Attachment

FPL Energy Duane Arnold Calculation CAL-E95-006, Revision 4
"4.16 KV Essential Bus Degraded Voltage Setpoint Calculation"

CAL-E95-006

REV. 4

DOCUMENT NUMBER: **CAL-E95-006**

Title : 4.16 KV ESSENTIAL BUS DEGRADED VOLTAGE SETPOINT CALCULATION

Contents :

REV	DATE	REVISION	DFT.	CHK.	ENG.	APR.
1	5/22/95	ISSUED PER DDC-2792	DA	TAK	ENC	CN
2	11/18/98	REVISED PER DDC-3656	DA	TAK	ENC	JE
3	9/5/02	REVISED PER DDC-4404	DA	JAH	ENC	JE
4	3-10-8	REVISED PER ECP-1846	TAK	DA	ML	SM

DESIGN VERIFICATION SUMMARY REPORT

DOCUMENTTYPE/NUMBER: CAL-E95-006 REVISION 4
VERIFIER: Tom Below DISCIPLINE: Elec/I&C

METHOD OF VERIFICATION:

☒ DESIGN REVIEW ☐ ALTERNATE CALCULATIONS ☐ QUALIFICATION TESTING

Design Inputs Considered:
UFSAR, M&TE Database (V148), STP 3.3.8.1-02, T3.3.8.1-01, DGC-E111, Startup Package for 4.00, ITP for Degraded Voltage Relays, 12-17-1997 through 11-16-2006, ACP1408.8

Document(s) Reviewed:
CAL-E95-006, DGVSMAZ.XLS

Conclusions & Comments:
See comments on form NG-008Z-2.

Verifier — 12/10/07 Date

Team Leader — 12-10-07 Date

DESIGN VERIFICATION COMMENT SHEET

DOCUMENT TYPE/NUMBER: CAL-E95-006 REVISION: 4

LINE/ ITEM NO	VERIFIER'S COMMENTS	PREPARER'S RESOLUTION	VERIFIER'S RESOLUTION
1	Coversheet should reference ECP #, and Design Review.	Added ECP 1846	Accepted TDB 12/6/07
2	Index Information should include either all of the references utilized or reference section 2.0 of the calc. Currently 2 of 17 inputs listed.	The intent was to include only those references which contain values that if changed may affect the results of calculation. Addition documents have been added to the list.	Accepted TDB 12/6/07
3	Index Information should include the excel file/ITP data used for SMAZ as an input.	Added ITP database.	Accepted TDB 12/6/07
4	Index Information should include Microsoft Excel if used for SMAZ analysis.	Added Microsoft Excel to list.	Accepted TDB 12/6/07
5	2.7 UFSAR rev out of date, see item #8 for more details.	Changed to current Rev.	Accepted TDB 12/6/07
6	2.17 ITP reference appears to have transposed switch 1 & 2 during the 2005 and 2006 calibrations, see item #17 for more details.	This was corrected in the Excel spreadsheet to ensure that correct data was used for the evaluation.	Accepted TDB 12/6/07
7	4.2 references the VOM from 2.6, which is V148 (Fluke M187) Accuracy ±0.4% + 0.40V or 0.88Vac. Section 7.3 lists a Fluke 8062A (V143), which has an accuracy of ±0.5% + 0.1V or 0.7Vac. Verify that STP3.3.8.1-02 is updated for that test equipment.	PWR 40325 has been initiated to revise STP 3.3.8.1-02 to require the use of a Fluke 8062A	Accepted TDB 12/7/07
8	4.5 references chapter 7 of the UFSAR, the only reference I could find for the minimum operating voltages was in UFSAR 8.3 (rev 19, 09/07). The values listed are correct.	Changed to reference section8.3 of UFSAR instead of chapter 7.	Accepted TDB 12/6/07

9	4.5 states 95.3% as the recovery voltage. That will actually be 95.6%. Include the reference electrical calc number where this value comes from. Also add to the reference section, Calc # not available at this time.	Corrected value and added reference to CAL-E07-003.	Accepted TDS 12/10/07
10	6.2 clarify AS-LEFT TRIP may be within ±0.2 volts of the TRIP. Does that mean 108.3 to 109? TRIP is defined as a range not a single value.	Added that the trip may be set at any value between those specified and that the ALT must be within ±0.2 of the selected trip value.	Accepted TDS 12/6/07
11	7.3 c1tc = 0.1 * 0.7 * (40 -28), where did the 40 – 28 value come from? According to V143 M&TE data sheet, the temperature degrades 0.1 * accuracy / °C in excess of 5 °C limit. (tol doubles when >15°C from cal temp) I see no data on what the cal temp was, nor what temp the readings are assumed. Ref 4.1 provides range of 75-104°F (23.9-40°C)	Added discussion to section 7.3 on how the temperatures are determine.	Accepted TDS 12/7/07
12	7.5.1 states A_N & A_T in multiple formulas, should those be A_L, or do those need to be added to the acronym list?	Added statement that because the normal and accident environmental conditions are the same that A_N, A_T, and A_L are equal.	Accepted TDS 12/6/07
13	7.5.1 UAV & UNTSP are affected by the change to recovery voltage, see item #9.	Recalculated affected values.	Accepted TDS 12/10/07
14	7.5.1 LER avoidance for UNTSP needs to be reevaluated with new values. May not be less than LNTSP anymore.	Calculated UNTSP1 considering LER avoidance which resulted in UNTSP1 greater than LNTSP1. Therefore, will include calculation of UNTSP1 in calculation.	Accepted TDS 12/10/07
15	8.1 value for C appears incorrect. C1 = 0.7, Cstd = 0.175 therefore $C = 2/3\ (0.7^2 + 0.175^2)^{1/2} = 0.481$ not 0.754. Is there an alternate	Corrected this value. Confirmation value still less than one with zero drift. Therefore,	Accepted TDS 12/6/07

	calculation?	drift assumption in 4.4 will still be used.	
16	8.1 I verified all within standard rounding deviations. Des Sqrt (SMAZ) and Confirmation Ratio are all correct assuming C = 0.754. See item #15 for more details.	OISD ave, Std Dev, and sqrt (SMAZ) remain the same with change to C. However, confirmation number goes up from .486 to .621.	Accepted TOB 12/7/07
17	8.1 spreadsheet DGVSMAZ.XLS appears to have the correct values for OISD Drift values, but please verify. All calculations dependent on these values.	Verified values to be correct.	Accepted TOB 12/6/07
18	6.1 & 6.2 values will need to be recalculated after all items resolved.	Values recalculated.	Accepted TOB 12/10/07

Verifier: Tom Below Date: ~~11/5/07~~ 12/5/07 TOB	Preparer: Eric Christopher Date: 12/7/07

DUANE ARNOLD ENERGY CENTER

ENGINEERING CALCULATION COVER SHEET

Calculation Number (If Required)	CAL-E95-006

Calculation Title	4.16 kV ESSENTIAL BUS DEGRADED VOLTAGE SETPOINT CALCULATION

Project Description:	

Assignment/ Implementation Document	AR No.	
	DDC No.	
	ECP No.	ECP 1846
	EMA No.	
	Other Doc. No.	

Method of Verification: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

Revision	Prepared/Date	Verified/Date	Approved/Date
6			
5			
4	12/10/07	12/10/07	12-10-07

INDEX INFORMATION

Calculation Number (If Required)	CAL-E95-006

Vendor Document (if applicable)	Vendor Name	Document No.	Rev. No.

Applicable SUS Nos.				
4.00				

Applicable Equipments IDs				
127-A1BUS1A3	127-B1BUS1A3			
127-A1BUS1A4	127-B1BUS1A4			
127-A2BUS1A3	127-B2BUS1A3			
127-A2BUS1A4	127-B2BUS1A4			

Input Documents			
VENDOR MANUAL B455SVR	Startup package for system 4.00	CAL-E07-003	ITP database
UFSAR	QUAL-SC101	Technical Specifications	

Output Documents			
STP 3.3.8.1-02			
TS T3.3.8.1-01			
UFSAR			

Topics			
Degraded Voltage	Essential Buss	Standby Transformer	

Software & Version			
Microsoft Office Excel 2003 (11.8105.8107) SP2			

Comments

CALCULATION REVISION SUMMARY SHEET
IES UTILITIES INC.
DUANE ARNOLD ENERGY CENTER

Document Number: __CAL-E95-006_____

Rev.	Affected Pages	Reason for Revision
1	all pages	new issue
2	page 2	Add reference 2.17.
2	page 3	Add acronym OISD.
2	page 4	In section 4.2 change ALT from ±0.25 to ±0.2.
2	page 5	Change 4.4 to state that drift is based on ITP data using SMAZ analysis. And that A_L and VD for the timers is based on the standard deviation of the OISD. Change 4.5 to state that AL is per the resolution of AR971707. Also change to state that an upper limit is needed and that it will be determined from the NTSP of 111 volts. Change basis for AL from 86% required to operate motor starters to 80% as required for MOV's to operate. Per rev 13 of UFSAR section 8.2, motor starters will operate down to 67%. MOVs then have the most limiting requirements.
2	page 6	Change 4.6 to state that the upper limit values of the timer will be determined based on an AV of 8.5 seconds and that the lower values will be determined from an NTSP of 8.0 seconds.
2	page 7	Values changed to reflect revisions.
2	page 9	Redefine A_L and D_L per revised section 4.4
2	page 10 and 11	Recalculate C_L based on new ALT in section 7.3 Remove calculation from 7.5 and replace with 7.5.1 Calculation Used and 7.5.2 Calculation.
2	page 12 and 13	Add section 8.0, 8.1 and 8.2. These section contain the SMAZ analysis.
3	Page 1	Change table in Purpose to reflect current TS surveillance requirements. Change revision of TS in Reference 2.2.
3	Page 9-11	Correct typographical errors identified in AR 30377 and clarify Z values used.
3	All pages	Remover signature block and add calculation number, rev. number and title at top of page.
4	All pages	Incorporated reduced calibration error based on

		use of more accurate voltmeter. Calculated new drift value based on last 10 years of calibration data. Removed calculation of relay values from table and moved to section 7.5.1.

1.0 PURPOSE

Based on a 15 month surveillance interval (conservatively chosen as 1 yr. + 25% grace period) determine the Allowable Value and NTSP for the following 4.16kV Emergency Bus Degraded Voltage relays.

Instrument	Surveillance Requirement	Table
127-A1BUS1A3,4	3.3.8.1.3	3.3.8.1-1
127-A2BUS1A3,4	3.3.8.1.3	3.3.8.1-1
127-B1BUS1A3,4	3.3.8.1.3	3.3.8.1-1
127-B2BUS1A3,4	3.3.8.1.3	3.3.8.1-1

The purpose of the degraded voltage relays is to prevent operation of Safety Systems and components at voltages below which loss of safety systems or damage to safety related equipment or components could occur.

2.0 REFERENCES

2.1 GE report NEDC-31336, GE Proprietary Information, GE Instrument Setpoint Methodology

2.2 Operation License and Technical Specification for DAEC-1, rev 223, 8/1/1998

2.3 QUAL-SC101, rev 7, DAEC Environmental and Seismic Service Conditions

2.4 VENDOR MANUAL B455SVR, BBC Brown Boveri Inc. ITE Single Phase Voltage Relays

2.5 M&TE data base

2.6 STP-42B030-A rev. 6 and 3.3.8.1-02

2.7 DAEC Updated Final Safety Analysis Report, rev. 19, 9/07

2.8 Letter IE-77-1624 dated 8-30-77 from Mr. Lee Lui of IES to Mr. George Lear of the NRC.

2.9 BECH-E023 rev. 22

2.10 DGC-E111 rev. 0, (GE Report GE-NE-901-007-0292), Setpoint Calculation Guidelines for DAEC

2.11 BECH-E006<1> rev. 24, Single Line Meter and Relay Diagram 480V System

2.12 BECH-E005 rev. 9, Single Line Meter and Relay Diagram 4160V System Essential Switchgear 1A3 and 1A4

2.13 BECH-E104<25A> rev. 3; <26A> rev. 4, 4160V and 480V System Control and Protection

2.14 NRC Letter to Iowa Electric dated June 2, 1977, to Mr. Duane Arnold, from Mr. George Lear

2.15 Startup package for system 4.00

2.16 ACP 1408.8 rev. 6, Control of Measurement and Test Equipment

2.17 ITP data for degraded voltage relays between the dates 12-17-97 and 11-16-06.

2.18 CAL-E07-003 Rev. 0

3.0 ACRONYMS

σ	standard deviation
AFT	as-found tolerance
AL	analytical limit
A_N	loop accuracy under normal environmental conditions
A_L	loop/channel accuracy
A_T	loop accuracy under normal accident conditions
ALT	as-left tolerance
ANSI	American National Standards Institute
APED	Atomic Power Equipment Department
AS	actual setpoint
AV	allowable value
C	degrees Celsius
ch	(instrument) channel
C_L	loop/channel calibration error
D_L	loop/channel drift
DMM	digital multimeter
ED	elementary diagram
EMI	electro-magnetic interference
F	degrees Fahrenheit
FCD	functional control diagram
FS	full scale
g	acceleration of gravity
Hz	hertz
IDS	instrument data sheet
LCO	limiting condition for operation
LOCA	loss of coolant accident
LOOP	loss of offsite power
M	metrology lab (accuracy of calibration standards)
MCC	motor control center
M&TE	maintenance and test equipment
MDP	maintenance department procedure
Mrad	megarad (10^6 rads)

NTSP	nominal trip setpoint
OL	operational limit
OISD	observed in-service difference
P&ID	piping and instrument diagram
PCIS	primary containment isolation system
PD	process diagram
PEA	primary element accuracy
PMA	process measurement accuracy
PPD	purchase part drawing
PT	potential transformer
RFI	radio-frequency interference
RHR	residual heat removal
STA	spurious trip avoidance
STP	surveillance test procedure
TID	total integrated dose (gamma equivalent)
VA	vendor accuracy
Vac	volt a-c
VD	vendor drift
Vdc	volt d-c
VOM	volt-ohm meter
ZPA	zero period acceleration

4.0 ASSUMPTIONS

4.1 Per Reference 2.1 the function time of the relays in this channel is such that the relays are subjected to expected (normal) environments (75 to 104°F, $<1.0(10)^3$, <0.5g ZPA per Reference 2.3) which are within the design and qualification characteristics of the devices (20 to 40°C (68-104°F),>6g ZPA per Reference 2.4). Hence the instrument error expressions are contained herein are assumed to apply as random errors to the overall environmental and seismic envelop to which the relays are expected to be subjected. Error effects resulting from power supply variations, EMI/RFI, and cable resistance are assumed negligible for bi-stable electro mechanical devices such as relays.

4.2 Error effects of maintenance procedures are covered by channel calibration accuracy determined by the methods outlined in Reference 2.10 utilizing data from Reference 2.5 and 2.6. The VOM referred to in Reference 2.6 is considered to have negligible error effects in measuring contact change-of-state only. The reading will be conservatively assumed to be 120 Vac. The ALT, will be established as ±0.2 VAC. Calibration errors are assumed to be 3σ errors. The calibration standard is assumed to be 1/4 of the M&TE equipment accuracy, per Reference 2.16.

For the time delay, the ALT will be considered to be +0/-0.2 seconds. Operator actuation time of the stopwatch is conservatively chosen as 0.5 seconds.

4.3 The Primary Element for the relays is a potential transformer. Per Reference 2.15, the worst case PT's turns ratio measured during startup testing was 34.844:1. The PT design turns ratio is 35:1 (4200:120). This corresponds to an error of 0.446%. Therefore the PEA is conservatively chosen as 0.5% which is equivalent to 0.6 volts (0.5%*120volts). The voltage drop in the measurement loop is minimal and there is no inherent Process Measurement Accuracy which may be considered independent of relay instrument accuracy. Therefore, PMA is assumed negligible.

4.4 Channel instrument drift is determined by evaluating Reference 2.17 data per the SMAZ method in Reference 2.1. Confirmation ratios of ≤1 shows conformance between design allowance and raw field data from Reference 2.17. The SMAZ method extracts the drift value form the actual calibration data based on the relay accuracy and the calibration error. Based on this method a drift value of 0 results in a confirmation ratio of less than 1. This suggests that the relays are performing significantly better than assumed in the calculation. However, to provide additional conservatism a drift value of two standard deviations of the OISD will be used. One standard deviation of the OISD for a 12 month calibration interval is 0.32 VAC. Therefore, a drift value of 0.64 volts will be assumed. To account for the 25% allowance for on the surveillance interval, the drift will be adjusted by $(15/12)^{1/2}$ as documented in Ref. 2.1.

SMAZ analysis of the ITP data for the timers shows that one standard deviation for the OISD is 0.185 seconds (for calibration intervals greater than 9 months. The OISD include all uncertainties, such as Vendor Accuracy, drift and calibration errors. To be conservative, VD will be assumed to equal two standard deviations of the OISD or 0.37 seconds

4.5 Per resolution of AR971707, the AL for the degraded voltage setpoint is 89.9% of the nominal essential bus voltage of 4160 v. This will ensure that all safety loads will receive their required minimum operating voltage of 70% (of nominal 460 volts) for motors and 80% for MOV's (of nominal 460 volts), as stated in chapter 8 section 8.3 of the UFSAR. Degraded voltage is measured off a 120 volts system, therefore, the Lower Analytical Limit (LAL) is 106.86 volt (120*(4160/4200)*89.9%).

The degraded voltage relays also have an important function on the reset (increasing voltage) which is to ensure that the relays resets following a degraded voltage transient shorter than 8.5 seconds. It is important that these relays reset to prevent an inadvertent degraded voltage signal corresponding to a Loss of offsite power (LOOP). The Upper Analytical Limit (UAL) will be the voltage to which the essential buss recovers under worst case grid conditions following a DBA-LOCA. Reference 2.18 has established that essential buss voltage will recover to 95.5% of nominal voltage. As such, the relay must reset prior to this

value. 95.5% buss voltage corresponds to 113.5 VAC on the secondary side (95.5%*120*(4160/4200)). These relays have a reset deadband of +3 percent of the trip setting, per reference 2.4. Using the UAL as the trip setting, the reset deadband becomes 3.4 volts (3%*113.5). The deadband will be considered a BIAS and applied only to the upper values.

4.6 Per Reference 2.14 the degraded voltage time delay is to be set to prevent equipment damage due to prolonged operation at degraded voltage conditions, and to prevent spurious transfer of power from the offsite power source to the onsite power source. However, no analysis, on which to base an AL, has been done to determine the affects of prolonged degraded voltage on equipment. An extensive analysis would have to be done to determine the affects of prolonged operation at degraded voltage. The current upper time delay limit of 8.5 second is conservative compared to other utilities, and is judged to be adequate, and will be considered the UAV. The UAL, UNTSP, and AS will be determined based on this UAV. The current lower limit of 8.0 seconds will be considered the LNTSP. The LAV, LAL and ASmin will be determined based on this value.

5.0 METHODOLOGY

This calculation is performed in accordance with Reference 2.1 and 2.10.

6.0 CONCLUSION

6.1 The AL, AV, and NTSP (in volts and seconds) are as follows:

	UAL	UAV	UNTSP	LNTSP	LAV	LAL
120v scale	113.5	109.2	108.7	108.5	108.0	106.86
4160v scale	3972.5	3822	3804.5	3797.5	3780	3740
% Nominal	95.49%	91.88%	91.45%	91.29%	90.87%	89.90%
Timer	9.26	8.5	8.4	8.0	7.92	7.16

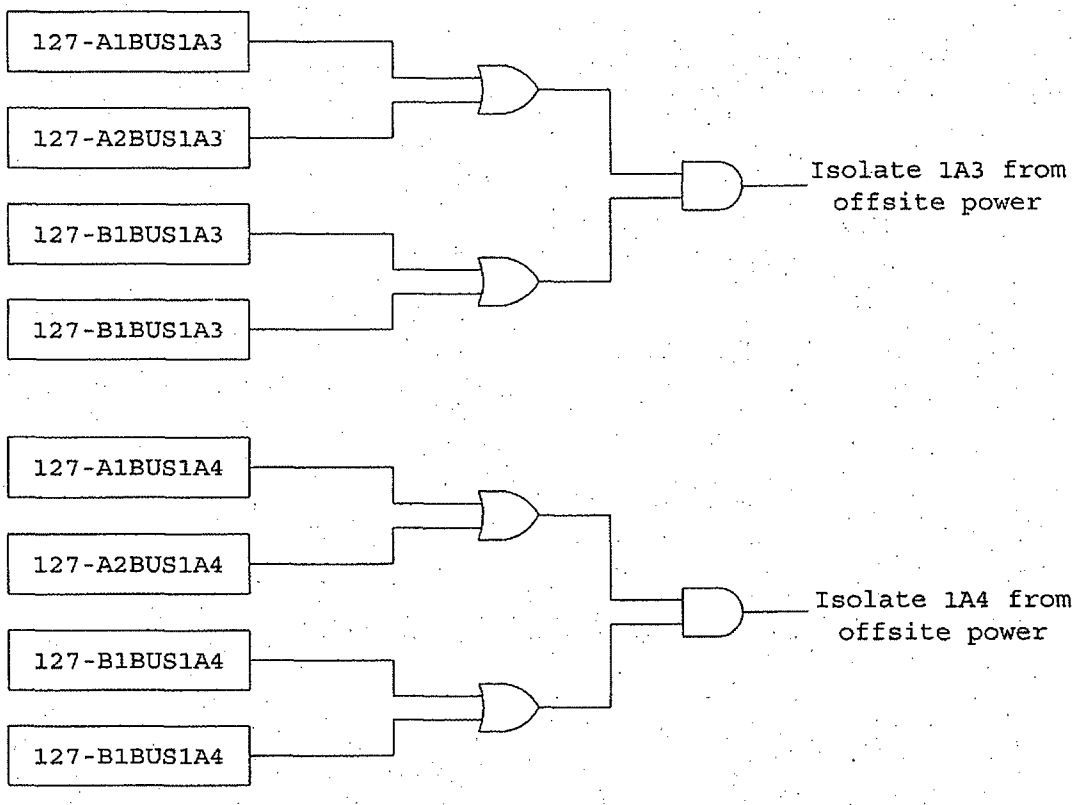
6.2 This calculation will support device settings and tolerances within the following limits:

relay The TRIP may be set at any value between 108.5 and 108.7 volts inclusive.
The AS-FOUND TRIP may be between 108 and 109.2 volts inclusive.
The AS-LEFT TRIP must be within ±0.2 volts of the selected TRIP value.

timer — The TRIP may be 8.2 seconds.
The AS-FOUND TRIP may be between 7.92 and 8.5 seconds.
The AS-LEFT TRIP may be within ±0.2 seconds of the TRIP.

7.0 CALCULATION

7.1 Channel Description



Logic is one-out-of-two-twice for each bus.

BBC Brown Boveri Inc., Single Phase Voltage Relays Model No. 211B4175, Type ITE-27D, Time Delay range 0-10 sec., Voltage range 60-110 volts.

7.2 Channel Instrument Accuracy

Per Reference 2.4 and 2.10 and Assumption 4.4.

Relay

A_L = VA = 0.2 volts (2σ)

Because the normal and accident environmental conditions are the same:

$A_N = A_T = A_L$

VD = 0.64 volts (2σ) for 12 months

$D_L = (15/12)^{1/2}*0.64$ volts = 0.72 volts (2σ) for 15 months

Time Delay

A_L = 10%*8.5 = 0.85 seconds (2σ)

VD = 0.37 seconds (2σ) for 12 months

$D_L = (15/12)^{1/2}*0.37$ = 0.42 seconds (2σ) for 15 months

7.3 Channel Calibration Accuracy

Per Reference 2.5 and Assumption 4.2

Calibration Accuracy for Voltage setting

Fluke DMM 8062A

cl = 0.5%*120 + 0.1 = 0.7

Per the M&TE database, the Fluke 8062A has an additional error due to temperature equal to 0.1*accuracy/°C. The database also states that there is no accuracy degradation within 5°C of the temperature at which the Fluke is calibrated. Per ACP 1408.8, M&TE equipment is calibrated between 21°C and 25°C. The relays are located in the essential switchgear rooms which have normal temperatures of 75°F to 104°F (23.9°C to 40°C). The worst case error would then occur if the Fluke were calibrated at the minimum allowed temperature of 21°C and used to calibrate the relays when the switchgear room is at 40°C. Considering that there is no accuracy degradation within 5°C of the calibration temperature the affective temperature for the error is 26°C to 40°C.

cl_{tc} = 0.1*0.7*(40-26) = 0.98

Cstd = 0.7/4 = 0.175

for ALT = 0.2

$C_L = 2/3*(0.7^2 + 0.98^2 + 0.175^2 + 0.2^2)^{1/2} = 0.822$

Calibration Accuracy for Time Delay

Digital Stopwatch

cl = 0.2 sec/min * 8.5sec/60 = 0.03 sec

cstd = .03/4 = 0.01 sec

ALT = 0.2 sec

operator actuation time = 0.5 sec

$C_L = 2/3(0.03^2 + 0.01^2 + 0.2^2 + 0.5^2)^{1/2} = 0.36$ sec

7.4 PMA and PEA

Per Assumption 4.3.

PMA = 0
PEA = 0.6

7.5 NTSP and AV Consideration

7.5.1 Degraded Voltage Relay Calculation

Per Reference 2.10 and Assumption 4.5.

Per Assumption 4.5, the Lower Analytical Limits (LAL) is 106.86 VAC. The Lower Allowable Value and Lower Nominal Trip Setpoint LNTSP) are calculated as follows:

$LAV = LAL + (1.645/2)(A_N^2 + C_L^2 + PMA^2 + PEA^2)^{1/2}$
$LAV = 106.86 + (1.645/2)(.2^2 + .822^2 + 0^2 + .6^2)^{1/2}$
LAV = 107.713 VAC round up to <u>107.8 VAC</u>

$LNTSP = LAL + (1.645/2)(A_T^2 + D_L^2 + C_L^2 + PMA^2 + PEA^2)^{1/2}$
$LNTSP = 106.86 + (1.645/2)(.2^2 + .72^2 + .822^2 + 0^2 + .6^2)^{1/2}$
LNTSP = 107.898 VAC round up to <u>107.9 VAC</u>

Both of these values are less than the Tech. Spec. Allowable Value of 108 VAC, established in revision 3 of this calculation. As such, the LNTSP will be calculated using the LER avoidance recommendation presented in Ref. 2.1, where Z equals 0.81, which provides a 90% probability of LER avoidance.

$$LNTSP1 = LAV + (Z/2)(A_N^2 + C_L^2 + D_L^2)^{1/2}$$
$$LNTSP1 = 108 + (.81/2)(0.2^2 + 0.822^2 + 0.72^2)^{1/2}$$
$$LNTSP1 = 108.45 \text{ VAC Round up to } \underline{108.5 \text{ VAC}}$$

The Upper Analytical Limit (UAL), per Assumption 4.5 is 113.5 VAC. The Upper Allowable Value is then calculated as follows:

$$UAV = UAL - (1.645/2)(A_N^2 + C_L^2 + PMA^2 + PEA^2)^{1/2} - BIAS$$
$$UAV = 113.5 - (1.645/2)(.2^2 + .822^2 + 0^2 + .6^2)^{1/2} - 3.4$$
$$UAV = 109.247 \text{ VAC round down to } \underline{109.2 \text{ VAC}}$$

The Upper Nominal Trip Setpoint is:

$$UNTSP = UAL - (1.645/2)(A_T^2 + D_L^2 + C_L^2 + PMA^2 + PEA^2)^{1/2} - BIAS$$
$$UNTSP = 113.5 - (1.645/2)(.2^2 + .72^2 + .822^2 + 0^2 + .6^2)^{1/2} - 3.4$$
$$UNTSP = 109.062 \text{ VAC round down to } \underline{109.0 \text{ VAC}}$$

To ensure adequate margin between the UAV and UNTSP, UNTSP1 will be calculated to considering the Ref. 2.1 recommendations for LER avoidance.

$$UNTSP1 = UAV - (.81/2)(A_N^2 + D_L^2 + C_L^2)^{1/2}$$
$$UNTSP1 = 109.2 - (.81/2)(0.2^2 + 0.72^2 + 0.822^2)^{1/2}$$
$$UNTSP1 = 108.75 \text{ VAC round down to } \underline{108.7 \text{ VAC}}$$

7.5.2 Timer Calculation

The equations used to determine the Timer settings are as follows:.

$$UNTSP = UAL - (1.645/2)(A_T^2 + D_T^2 + C_L^2 + PMA^2 + PEA^2)^{1/2} - BIAS$$
$$UNTSP_{LER} = UAV - (.81/2)(A_N^2 + C_L^2 + D_L^2)^{1/2}$$
$$AS_{max} = UNTSP_{LER} - ALT \text{ (for switch)}$$
$$AS_{max} = UNTSP - ALT \text{ (for the timer)}$$
$$AS_{min} = LNTSP + ALT \text{ (for the timer)}$$
$$AS_{min} = LNTSP_{LER} + ALT \text{ (for switch}$$
$$LNTSP_{LER} = LAV + (.81/2)(A_N^2 + C_L^2 + D_L^2)^{1/2}$$
$$LNTSP = LAL + (1.645/2)(A_T^2 + D_T^2 + C_L^2 + PMA^2 + PEA^2)^{1/2} + BIAS$$
$$LAV = LAL + (1.645/2)(A_T^2 + C_L^2 + PMA^2 + PEA^2)^{1/2} + BIAS$$

The results are contained in the following table.

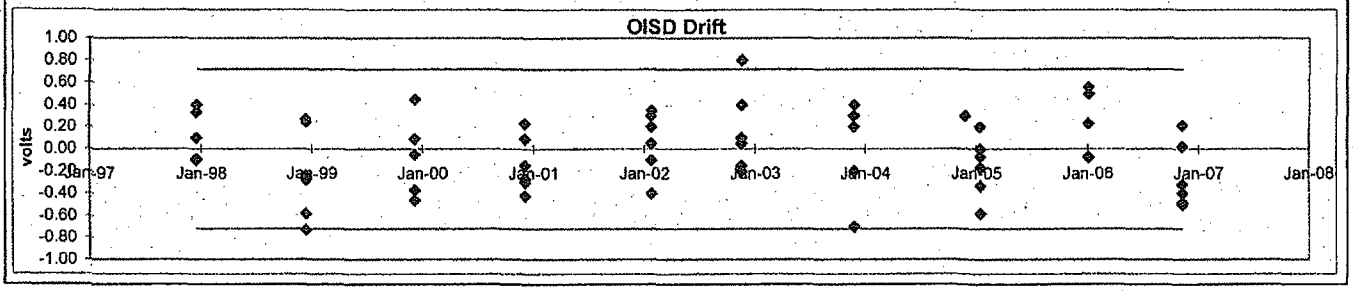
INSTR ID	D	timer
Loop Accuracy under Trip conditions (A_{TL})		0.850
Loop Accuracy under Normal conditions (A_{NL})		0.850
Loop Drift (D_L)		0.420
Positive As-Left-Tolerance (+ ALT)		0.200
Negative As-Left-Tolerance (- ALT)		0.200
Loop Calibration Error for +ALT ($+C_L$)		0.360
Loop Calibration Error for -ALT ($-C_L$)		0.360
Process Measurement Accuracy (PMA)		0.000
Primary Element Accuracy (PEA)		0.000
BIAS		0.000
reset		0.000
Z for LER Avoidance		0.810
Upper Operational Limit (UOL)		n/a
Upper Analytical Limit (UAL)		9.260
Upper Allowable Value (UAV, Tech Spec Value)	2	8.500
Upper Nominal Trip Setpoint for Spurious Trip Avoidance ($UNTSPS_{TA}$)	2	n/a
Upper Nominal Trip Setpoint (UNTSP)	2	8.420
Upper Nominal Trip Setpoint for LER Avoidance ($UNTSP_{LER}$)	2	8.080
Maximum Actual Setpoint (AS_{max})	2	8.220
Minimum Actual Setpoint (AS_{min})	2	8.200
Lower Nominal Trip Setpoint for LER Avoidance ($LNTSP_{LER}$)	2	8.340
Lower Nominal Trip Setpoint (LNTSP)	2	8.000
Lower Nominal Trip Setpoint for Spurious Trip Avoidance ($LNTSP_{TA}$)	2	n/a
Lower Allowable Value (LAV)	2	7.920
Lower Analytical Limit (LAL)		7.160
Lower Operational Limit (LOL)		n/a

8.0 SMAZ Summary

8.1 Summary for Relay

SMAZ Analysis for BBC Brown Bovari Type ITE-27D Relays

	A (2 sig)	C (2 sig)	D 12 Mo	Results
Des Sqrt(SMAZ) (volts)	0.200	0.481	0.720	0.515
OISD Count				80.000
OISD Avg (volts)				-0.007
OISD Std (volts)				0.320
OISD Sqrt(SMAZ) (volts)				0.320
Confirmation Ratio				0.621



The equations used for the SMAZ calculation are:

$$\text{OISD SMAZ}^{1/2} = (\text{OISD Avg}^2 + \text{OISD Std}^2)^{1/2}$$

$$\text{Des SMAZ}^{1/2} = (2*(A/2)^2 + 2*(C/2)^2 + (D/2)^2)^{1/2},$$

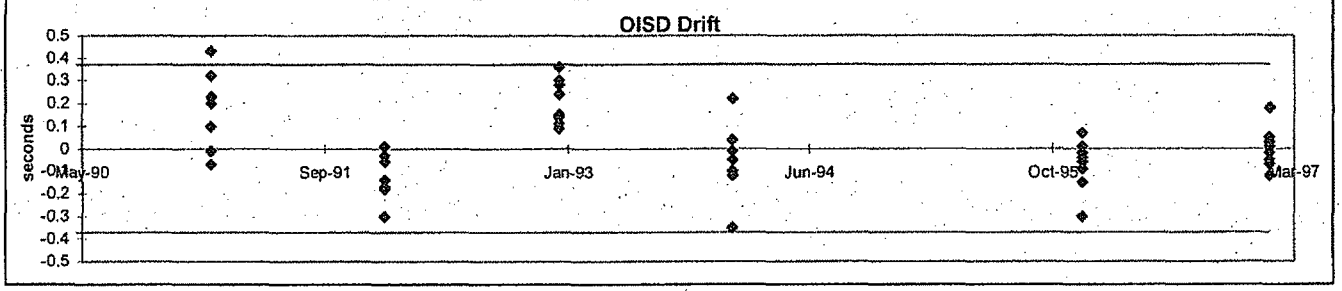
where A, C and D are 2 sigma values and $C = 2/3*(C1^2 + Cstd^2)^{1/2}$

$$\text{Confirmation Ratio} = \text{OISD SMAZ}^{1/2}/\text{Des SMAZ}^{1/2}$$

This analysis is based on data from the ITP Database using data for calibration performed from 12/17/97 to 11/16/2006.

8.2 Summary for Timer

SMAZ Analysis for BBC Brown Bovari Type ITE-27D Relays				
	A (2 sig)	C (2 sig)	D 12 Mo	Results
Des Sqrt(SMAZ) (seconds)	0.850	0.360	0.370	0.678
OISD Count				55.000
OISD Avg (seconds)				-0.005
OISD Std (seconds)				0.185
OISD Sqrt(SMAZ) (seconds)				0.185
Confirmation Ratio				0.273



The equations used for the SMAZ calculation are:

OISD SMAZ^{½} = (OISD Avg^2 + OISD Std^2)^{½}

Des SMAZ^{½} = (2*(A/2)^2 + 2*(C/2)^2 + (D/2)^2)^{½},

where A, C and D are 2 sigma values and C = 2/3*(C1^2 + Cstd^2)^{½}

Confirmation Ratio = OISD SMAZ^{½}/Des SMAZ^{½}

This analysis is based on data from the ITP Database using the following criteria:

1) Calibration dates were between 1/28/91 and 1/20/97

2) Calibration with intervals less than 9 months are excluded.