test

Selected Verifier: Salvatore D'Auria / IDEE / X2542
print name_department_phone ext.

#	Design Verification Questionnaire All questions shall be explained in the space provided.
1.	Were the inputs correct and incorporated into the design? **Yes.**
	Explanation: **The inputs from both vendor and NYPA documents were reviewed and found to be correct and appropriate.**
2.	Are the physical and functional characteristics of the proposed design within the approved design basis of the system(s) structure(s) or component(s)? **Yes.**
	Explanation: **The functional setpoints support the current Technical Specification requirements for the Reactor Protection System.**
3.	Does the proposed design incorporate license Commitments? **Yes.**
	Explanation: **The current Technical Specification requirements are supported as part of the Plant License.** (Reference Table 4.1-1, Line Item # 8).
4.	Are assumptions necessary to perform the design activity adequately described and reasonable: Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities are completed? **Yes.**
	Explanation: **The assumptions are adequately described, and have been determined to be reasonable for the application.**
5.	Are the appropriate quality and quality assurance requirements specified? e.g., safety classification? **Yes**
	Explanation: **As a Setpoint Calculation, prepared in accordance with DCM-2, all QA requirements have been met.**
6.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met? **Yes.**
	Explanation: **Reg. Guide 1.97, Reg. Guide 1.105 and ISA 67.04 are identified in the calculation as references, and their use as applicable.**

#	Design Verification Questionnaire All questions shall be explained in the space provided.

7. Have applicable construction and operating experience been considered? **Yes.**

Explanation: **Previous As-Found & As-Left Data was obtained and all data was reviewed, including any deficiencies. The location, maintenance, and previous operation has been considered.**

8. Have the design interface requirements for mechanical, electrical/I&C, and civil/structural engineering been satisfied? **Yes.**

Explanation: **The interface requirements are identified on the calculation Control Sheet. The calibration requirements are identified to insure responsible organizations interface. The consideration of Mechanical, Electrical, and Civil / Structural interfaces have been considered and used as input, as necessary.**

9. Was the appropriate design method used? **Yes.**

Explanation: **The System was originally installed adequately to perform it's function, and the calculation methods utilized in accordance with IES-3.**

10. Is the output reasonable compared to inputs? **Yes.**

Explanation: **Relative to the calculation inputs used, the output values are reasonable, and as expected.**

11. Are the specified parts, equipment and processes properly suited for the fire protection Appendix R, QA and EQ classifications required for the application? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

12. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

13. Have personnel requirements and limitations for maintenance, testing, and inspection been satisfied? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

14. Are accessibility, maintenance, repair, and inservice inspection requirements for the plant including the plant conditions under these will be performed been considered? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

15. Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

#	Design Verification Questionnaire All questions shall be explained in the space provided.
16.	Has the design properly considered radiation exposure to the public and plant personnel? (ALARA/cobalt reduction) **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
17.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have satisfactorily accomplished? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
18.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified? **Yes.**
	Explanation: **Procedural requirements for surveillance test are identified in the Calculation title, and the body of the Calculation describes the Measuring and Test Equipment.**
19.	Are adequate handling, storage, cleaning and shipping requirements specified? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable**
22.	Are adequate identification requirements specified? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
21.	Are the conclusions drawn in the Safety Evaluation fully supported by adequate discussion in the test or Safety Evaluation itself? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
22.	Are necessary procedural changes specified and are responsibilities for such changes clearly delineated? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
23.	Are requirements for record preparation, review, approval, retention, etc., adequately specified? **Yes.**
	Explanation: **As identified in the calculation; preparation, review, approval and retention / distribution are controlled In accordance with DCM-2**
24.	Have supplemental reviews by other engineering disciplines (seismic, electrical, etc.) been performed on the integrated design package? **N/A.**
	Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**
25.	Have the drawings, sketches, calculations, etc., included in the integrated design package been reviewed? **Yes.**
	Explanation: **All referenced calculation documents which provide design input, have been reviewed.**

#	Design Verification Questionnaire All questions shall be explained in the space provided.

26. Have reviews been performed to identify any effect on the Check Valve Maintenance Program? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

27. Does the design for check valves meet the intents of INPO SOER 86-03? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

28. Is the plant reference simulator physical fidelity affected and it's design change been factored into the cost? **N/A.**

Explanation: **For a setpoint and / or uncertainty calculation performed in a manner consistent with IES-3, this question is not applicable.**

29. Are all references listed (including design calculations/analysis) that were used as part of the design review? **Yes.**

Explanation: **All references used in the calculations are listed in Section 3.0, or as an Attachment of the Calculation.**

REMARKS/COMMENTS:

Design Verification Complete: SALVATORE D'AURIA 2/17/98
(print name-signature-date)