NRR-PMDAPEm Resource

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Sent: Wednesday, June 03, 2015 12:48 PM
To: Mozafari, Brenda
Subject: Calculation DA-EE-93-006-08 Rev 2 Part 2
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9.3.3 Control Voltage Uncertainty (CVu) for Type 27N Relays

VTD-A0500-4201 lists **0.1%** variation in operating voltage for the allowable variation in control voltage of 100 to 140 VDC. Control voltage is normally **133.5 ± 0.5 volts** (CMIS Setpoint **SP-1806**), and equalizing voltage is **139.8 volts** (CMIS Setpoint **SP-1802**). These are within the range of allowable control voltage, so using **0.1%** variation in operating voltage is conservative. The Control Voltage Uncertainty is therefore **± 0.1%** of a 120 volt span.

NOTE: The vital battery minimum voltage of **108.6 volts** (CMIS Setpoint **SP-1795**) is not applicable because it assumes a long term loss of AC power.

9.3.4 Drift Uncertainty (Du) for Type 27N Relays

An IHPA computer run dated 12/14/01 (See Attachment 7 page entitled "Ks Results Summary") calculated a drift of **± 0.27%** of a 120 volt span for the Type 27N relay. The drift uncertainty is therefore **± 0.27%** of a 120 volt span.

9.3.5 Potential Transformer Uncertainty (PTu) for Type 27N Relays

9.3.5.1 Potential transformer accuracy depends on its accuracy class and the total connected burden. Nameplate information for the PT is documented in CMIS:

(Westinghouse 480/120V Potential Transformers, Style 254A481G04, Type EMPL 0.6, ACC CL IL-44-060-2 Line 7, FW Impulse Test 10KV. Thermal ratings at ambient temperatures are 750 VA @ 30 degrees C, 500VA @ 55 degrees C.

9.3.5.2 Attachment 4 (Westinghouse bulletin 44-204) shows that the type EMPL potential transformer has an accuracy rating of **± 0.3%** for burdens up to 75 VA and 85% pf (for W, X, and Y burdens).

Based on drawings 10905-0054,3, 10905-0055,3, 10905-0056,3 and 10905-0057,3 The total burden on a PT consists of a type 27 and a type 27N relay. Based on Attachment 5 pages 2 and 3, the burdens for these relays are 1.2 VA and 0.5 VA respectively, for a total burden of 1.7 VA.

The total burden of 1.7 VA is less than 75 VA. Therefore the potential transformer uncertainty is **± 0.3%** of a 120 volt span.

9.3.5.3 Using other references, the same potential transformer accuracy is shown: The nameplate references Westinghouse I.L. 44-060-2 line 7. Attachment 6 Table 1 Line 7 shows **± 0.3%** accuracy for W, X, and Y burdens. The Electrical Metermen's Handbook (Attachment 5 page 1 Table 11-13) shows that the highest of these burdens (Y) corresponds to 75VA.

9.3.6 M&TE Uncertainty (MTEu) for Type 27N Relays

a. A review of work orders determined that Doble F2000 series M&TE was used to calibrate the relays. Per the Doble Operating Manual, Doble F2000 series M&TE has an AC voltage output accurate to ± 0.25% of setting typical, and ± 0.5% of setting maximum. Laboratory Test Procedure LTP-2000 Table 5.2 shows that the Doble 150 volt range has the following calibration tolerances greater than and less than the setpoint of 90.0 volts:

Value	Minimum	Maximum	Tolerance
75.0 volts	74.62 volts	75.38 volts	± 0.51%
150.0 volts	149.2 volts	150.8 volts	± 0.53%

b. Since the tolerance of 0.53% is greater than the 0.25% accuracy, the 0.53% tolerance will be applied in this analysis. The M&TE uncertainty is therefore = **± 0.53%** of a 120 volt span.

9.3.7 Calibration Uncertainty (Cu) for Type 27N Relays

Section 9.2.2a shows the relay setting as 93.2 volts with a calibration tolerance of (+0.5,-0.0 volts). The 0.5 volts is 0.42% of 120 volts. The calibration uncertainty is therefore a bias of **+ 0.42%** of a 120 volt span.

NOTE: The net positive calibration tolerance is a biasing effect similar to raising the nominal setpoint of the relay, and will be considered a positive bias. This positive bias has the effect of decreasing the margin between the nominal setpoint and the maximum calculated setpoint, and increasing the margin between the nominal setpoint and the minimum calculated setpoint.

9.3.8 Voltage Drop Uncertainty (VDu) for Type 27N Relays

A review of drawings 21946-0054, 0055, 0056, and 0057 and the circuit schedules shown on these drawings shows that circuit L683 is the worst case. It is 520 feet long, #14 AWG wire run in conduit.

The total burden on a PT is 1.7 VA.
(Based on section 9.3.5.2)
I = (1.7 VA burden)/(120 V) = 0.014 amps
R = Impedance of 1040' of #14AWG wire routed in steel conduit: $1.04(3.1^2 + 0.073^2)^{1/2} = 3.22$ Ohms
(Impedance is from NEC Handbook Chapter 9 Table 9)
Voltage drop = IR = 0.045 volts
(0.04% of a 120 volt span)

The voltage drop uncertainty is therefore a bias of **+0.04%** of a 120 volt span.

NOTE: Voltage drop to the relay is a biasing effect similar to raising the nominal setpoint of the relay, and will be considered a positive bias. This positive bias has the effect of decreasing the margin between the nominal setpoint and the maximum calculated setpoint, and increasing the margin between the nominal setpoint and the minimum calculated setpoint.

9.3.9 Summary of Uncertainties for Type 27N Relays

Parameter	Uncertainty	Section
Relay Uncertainty (Ru)	± 0.1%	9.3.1
Temperature Uncertainty (Tu)	± 0.4%	9.3.2
Control Voltage Uncertainty (CVu)	± 0.1%	9.3.3
Drift Uncertainty (Du)	± 0.27%	9.3.4
P.T. Uncertainty (PTu)	± 0.3%	9.3.5
M&TE Uncertainty (MTEu)	± 0.53%	9.3.6
Calibration Uncertainty (Cu)	+ 0.42% bias	9.3.7
Voltage Drop Uncertainty (VDu)	+ 0.04% bias	9.3.8

9.4 Setpoint Evaluations

9.4.1 Determining the Upper TLU for Type 27N Relays

The Upper Total Loop Uncertainty TLU_{UPPER} will be subtracted from the Maximum Analytical Limit to determine the Maximum Calculated Setpoint. The uncertainties of the relays and test equipment listed in the table above are assumed to be independent, random, linear, and approximately normally distributed. The Total Loop Uncertainty (TLU) is therefore calculated by the square root of the sum of the squares: (See note below, and see section 9.3.9 for uncertainty values)

$$TLU_{UPPER} = (Ru^2+Tu^2+CVu^2+Du^2+PTu^2+MTEu^2)^{1/2} +Cu+VDu$$

$$TLU_{UPPER} = 0.79\% + 0.42\% + 0.04\% = 1.25\%$$

TLU_{UPPER} = 0.0125 x 120 = **1.5 volts**

NOTE: The sum of the biased uncertainties Cu and VDu is positive, which increases the magnitude of TLU_{UPPER}, lessens the Maximum Calculated Setpoint, and reduces the Upper Margin to the Nominal Setpoint.

9.4.2 Determining the Lower TLU for Type 27N Relays

The Lower Total Loop Uncertainty TLU_{LOWER} will be added to the Minimum Analytical Limit to determine the Minimum Calculated Setpoint. The uncertainties of the relays and test equipment listed in the table above are assumed to be independent, random, linear, and approximately normally distributed; with the exception of the biased uncertainties. The Lower Total Loop Uncertainty TLU_{LOWER} could be calculated by subtracting the net positive biased uncertainties from the square root of the sum of the squares of the random uncertainties. However, in this analysis, the net positive uncertainties will be neglected for conservatism. (See note below, and see section 9.3.9 for uncertainty values).

$$TLU_{LOWER} = (Ru^2+Tu^2+CVu^{2+}Du^2+PTu^2+MTEu^2)^{1/2} = 0.79\%$$

TLU_{LOWER} = 0.0079 x 120 = **0.9 volts**

NOTE: Subtracting the net positive biased uncertainties Cu and VDu from TLU_{LOWER} would decrease the magnitude of TLU_{LOWER}, decrease the Minimum Calculated Setpoint, and increase the Lower Margin to the Nominal Setpoint. However, the net positive biased uncertainties are neglected when calculating TLU_{LOWER} so that the Lower Margin between the Minimum Calculated Setpoint and the nominal setpoint will remain conservatively small.

9.4.3 Determining the Maximum and Minimum Calculated Setpoints for Type 27N Relays:

a. To ensure that undervoltage trip actually occurs at or less than the Maximum Analytical Limit AL_{MAX}, the Maximum Calculated Setpoint CS_{MAX} is required to be less than AL_{MAX} by the magnitude of the upper Total Loop Uncertainty TLU_{UPPER}. AL_{MAX} is established in sections 9.2.1c and 9.2.1d.

$CS_{MAX} = AL_{MAX} - TLU_{UPPER}$

CS_{MAX} =96.0 volts - 1.5 volts = **94.5 volts**

(94.5 x 4 =378.0 volts at the bus)

NOTE: The net positive sum of the biased uncertainties has been included in TLU_{UPPER}, so the magnitude of CS_{MAX} has been decreased by this amount. (See section 9.4.1)

b. To ensure that undervoltage trip actually occurs at or above the Minimum Analytical Limit AL_{MIN}, the Minimum Calculated Setpoint CS_{MIN} is required to be greater than AL_{MIN} by the magnitude of the Lower Total Loop Uncertainty TLU_{LOWER}. AL_{MIN} is established in section 9.2.1.b.

$CS_{MIN} = AL_{MIN} + TLU_{LOWER}$

CS_{MIN} = 92.0 volts + 0.9 volts = **92.9 volts**

(92.9 x 4 = 371.6 volts at the bus)

NOTE: The biased uncertainties have been neglected in TLU_{LOWER}, so the magnitude of CS_{MIN} is not affected by the biased uncertainties. (See section 9.4.2)

9.4.4 Determining Upper and Lower Margins, using the Nominal Setpoint from Section 9.2.2a for Type 27N Relays:

a. Upper Margin = CS_{MAX} - NS

Upper Margin = 94.5 - 93.2 = **1.3 volts**

NOTE: CS_{MAX} has been decreased by the net positive sum of the biased uncertainties (See section 9.4.3a). Therefore, the upper margin has been decreased by the same amount.

b. Lower Margin = NS - CS_{MIN}

Lower Margin = 93.2 - 92.9 = **0.3 Volts**

NOTE: The lower margin is not affected by the biased uncertainties because the CS_{MIN} is not affected by the biased uncertainties. (See section 9.4.3b)

9.4.5 Determining the Upper and Lower Channel Operability Test Values for Type 27N Relays:
(See section 9.3.9 for uncertainty values)

NOTE: The Upper COT is applied to calculate the Maximum Allowable Value. The Lower COT is applied to calculate the Minimum Allowable Value. PTu and VDu are process uncertainties that are not applicable to the COT calculation. M&TEu is also not applicable.

a. $COT_{UPPER} = (Ru^2 + Tu^2 + CVu^2 + Du^2)^{½} + Cu$

COT_{UPPER} = 0.50% + 0.42% = 0.92%

COT_{UPPER} = .0092 x 120 = **1.1 volts**

b. $COT_{LOWER} = (Ru^2 + Tu^2 + CVu^2 + Du^2)^{½}$ = 0.50%

COT_{LOWER} = .0050 x 120 = **0.6 volts**

9.4.6 Determining the Total Instrument Uncertainty for Type 27N Relays:
(See section 9.3.9 for uncertainty values)

NOTE: PTu and VDu are process uncertainties that are not applicable to the TIU calculation.

$TIU = \pm(Ru^2+Tu^2+CVu^2 {}^+Du^2+MTEu^2)^{1/2} +Cu$

TIU = ±0.73% +0.42% = **(+1.15,-0.31)%**

TIU x 120 = ±1.38 +0.50 = **(+1.88,-0.88)volts**

9.4.7 Determining the Maximum and Minimum Allowable Values for Type 27N Relays:

a. $AV_{MAX} = CS_{MAX} + COT_{UPPER}$

AV_{MAX} = 94.5 + 1.1 = **95.6 volts**

(95.6 x 4 = 382.4 volts at the bus)

b. $AV_{MIN} = CS_{MIN} - COT_{LOWER}$

AV_{MIN} = 92.9 - 0.6 = **92.3 volts**

(92.3 x 4 = 369.2 volts at the bus)

c. Compare calibration procedure PR-1.1 dropout test as-found tolerance: ± 0.6 volt of previous as-left Test (see section 9.2.3.a). The as-left tolerance is 93.2 to 93.7 volts (section 9.2.2.a). The as-found tolerance is therefore ± 0.6 volt from the as-left tolerance, or 92.6 to 94.3 volts. This is acceptable because it is within the range of allowable values AV_{MIN} to AV_{MAX} in (b) and (a) above.

d. Compare Periodic Test procedure PT-9.1.14, PT-9.1.16, PT-9.1.17, PT-9.1.18 dropout test as-found acceptance criteria: 92.6 to 94.3 volts (see section 9.2.3.b). This is acceptable because it is within the range of allowable values AV_{MIN} to AV_{MAX} in (b) and (a) above.

9.4.8 Determining the Reset Nominal Setpoint (NSr) for Type 27N Relays:

a. VTD-A0500-4201 states that "Multiturn internal calibration potentiometers provide means for accurate adjustment of the relay operating points, and allow the difference between pickup and dropout to be set as low as 0.5%." For a nominal setpoint voltage of 93.2 volts (from section 9.2.2a), this is (0.5%)(93.2 volts) = 0.47 volts.

NSr = NS + 0.47

NSr = 93.2 + 0.47 = **93.7 volts**

b. Compare calibration procedure PR-1.1 pickup test nominal setpoint: 93.7 volts. This is acceptable because it corresponds with the pickup test nominal setpoint calculated in (a) above.

9.4.9 Determining the Reset Calibration Tolerance (CTr) for Type 27N Relays:

a. The Calibration Tolerance from section 9.2.2a will be applied to the reset Nominal Setpoint from section 9.4.8a to determine a reset calibration tolerance CTr:

CTr = CT + NSr

CTr = (+0.5,-0.0) + 93.7 = **93.7 to 94.2 volts**

NOTE: From section 9.2.2.a the dropout test as-left calibration tolerance is 93.2 to 93.7 volts. Therefore, there is no overlap between dropout and reset calibration tolerances.

b. Compare calibration procedure PR-1.1 as-left pickup test tolerance: 93.7 to 94.2 volts, as close to 93.7 volts as practical (see section 9.2.5). This is acceptable since it corresponds with the Calibration Tolerance calculated in (a) above.

9.4.10 Determining the Reset As-Found Tolerance (AFTr) for Type 27N Relays:

a. Based on section 9.4.8a, the difference between pickup and dropout will not exceed 0.5%. The Reset As-Found Tolerances will be determined from the Allowable Values in section 9.4.7 as follows: (The maximum tolerance is 0.5% greater than the maximum allowable value; the minimum tolerance is 0.0% greater than the minimum allowable value.)

$AFTr_{MAX} = AV_{MAX}$ (1.005)

$AFTr_{MAX}$ = 95.6 (1.005) = **96.1 volts**

$AFTr_{MIN} = AV_{MIN}$ (1.000)

$AFTr_{MIN}$ = 92.3 (1.000) = **92.3 volts**

b. Compare calibration procedure PR-1.1 as-found pickup test tolerance: ± 1.0 volts from the previous as-left test (see section 9.2.6a). The as-left tolerance is 93.7 to 94.2 volts (section 9.4.9a). The as-found tolerance is therefore ± 1.0 volt from the as-left tolerance, or 92.7 to 95.2 volts. This is acceptable because it is within the range of allowable values calculated in (a) above.

c. Compare Periodic Test procedure PT-9.1.14, PT-9.1.16, PT-9.1.17 and PT-9.1.18 pickup test as-found acceptance criteria: 92.6 to 94.8 volts. (See section 9.2.6b) This is acceptable because it is within the range of allowable values calculated in (a) above.

10.0 Time Delay Setpoint Analysis for Type 27N Relays

10.1 Description of the Type 27N Relay Time Delay

10.1.1 The type 27N relay is a definite time relay with constant time delay less than its voltage setpoint. The time delay to dropout (trip) is adjustable.

10.2 Evaluation of the Existing Type 27N Relay Time Delay Against Documented Requirements

10.2.1 Time Delay Analytical Limit (ALt)

a. COLR Accident Analysis Assumptions Setpoints includes analytical limit **SP-2241**, UV Detection Delay, $\leq$**2.75 seconds**. This maximum analytical limit applies to the type 27N loss of voltage relay. This value appears in Tech Specs

b. Ginna Technical Specification SR3.3.4.2 lists the loss of voltage time delay "allowable value" as $\leq$**2.75 seconds** (CMIS setpoint **SP-2324**). Although the term "allowable value" is used in the Ginna Technical Specifications, this is actually the safeguards bus loss of voltage time delay maximum analytical limit.

c. The worst-case voltage dips on the safeguards buses result from diesel generator load sequencing (See assumption 5.11). The time delay minimum analytical limit will be established as the time that the one worst-case voltage dip is between the loss of voltage analytical limit (80% line) and a relay reset value that is 0.5% higher than this, on Attachments 2 and 3. The combination of the loss of voltage maximum analytical limit and the time delay minimum analytical limit will ensure that the type 27N relay will not trip during diesel generator load sequencing. The section 9.2.1d tables show that 1.1 seconds is the worst case. A margin of 0.4 seconds will be added to allow for potential future load changes. The time delay minimum analytical limit is therefore 1.1+0.4= **1.5 seconds**.

NOTE: It is shown in section 5.11.5 that the worst case bus 14 voltage during normal offsite power load sequencing is 387 volts for the worst case probable combination of simultaneous motor starts. The bus voltage of 387 volts is higher than the maximum analytical limit of 384 volts. Therefore, normal offsite power load sequencing can not cause operation of the type 27N relay.

10.2.2 Time Delay Allowable Value (AVt)

a. Periodic Test procedure PT-9.1.14, PT-9.1.16, PT-9.1.17, PT-9.1.18 dropout time test as-found acceptance criteria: 2.18 to 2.62 seconds (CMIS setpoint **SP-1371)** (**2.4 ± 0.22 second** @ 0.0 volts and 92.6 volts).

b. Calibration procedure PR-1.1 dropout time test as-found tolerance: 2.05 to 2.75 seconds (**2.4 ± 0.35 second** @ 92.6 volts).

10.2.3 Time Delay Nominal Setpoint and Calibration Tolerance

a. Ginna Technical Specification SR3.3.4.2 lists the loss of voltage time delay setpoint as **2.4 ± 0.12 seconds** at 93.2 volts (372.8 volts bus voltage) (CMIS setpoint **SP-2311**).

b. Calibration procedure PR-1.1 dropout time test: nominal setpoint 2.4 seconds, as-left tolerance: 2.28 to 2.52 seconds (**2.4 ± 0.12 second** @ 92.6 volts), (CMIS setpoint **SP-2311**).

c. Drawing 11253-1 sheets 3 and 4 show that these relays have a 2.4 second dropout and time lever setting of 2.

10.3 Evaluation of Time Delay Instrument Uncertainties for Type 27N Relay

NOTE: A 5 second span is applied below because this is greater than the 2.75 second analytical limit.

10.3.1 Relay Time Delay Uncertainty (Rut)

VTD-A0500-4201 does not specify a relay time delay accuracy. This accuracy will be conservatively based on how accurately the field calibration is performed. Since the relay is field calibrated to the nearest 0.1 second, the relay time delay accuracy is ±0.05 second, which is ±1.0% of a 5 second span. Therefore the relay time delay uncertainty is **± 1.0%** of a 5 second span.

10.3.2 Time Delay Temperature Uncertainty (Tut)

VTD-A0500-4201 lists 0.5 volts variation in operating voltage over the temperature range 20-40 deg. C. This is **0.42%** of a 120 volt span. Since VTD-A0500-4201 lists no variation of time delay with temperature, it will be conservatively assumed the same as the operating voltage variation. Therefore the time delay temperature uncertainty is **± 0.42%** of a 5 second span.

10.3.3 Time Delay Control Voltage Uncertainty (CVut)

VTD-A0500-4201 lists 0.1% variation in operating voltage over the allowable dc control voltage range of (100 to 140vdc). Control voltage is normally **133.5 ± 0.5 volts** (CMIS Setpoint **SP-1806**), and equalizing voltage is **139.8 volts** (CMIS Setpoint **SP-1802**). Since VTD-A0500-4002 lists no variation of time delay with control voltage, it will be conservatively assumed the same as the operating voltage variation. Therefore the time delay control voltage uncertainty is **± 0.1%** of a 5 second span.

10.3.4 Time Delay Drift Uncertainty (Dut)

An IHPA computer run dated 12/18/01 (See Attachment 8 page entitled "Ks Results Summary") calculated a time delay drift of **± 0.051%** of a 60 second span (0.0306 seconds) for the Type 27N relay. 0.0306 seconds is 0.612% of a 5 second span. Therefore the time delay drift uncertainty is **± 0.61%** of a 5 second span.

10.3.5 Time Delay M&TE Uncertainty (MTEut)

Per Attachment 5 pages 4-6, the Dranetz model 325 polymeter's time measurements accuracy is ±0.003% of reading ± least significant digit. Test timing is performed on the 0 to 999.99 or 0 to 99.999 second range. Measurement accuracy is therefore ±(0.003%*100 sec + .01 sec) = ±0.013 second. This is equal to **±0.26%** of a 5 second span. Therefore the time delay M&TE uncertainty is **±0.26%** of a 5 second span.

10.3.6 Time Delay Calibration Uncertainty (Cut)

Section 10.2.2 shows the relay setting as 2.4 seconds with a calibration tolerance of (±0.12 second). ±0.12 seconds is **±2.4%** of a 5 second span. Therefore the time delay calibration uncertainty is **±2.4%** of a 5 second span.

10.3.7 Summary of Time Delay Uncertainties

Parameter	Uncertainty	Section
Relay Uncertainty (Rut)	± 1.0%	10.3.1
Temperature Uncertainty (Tut)	± 0.42%	10.3.2
Control Voltage Uncertainty (CVut)	± 0.1%	10.3.3
Drift Uncertainty (Dut)	± 0.61%	10.3.4
M&TE Uncertainty (MTEut)	± 0.26%	10.3.5
Calibration Uncertainty (Cut)	± 2.4%	10.3.6

10.4 Setpoint Evaluation for Type 27N Relay Time Delay

10.4.1 Determining the Time Delay Total Loop Uncertainty for Type 27N Relays:

The uncertainties of the relays and test equipment listed in the table above are assumed to be independent, random, linear, and approximately normally distributed. The Total Loop Uncertainty (TLUt) is therefore calculated by the square root of the sum of the squares: (See section 10.3.7 for uncertainty values)

$TLUt = \pm (Rut^2 + Tut^2 + CVut^2 + Dut^2 + MTEut^2 + Cut^2)^{1/2} = \mathbf{\pm 2.7}\%$

$TLUt = \pm\ 0.027 \times 5$ seconds = **± 0.14 seconds**

10.4.2 Determining the Maximum and Minimum Time Delay Calculated Setpoints for Type 27N Relays:

a. To ensure that undervoltage trip actually occurs at or less than the Maximum Analytical Limit ALt_{MAX}, the Maximum Calculated Setpoint CSt_{MAX} is required to be less than the ALt_{MAX} by the magnitude of the Total Loop Uncertainty TLUt. ALt_{MAX} is established in sections 10.2.1a and 10.2.1b.

$CSt_{MAX} = ALt_{MAX} - TLUt$

CSt_{MAX} = 2.75 seconds - 0.14 seconds = **2.61 seconds**

b. To ensure that undervoltage trip actually occurs at or greater than the Minimum Analytical Limit ALt_{MIN}, the Minimum Calculated Setpoint CSt_{MIN} is required to be greater than ALt_{MIN} by the Total Loop Uncertainty TLUt. ALt_{MIN} is established in section 10.2.1c.

$CSt_{MIN} = ALt_{MIN} + TLUt$

CSt_{MIN} = 1.5 seconds + 0.14 seconds = **1.64 seconds**

10.4.3 Determining Upper and Lower Time Delay Margins using Time Delay Nominal Setpoint from section 10.2.3b for Type 27N Relays:

a. Upper Margin = CSt_{MAX} - NSt

Upper Margin = 2.61 - 2.40 seconds = **0.21 seconds**

b. Lower Margin = NSt - CSt_{MIN}

Lower Margin = 2.40 - 1.64 seconds = **0.76 seconds**

10.4.4 Determining the Time Delay Channel Operability Test Value for Type 27N Relays:
(See section 10.3.7 for uncertainty values)

$COTt = (Rut^2 + Tut^2 + CVut^2 + Dut^2 + Cut^2)^{1/2}$ = **± 2.7%**

COTt = 0.027 x 5 second span = **± 0.14 seconds**

10.4.5 Determining the Time Delay Total Instrument Uncertainty for Type 27N Relays:
(See section 10.3.7 for uncertainty values)

$TIUt = (Rut^2 + Tut^2 + CVut^2 + Dut^2 + MTEut^2 + Cut^2)^{1/2}$ = **± 2.7%**

TIUt = 0.027 x 5 second span = **± 0.14 seconds**

10.4.6 Determining the Maximum and Minimum Time Delay Allowable Values for type 27N Relays:

a. $AVt_{MAX} = CSt_{MAX} + COTt$

AVt_{MAX} = 2.61 + 0.14 = **2.75 seconds**

b. $AVt_{MIN} = CSt_{MIN} - COTt$

AVt_{MIN} = 1.64 - 0.14 = **1.50 seconds**

10.4.7 Compare calibration procedure PR-1.1 dropout time test as-found tolerance: 2.05 to 2.75 seconds at 92.6 volts (see section 10.2.2b). This is acceptable because this range is within the range of allowable values in section 10.4.6 above.

10.4.8 Compare Periodic Test procedure PT-9.1.14, PT-9.1.16, PT-9.1.17, PT-9.1.18 dropout time test as-found acceptance criteria: 2.18 to 2.62 seconds (CMIS setpoint **SP-1371**) at 0 volts and 92.6 volts (see section 10.2.2.a). This is acceptable because this range is within the range of allowable values in section 10.4.6 above.

11.0 Uncertainty Analysis for Type KA-241 Voltmeters

11.1 Instrument Channel and Scope of Analysis

11.1.1 Description of Functions

The following voltmeters will be analyzed:

Bus	Voltmeter
BUS14	EI/PD
BUS16	EI/NN
BUS17	EI/NI
BUS18	EI/ND

11.1.2 Protection

These loops do not perform any protective functions.

11.1.3 Control

These loops do not perform any control functions. However, synchroscopes are powered by the same potential transformers.

11.1.4 Indication

Voltmeters provide plant operators with indication of Safeguards bus voltage.

Emergency Operating Procedures reference two EOP setpoints that use these voltmeters:

R.1 (**420 volts**) (Operator Decision Point, CMIS setpoint **SP-0078**)
R.11 (**414 volts**) (Analytical Limit, CMIS setpoint **SP-2312**)

For a list of EOP procedure numbers that use these setpoints, see "EOP Setpoints" in the Reference section

Ginna Technical Specifications reference the same two setpoints that use these voltmeters (See sections 3.1.1, 3.1.2):

Setpoint	Value
SP-0078	**420 VAC**
SP-2312	**414 VAC**

Safeguards Bus Voltmeters - Summary of Instrument Channel Functions

Function	Description of Function	Safety Classification	Within this Scope?
Reactor Protection	NONE	N/A	N/A
Eng.Safety Features	NONE	N/A	N/A
Control	NONE	N/A	N/A
Alarm	NONE	N/A	N/A
Indication	Monitor 0 to 600 VAC safeguards bus voltages	NS	YES
Other	N/A	N/A	N/A

11.2 Documenting the Components of Sensor Accident Uncertainty (AEUp and AEUs)

11.2.1 Pipe Breaks

N/A, not required during harsh environment conditions.

11.2.2 Seismic Event

N/A, instrument uncertainty for these indicators is not required to be considered for a seismic event.

11.2.3 Documenting the Components of the Accident Current Leakage Effect (CLU)

N/A, not required during harsh environment conditions.

11.2.4 Determining the Components of Process Measurement Uncertainty (PMU):

Random Process Measurement Uncertainty

There are two potential transformers which sense and step down the voltage to acceptable levels for inputs to the voltmeter. A selector switch determines the phase voltage to be measured. The accuracy class of the potential transformers is 0.6%. (See section 11.5)

Biased Process Measurement Errors

There is no calibration uncertainty due to bias effects.

11.3 Instrument Loop Performance Requirements

11.3.1 Documenting the Design Requirements for Monitoring the Process Parameter

11.3.2 Identify Performance Related Design Bases Associated With the Instrument Loop:

__NS___ Safety Classification (SR/SS/NS) as documented in CMIS.

The Safeguards Bus Voltmeters are listed as NS in CMIS.

__NO___ NUREG 0737/RG 1.97 as documented in Table 7.5-1, of the Ginna UFSAR.

These voltmeters are not listed in UFSAR Table 7.5-1. The EDG A, B Voltmeters that are listed refer to different instrumentation.

__N/A___ EQ (per the IP-EQP-1 Master List)

These instrument loops are not identified in the IP-EQP-1 Master List as requiring environmental qualification.

__N/A__ Seismic Category (Seismic Class I/ Structural Integrity Only / NS)

This instrumentation is non safety related and therefore does not require seismic qualification.

<u>YES</u> Technical Specifications

Per a review of the following ITS sections, these instruments are Technical Specification related in that they are used to verify acceptance criteria.

Section	Setpoint	Value
SR 3.8.10.1	**SP-0078**	**420 VAC**
SR 3.8.10.1	"	"
SR 3.8.9.1	"	"
SR 3.8.9.1	"	"

<u>NO</u> UFSAR

The UFSAR does not describe these voltmeters or operator actions based on readings from these voltmeters. Searches were conducted using "voltmeter", "420", and "414".

<u>YES</u> EOP

Per a review of the EOP Setpoint database, the following EOP setpoints are related to this analysis:

EOP No.	Limit	Basis
R.1	**420** volts	Tech Specs
R.11	**414** volts	Tech Specs

11.3.3 Summary of Design Basis Setpoints

Documents Reviewed	Requirements, Limits, Design Bases	Associated Instrument Channel Path Name
Ginna Technical Specifications SR 3.8.9.1 SR 3.8.10.1	 420 vac 420 vac	EI/PD, EI/NN, EI/NI, EI/ND
Ginna Station UFSAR	NO	N/A
NUREG 0737/RG 1.97 (UFSAR Table 7.5-1)	NO	NO
EQ Master List (IP-EQP-1)	N/A	N/A
Seismic Qualification	N/A	N/A
EOPs AP-ELEC.2 AP-ELEC.1 AP-ELEC.2 AP-ELEC.3 AP-IA.1 AP-RCS.4 E-0 E-1 ES-0.1 ES-1.1 E-3 ES-1.2 ES-1.3 ECA-2.1 ECA-3.1 ECA-3.2 ECA-3.3	 **414 v** **420 volts** " " " " " " " " " " " " " "	**EI/PD, EI/NN, EI/NI, EI/ND**
Other	N/A	N/A

11.4 Instrument Channel Component Specifications:

Identify and summarize the specifications associated with each instrument within the scope of this analysis. Complete one Instrument Specification Table below for each instrument:

11.4.1 EIN: EI/PD, EI/NN, EI/NI, EI/ND

Specification	Data	Source
Manufacturer/Model No	Westinghouse type KA-241, style BA-81490-N3-195, tbs (taut-band suspension) full scale=150 VAC.	1/4/02 Walkdown
Input Range	0-150 volts	CP-501.3,CP-501.4, CP-501.5,CP-501.6
Output Range	0-600 volts	CP-501.3,CP-501.4, CP-501.5,CP-501.6
Input/Output Conversion Type	repulsion-attraction, moving iron (Electro-mechanical)	VTD-W0120-4769 page 1
Safety Classification	NS	CMIS
Setpoint	**420 Volts** **414 Volts**	**R.1, SP-0078** **R.11, SP-2312**
Location	Control Room	CMIS, 1/4/02 walkdown
Reference Accuracy	±1.0% full scale	VTD-W0120-4769
Drift	±1.0% full scale	Assumption 5.5
Calibration Uncertainty	±0.25% full scale	Vendor Manual, Arviter Model 1040C.
Temperature Effect	Negligible	Assumption 5.4
Repeatability, Hysteresis, Linearity	negligible	Assumption 5.7
Parallax	negligible	Assumption 5.2
Scale Readability	±0.83% full scale	Assumption 5.2

11.5 Documenting the Components of Process Measurement Uncertainty (PMU)

Potential transformers are Westinghouse Style 7526A02G04, ratio 4/1, 0.6% accuracy class @ W burden and 1.2% accuracy class @ X burden, per CMIS.

The total burden includes the voltmeter and a synchroscope. Westinghouse application data 43-200 page 4 lists the following burdens:

Type KA-241 Repulsion-Attraction voltmeter:
(style # BA-81490-N3-195 per 1/4/02 walkdown)
Burden: 1.92 Watts and 0.0 VARs, at 150 volts.

Type KI-241 Synchroscope:
(style # 186A235A01 per drawing 33013-1736,8)
Burden: 3.7 Watts and 2.8 VAR at 120 volts

The synchroscope burden at 150 volts is:
(3.7+j2.8)(150/120)=4.63 Watts and 3.5 VAR

The total burden is (1.92+4.63)Watts and 3.5 VAR, which calculates to 7.4 VA at 150 volts, and 88% power factor.

Attachment 5 Table 11-13 shows that the W burden rating is 12.5 VA. The total burden calculated above is well within this rating. Therefore, ASA 0.6% accuracy class applies.

11.5.1 Process Measurement Uncertainty

The process measurement uncertainties are associated with the potential transformer accuracy and the voltage drop uncertainty.

Potential Transformer Uncertainty: The potential transformers are ASA Accuracy Class 0.6%, in accordance with section 11.5 above.

Voltage Drop Uncertainty: A review of drawings 21946-0054, 0055, 0056, and 0057 and the circuit schedules shown on these drawings shows that circuits L425 and L502 are the worst cases. They are 350 feet long, #10 AWG wire, run in conduit for 120 feet. For conservatism, the entire run will be considered to be run in steel conduit. Voltage drop in the wiring is 0.03% as shown below.

The total burden on a PT consists of a type KA-241 voltmeter and a type KI-241 synchroscope, with a total 7.4 VA burden at 150 volts per section 11.5 above.
I = (7.4 VA burden)/(150 V) = 0.049 amps
R = Impedance of 700' of #10AWG wire routed in steel conduit: $0.7(1.2^2 + 0.063^2)^{1/2}$ = 0.84 Ohms
(Impedance is from NEC Handbook Chapter 9 Table 9)
Voltage drop = IR = 0.041 volts
(0.03% of a 120 volt span)

Parameter	Uncertainty	Ref/Section
Potential Transformer Uncertainty (Pma_1)	0.60%	Section 11.5
Voltage Drop Uncertainty (Pma_2)	0.03%	Section 11.5.1
Primary Element Accuracy (Pea)	N/A	N/A

11.5.2 Documenting Measurement and Test Equipment Uncertainty (M&TEU)

Per the Arbiter vendor manual for Model 1040C, an uncertainty of ± 0.25% is used as M&TE accuracy for the Arbiter voltage input.

Rce_1 = ± 0.25% full scale

11.5.3 Documenting Rack Equipment Uncertainty (REU)

REU	Uncertainty	Ref/Section
Rack Equipment Reference Accuracy (Rea_1)	1.0% full scale	VTD-W0120-4769
Rack Temperature Effect (Rte)	1.0% full scale	ANSI C39.1-1981
Rack Power Supply Effect (Rpse)	N/A	N/A
Rack Miscellaneous Effect (Rme_1) (repeatability, hysteresis, linearity)	negligible	Assumption 5.7
Rack Miscellaneous Effect (Rme_2) (Readability)	0.83% full scale	Assumption 5.2

11.5.4 Documenting Sensor Uncertainty (SU)

N/A, this instrument loop does not contain a sensor.

11.5.5 Documenting Drift Uncertainty (DU)

Parameter	Uncertainty	Ref/Section
Sensor Drift (Sd)	N/A	N/A
Rack Equipment Drift (meter)(Red)	1.0% full scale	Assumption 5.5

11.5.6 Documenting Tolerance Uncertainty (TU)

Parameter	Uncertainty	Ref/Section
Sensor Tolerance (St)	N/A	N/A
Rack Equipment Tolerance (Ret)	2.0% full scale	CP-501.3 CP-501.4 CP-501.5 CP-501.6

11.5.7 Process Measurement Uncertainty (PMU)

$$PMU = (Pma_1^2 + Pma_2^2)^{½}$$

$$PMU = \pm 0.6\%$$

11.5.8 Measurement and Test Equipment Uncertainty (M&TEU)

$$M\&TEU = Rce_1$$

$$M\&TEU = \pm\ 0.25\%$$

11.5.9 Determining the Accident Environmental Uncertainties (AEU)

For Pipe Breaks:

N/A. This loop is not required during harsh environment conditions.

For Seismic Events:

N/A. Instrument uncertainty for these indicators is not required to be considered for a seismic event.

11.5.10 Accident Current Leakage Effect (CLU)

This loop is not required during harsh environment conditions.

CLU = 0

11.5.11 Rack Equipment Uncertainty (REU)

$$REU = \pm[(Rea_1)^2 + (Rte)^2 + (Rme_1)^2 + (Rme_2)^2]^{1/2}$$

$$REU = \pm\ [(1.0)^2 + (1.0)^2 + (0.0)^2 + (0.83)^2]^{1/2}$$

$$REU = 1.64\%$$

11.5.12 Sensor Uncertainty (SU)

N/A

11.5.13 Drift Uncertainty (DU)

$$DU = \pm Red$$

$$DU = \pm\ 1.0\%$$

11.5.14 Tolerance Uncertainty (TU)

$$TU = \pm Ret$$

$$TU = \pm\ 2.0\%$$

11.6 Calculating the Total Loop Uncertainties

11.6.1 Provide the total loop uncertainty (TLU) for each end device for normal, seismic and accident conditions as applicable.

TLU Normal-Indicator:

$$TLU = \pm\ [(M\&TEU^2 + REU^2 + SU^2 + DU^2 + TU^2 + PMU^2]^{1/2}$$

$$TLU = \pm\ (0.25^2 + 1.64^2 + N/A* + 1.0^2 + 2.0^2 + 0.6^2)^{1/2}$$

$$TLU(+) = \pm\ 2.85\%$$

* There is no sensor associated with this instrument loop.

Where:

M&TEU	=	Measurement and Test Equipment Uncertainty
REU	=	Rack Equipment Uncertainty
SU	=	Sensor Uncertainty
DU	=	Drift Uncertainty
TU	=	Tolerance Uncertainty
PMU	=	Process Measurement Uncertainties

End Device	Normal TLU	Seismic TLU	Acc. TLU
voltmeters	±2.85%	N/A	N/A

A Total Instrument Uncertainty of ±2.85%

±0.0285 x 600 volts scale = ±17 volts

11.6.2 Comparing the Reference Accuracy vs. the Calibration Tolerance

From the calibration procedure(s), identify the calibration tolerance associated with each component. Next, obtain the reference accuracy associated with each component. Translate both effects into the equivalent units. Ensure that the calibration tolerance is greater than or equal to the reference accuracy for each component.

Tag No.	Reference Accuracy	Calibration Tolerance
EI/PD	±1.0%	±2.0% (±12 VAC)
EI/NN	±1.0%	±2.0% (±12 VAC)
EI/NI	±1.0%	±2.0% (±12 VAC)
EI/ND	±1.0%	±2.0% (±12 VAC)

PCNs have been initiated to add 1% calibration points at 420 VAC, which corresponds with the EOP setpoint.

The calibration tolerance is greater than or equal to the reference accuracy for each component. Therefore, the calibration is acceptable.

11.6.3 Determining the Calculated Minimum Setpoint (CS) for Type KA-241 Voltmeters:

The minimum Analytical Limit (AL) is EOP setpoint **R.11** (CMIS setpoint **SP-2312,** see section 11.1.4). The calculated minimum setpoint (CS) is required to be greater than the minimum analytical limit by the Total Loop Uncertainty (TLU):

CS = AL + TLU

CS = 414 volts + 17 volts = **431 volts**

11.6.4 The existing Operator Decision Setpoint (OD) is **420 volts** (EOP Setpoint **R.1,** CMIS setpoint **SP-0078,** see section 11.1.4).

11.6.5 The existing setpoint of 420 volts is less than the calculated minimum setpoint of 431 volts. However, the existing 420 volt setpoint is considered adequate and appropriate for the following reasons:

a. Short-term voltage drops may occur in the range between 420 volts and 431 volts during diesel generator load sequencing, as shown on Attachments 2 and 3. It is undesirable to divert operator time for voltage drops that are of durations less than the degraded voltage relay time delays (See section 8.0), because the Analytical Limit and Calculated Setpoint are based on longer term voltage drops that cause equipment overheating.

b The calculated setpoint is based on conservative uncertainty values and methodology. The actual TLU is expected to be closer to 1%, based on the calibration history. A TLU of 1% is 6 volts out of a 600 volt span. This would result in a calculated setpoint of 420 volts. Calibration procedures CP-501.3, CP-501.4, CP-501.5 and CP-501.6 currently use ±2% calibration tolerances for the 480 volt bus voltmeters. PCNs have been initiated to these procedures to add 1% calibration points at 420 VAC, which corresponds with the EOP setpoint.

12.0 Results:

12.1 Results of Type 27 Relay Uncertainty Analysis

12.1.1 Periodic Test procedure PT-9.1.14, PT-9.1.16, PT-9.1.17, PT-9.1.18 dropout time test as-found acceptance criteria shall include a new administrative range of 45 to 125 seconds at 104.2 volts. See sections 8.2.2e and 8.4.9.

12.1.2 Calibration procedure PR-1.1 dropout time test as-left acceptance criteria shall be changed from a range of 0 to 300 seconds at 104.2 volts to a new range of 45 to 125 seconds at 104.2 volts. See sections 8.2.2g and 8.4.10.

12.1.3 Summary of Type 27 Relay Setpoints:

Parameter	Value	Section
Min Analytical Limit (AL_{MAX}) Max Analytical Limit (AL_{MIN})	103.5 volts (414 volts @ bus) 108 volts (432 volts @ bus)	7.2.1b 7.2.1c
Nominal Setpoint (NS)	105.2 volts (420.8 volts @ bus)	7.2.2a
Calibration Tolerance	+0.5, -0.0 volts (+2.0,-0.0 volts @ bus)	7.2.2a
Time Delay Maximum Analytical Limit (ALt_{MAX})	1600 sec @ ≥103.5 volts (≥414 volts @ bus), 500 sec @ 92 volts (368 volts @ bus)	8.2.1b 8.2.1c
Time Delay Minimum Analytical Limit (ALt_{MIN})	20 sec @ ≤108 volts (≤432 volts @ bus)	8.2.1d, 8.2.1e
Time Delay Allowable Value	1520 sec @ ≥103.5 volts (≥414 volts @ bus), 475 sec @ 92 volts (368 volts @ bus)	8.2.2a 8.2.2b
Time Delay Nominal Setpoint (NSt)	40.0 sec @ 92 volts (368 volts @ bus)	8.2.3a
Time Delay Calibration Tolerance	± 1.0 sec	8.2.3a

12.2 Results of Type 27N Relay Uncertainty Analysis

12.2.1 Summary of Type 27N Relay Setpoints:

Parameter	Value	Section
Min Analytical Limit (AL_{MIN})	92 volts (368 volts @ bus)	9.2.1b
Max Analytical Limit (AL_{MAX})	96 volts (384 volts @ bus)	9.2.1c 9.2.1d
Nominal Setpoint (NS)	93.2 volts (372.8 volts @ bus)	9.2.2a
Calibration Tolerance	+0.5, -0.0 volts (+2.0,-0.0 volts @ bus)	9.2.2a
Time Delay Maximum Analytical Limit (ALt_{MAX})	2.75 sec	10.2.1a 10.2.1b
Time Delay Minimum Analytical Limit (ALt_{MIN})	1.5 sec	10.2.1c
Time Delay Nominal Setpoint (NSt)	2.4 sec	10.2.2a 10.2.2b
Time Delay Calibration Tolerance	± 0.12 sec	10.2.3a 10.2.3b

12.3 Results of Voltmeter Uncertainty Analysis

12.3.1 Summary of Voltmeter Setpoints:

Parameter	Value	Section
Analytical Limit (AL)	414 volts @ bus	11.6.3
Operator Decision Setpoint (OD)	420 volts @ bus	11.6.4, 11.6.5
Calibration Tolerance	± 12 volts @ bus	11.6.2

NOTE: PCNs have been initiated to add 1% (± 6 volts) calibration points at 420 VAC, which corresponds with the EOP setpoint. (See sections 11.6.2 and 11.6.5b)

12.4 Summary of Type 27 Relay Setpoint Evaluations:

Parameter	Value	Section
Upper Total Loop Uncertainty Lower Total Loop Uncertainty	1.9 V 1.4 V	7.4.1 7.4.2
Maximum Calculated Setpoint Minimum Calculated Setpoint	106.1 V 104.9 V	7.4.3a 7.4.3b
Upper Margin Lower Margin	0.9 V 0.3 V	7.4.4a 7.4.4b
Upper Channel Operability Test Lower Channel Operability Test	1.7 V 1.2 V	7.4.5a 7.4.5b
Total Instrument Uncertainty	+1.82 V, -0.82 V	7.4.6
Maximum Allowable Value Minimum Allowable Value	107.8 V (431.2 V @ bus) 103.7 V (414.8 V @ bus)	7.4.7a 7.4.7b
Reset Nominal Setpoint	105.7 V	7.4.8
Reset Calibration Tolerance	105.7 to 106.2 V	7.4.9a
Reset As-Found Tolerance	103.7 to 108.3 V	7.4.10a
Time Delay TLU @104.2 V Time Delay TLU @92 V	± 10.7 s ± 5.1 s	8.4.3 8.4.3
Maximum Calc Setpoint @ 104.2V Minimum Calc Setpoint @ 104.2V	1589 s 30.7 s	8.4.4a 8.4.4b
Maximum Calc Setpoint @ 92V Minimum Calc Setpoint @ 92V	494.9 s 25.1 s	8.4.5a 8.4.5b
Time Delay Margins @ 104.2 V Upper Margin: Lower Margin:	 1509 s 49.3 s	 8.4.4a 8.4.4b
Time Delay Margins @ 92 V Upper Margin: Lower Margin:	 454.9 s 14.9 s	 8.4.5a 8.4.5b
Allowable Values @ 104.2 V Time Delay Max Allowable Value Time Delay Min Allowable Value	 1520 s 30.7 s	 8.4.6a 8.4.6a
Allowable Values @ 92 V Time Delay Max Allowable Value Time Delay Min Allowable Value	 475 s 25.1 s	 8.4.6b 8.4.6b

12.5 Summary of Type 27N Relay Setpoint Evaluations:

Parameter	Value	Section
Upper Total Loop Uncertainty Lower Total Loop Uncertainty	1.5 V 0.9 V	9.4.1 9.4.2
Maximum Calculated Setpoint Minimum Calculated Setpoint	94.5 V 92.9 V	9.4.3a 9.4.3b
Upper Margin Lower Margin	1.3 V 0.3 V	9.4.4a 9.4.4b
Upper Channel Operability Test Lower Channel Operability Test	1.1 V 0.6 V	9.4.5a 9.4.5b
Total Instrument Uncertainty	+1.88V, -0.88V	9.4.6
Maximum Allowable Value Minimum Allowable Value	95.6 V (382.4V @ bus) 92.3 V (369.2V @ bus)	9.4.7a 9.4.7b
Reset Nominal Setpoint	93.7 V	9.4.8
Reset Calibration Tolerance	93.7 to 94.2 V	9.4.9a
Reset As-Found Tolerance	92.3 to 96.1 V	9.4.10a
Time Delay TLU	±0.14sec	10.4.1
Maximum Calculated Setpoint Minimum Calculated Setpoint	2.61 sec 1.64 sec	10.4.2a 10.4.2b
Time Delay Upper Margin Time Delay Lower Margin	0.21 sec 0.76 sec	10.4.3a 10.4.3b
Channel Operability Test	±0.14sec	10.4.4
Time Delay TIU	±0.14sec	10.4.5
Time Delay Max Allowable Value Time Delay Min Allowable Value	2.75 sec 1.50 sec	10.4.6a 10.4.6b

12.6 Summary of Voltmeter Setpoint Evaluations:

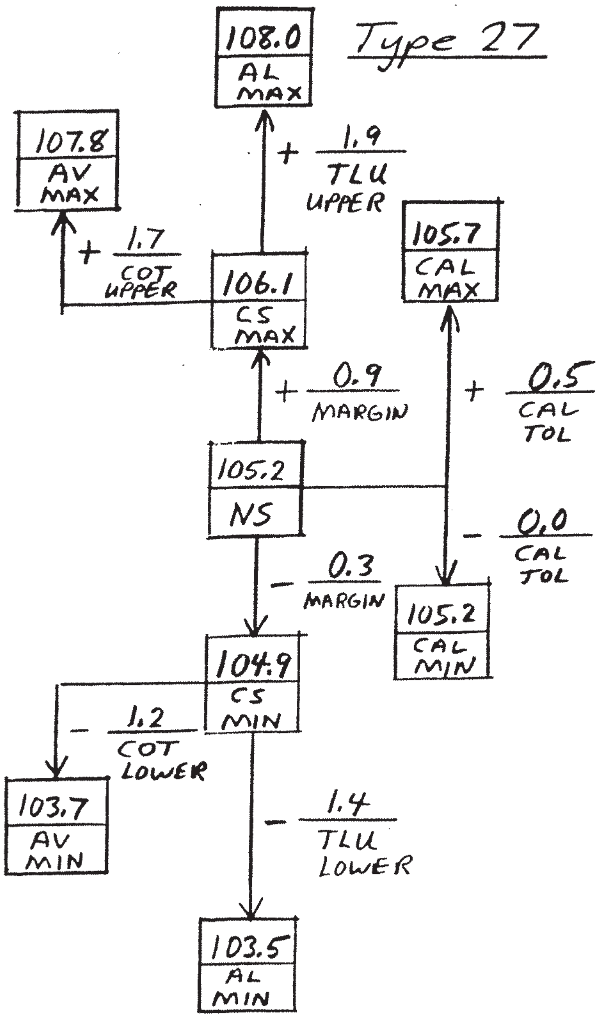
Parameter	Value	Section
Total Loop Uncertainty (TLU)	± 17 volts @ bus	11.6.1
Minimum Calc Setpoint (CS)	431 volts @ bus	11.6.3

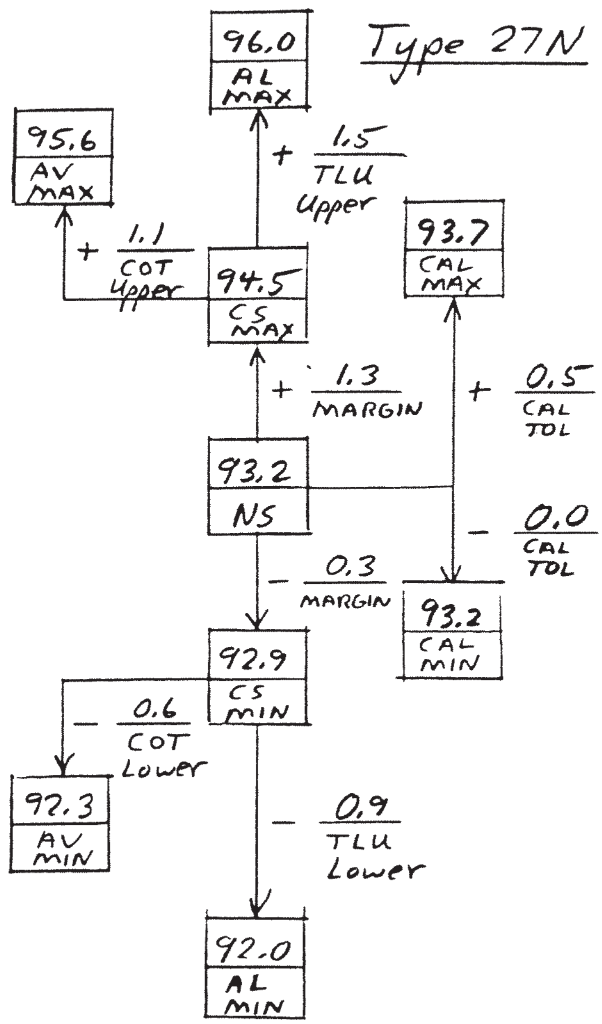
Attachment 1

Flowchart - Setpoint Calculations

← Degraded Voltage

Loss-of-Voltage ↓

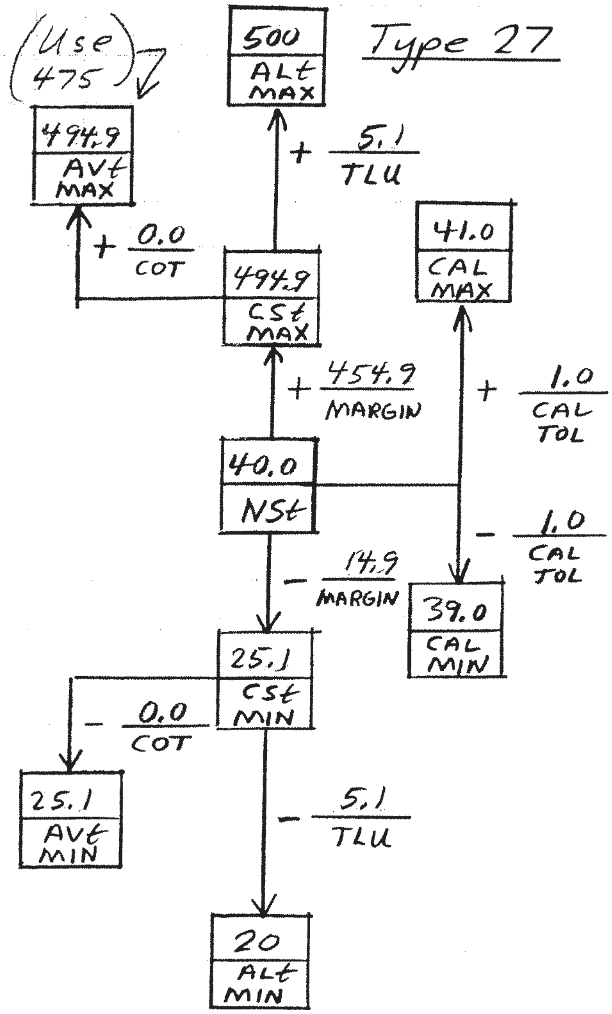




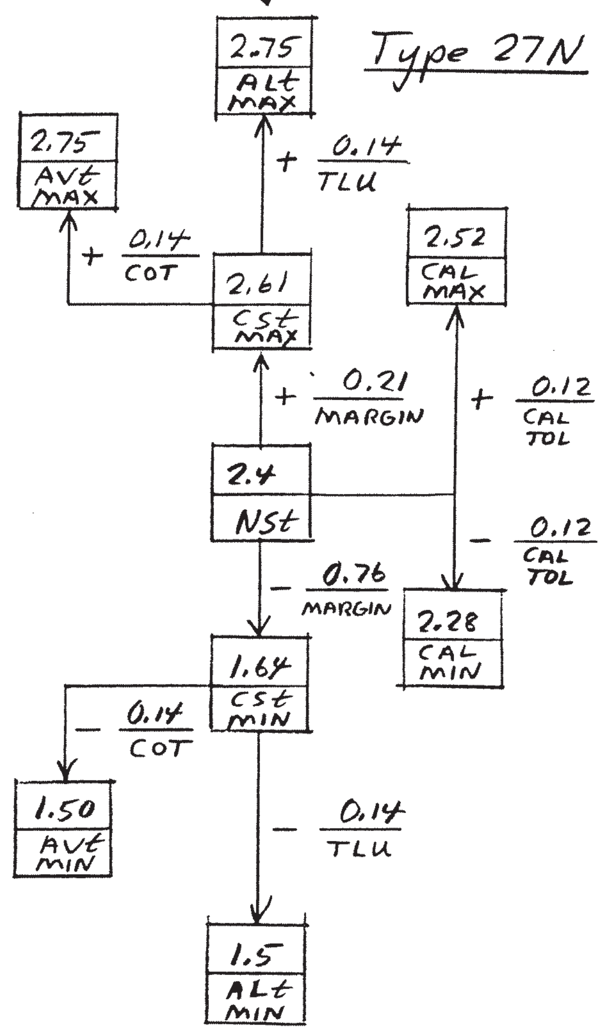
Attachment 1

Flowchart - Setpoint Calculations (Time Delay, Seconds)

← Degraded Voltage (92V)

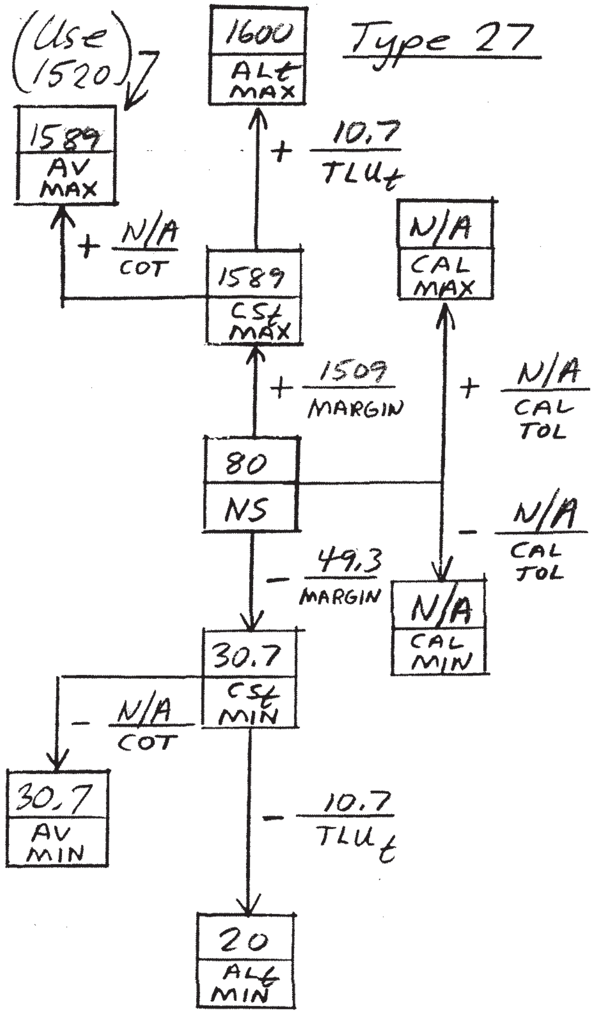


Loss-of-Voltage ↓

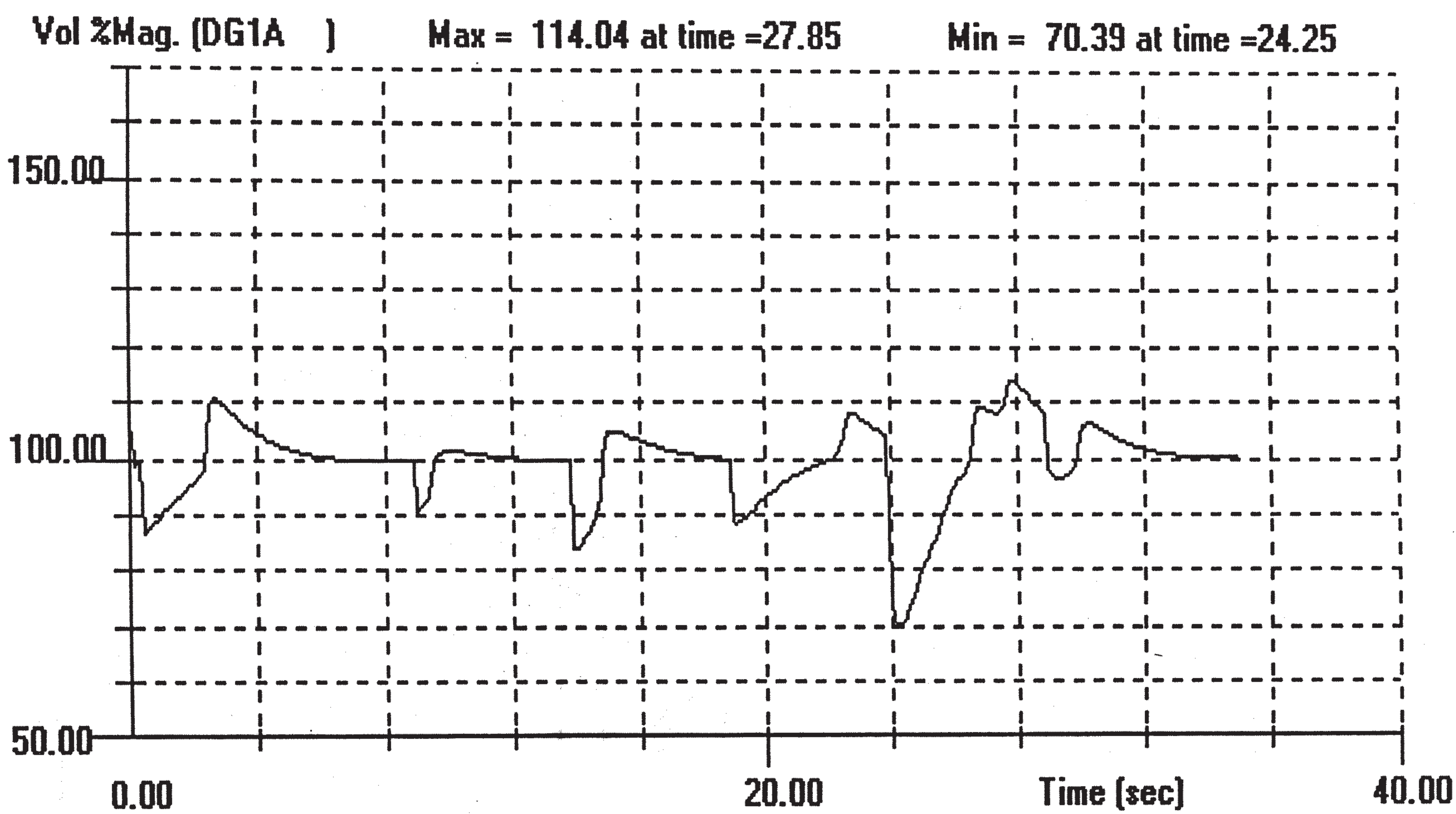


Attachment 1

Flowchart - Setpoint Calculations (Time Delay, Seconds) ← Degraded Voltage (104.2 V)

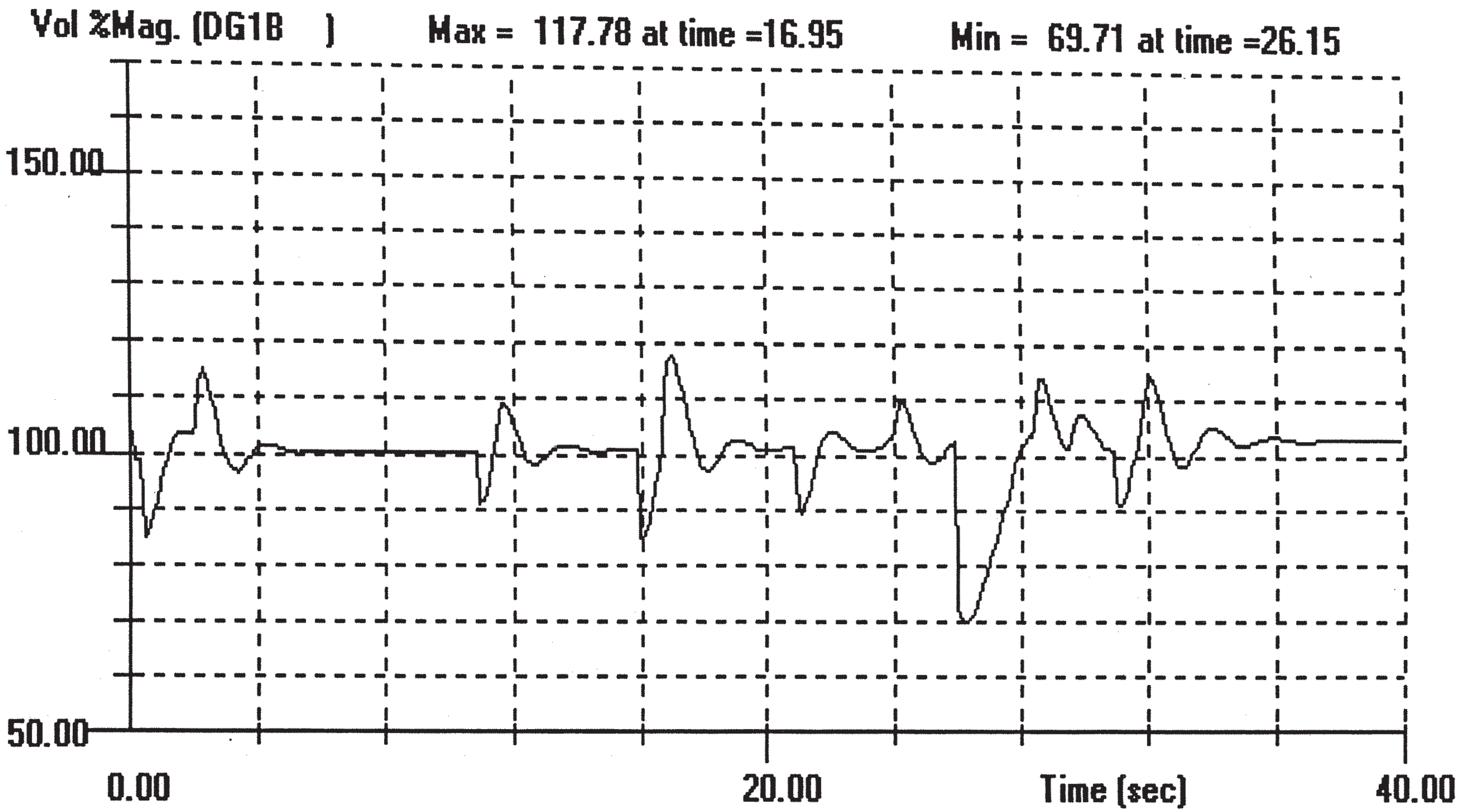


Engineer: Joseph Pacher Study Case # 900
LOOP - LOCA : CS, SI C and 2nd CF Starting At Same Time



Engineer: Bill Roettger   Study Case # 901

LOOP-LOCA: CS, SI C and 2nd CF coincident start



Westinghouse

Type EMPL Potential Transformers

600 and 1200 Volts, Indoor or Outdoor,
Primary Volts: 240 Through 600, 60 Hertz

Application

Type EMPL is a rubber molded potential transformer. It is designed to meet 0.3 accuracy for 75 va and 85% pf as well as for 40 va and 20% pf which is the typical requirement of installations using two meters with phase shifting transformer.

Ratings

ASA metering accuracy class (60 Hz.):
0.3 Class for W, X, Y Burdens
1.2 Class for Z Burdens

Thermal Rating:
750 Va at 30°C Ambient
500 Va at 55°C Ambient

Temperature Rise:
55°C at 30°C Ambient
30°C at 55°C Ambient

Construction Features

Core and Coils

Pre-molded forms are used for the winding spool and terminal brackets. A wound type core is assembled with the coil by banding the two securely into a cradle form. This rigid assembly is then completely enclosed in rubber.

Primary and Secondary Terminals

The terminals are stud type. Polarity markings and high and low voltage identification are molded in raised letters in the body of the transformer. Sealable terminal covers can be supplied for both high and low voltage.

The indoor 1200 Volt Type EMPL can be supplied with fuses. The fuse assembly, complete with two Type H 2 Amp fuses, style number 562 477, is mounted on top of the unit.

Base Mounting

A detachable aluminum base comes with all ratings. In the 600-volt class this is designed to meet NEMA standards style number 3, and for 1200 volt class to meet NEMA standards style number 2.

Bases for 600 and 1200 volt transformers are interchangeable.

Further Information

Prices: See Price List 44-020

Selector Guide

Primary Volts	Winding Ratio	Without Terminal Cover Style Number	With Terminal Covers Style Number
600 Volt Class, 10 Kv BIL: Indoor or Outdoor			
240/416 Y	2:1	254A481G01	254A483G01
288/500 Y	2.4:1	254A481G02	254A483G02
300/520 Y	2.5:1	254A481G03	254A483G03
480/480 Y	4:1	254A481G04	254A483G04
600/600 Y	5:1	254A481G05	254A483G05
1200 Volt Class, 30 Kv BIL: Indoor or Outdoor			
240/416 Y	2:1	254A481G31	254A483G31
288/500 Y	2.4:1	254A481G32	254A483G32
300/520 Y	2.5:1	254A481G33	254A483G33
480/832 Y	4:1	254A481G34	254A483G34
600/1040 Y	5:1	254A481G35	254A483G35
1200 Volt Class, 30 Kv BIL: Indoor Fused			
240/416 Y	2:1	254A481G26	.. ....
288/500 Y	2.4:1	254A481G27	. .
300/520 Y	2.5:1	254A481G28	.. ..
480/832 Y	4:1	254A481G29	.. . . .
600/1040 Y	5:1	254A481G30	. ...

ATTACHMENT 4

DA-EE-93-006-08 Pg 1 of 1 REV. 2

June, 1969
Supersedes Descriptive Bulletin 44-204 dated April, 1966
E. O. C. [illegible]

former accuracy classes can best be shown by parallelograms as is done in Fig. 11-15 for current transformers and Fig. 11-16 for potential transformers. Note that the inclination of the accuracy class parallelogram for potential transformers is opposite to that for current transformers. It may also be noted that except in accuracy class 0.5 the current transformer allowable *TCF* at 10 percent current is double that at 100 percent current.

It has been shown that an instrument transformer correction factor is not a constant but depends on the secondary burden. Hence, the accuracy class is designated by the limiting percent error caused by the transformer followed by the standard burden designation at which the transformer accuracy is determined. For instance, for a current transformer the accuracy class may be written: 0.3 *B*-0.5, 0.6 *B*-2. This means that the transformer at burden *B*-0.5 would not affect the meter accuracy more than ±0.3 percent at 100 percent rated current or ±0.6 percent at 10 percent rated current, and at burden *B*-2 the transformer would not affect the meter accuracy more than ±0.6 percent at 100 percent rated current or ±1.2 percent at 10 percent rated current, when the power factor of the metered load is between 0.6 and 1.0 lagging.

Likewise the accuracy of a potential transformer could be given as 0.3 *X*, 0.3 *Y*, 1.2 *Z*, with similar meanings. Accuracy classes of po-

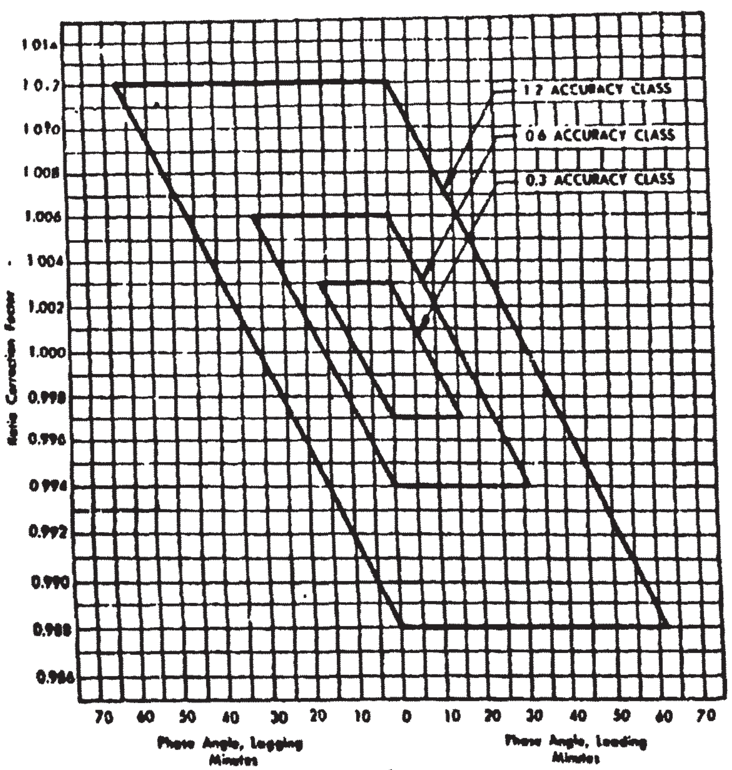


Fig. 11-16—Parallelograms Showing Graphical Equivalent of ASA Accuracy Classes 0.3, 0.6, and 1.2 for Potential Transformers.

tential and current transformers are shown in Tables 11-12 and 11-14.

The standard burdens for both potential and current transformers are precisely defined by ASA. Standard burdens and their characteristics are given in Tables 11-13 and 11-15.

The use of the ASA accuracy classifications permits the installation of instrument transformers with reasonable assurance that errors will be held within known limits provided that burden limitations are strictly adhered to and

TABLE 11-12—ASA ACCURACY CLASSES FOR POTENTIAL TRANSFORMERS

Accuracy Class	Limits of Ratio Correction Factor and Transformer Correction Factor	Limits of Power Factor (Lagging) of Metered Power Load
1.2	1.012-0.988	0.6-1.0
0.6	1.006-0.994	0.6-1.0
0.3	1.003-0.997	0.6-1.0

The limits given for each accuracy class apply from 10 percent above rated voltage to 10 percent below rated voltage, at rated frequency, and from no burden on the potential transformer to the specified burden.

TABLE 11-13—ASA STANDARD BURDENS FOR POTENTIAL TRANSFORMERS

Burden	Volt-Amperes	Burden Power Factor
W	12.5	0.10
X	25.	0.70
Y	75.	0.85
Z	200.	0.85
ZZ	400.	0.85

TABLE 11-14—ASA ACCURACY CLASSES FOR METERING CURRENT TRANSFORMERS

Accuracy Class	Limits of Ratio Correction Factor and Transformer Correction Factor				Limits of Power Factor (Lagging) of Metered Power Load
	100% Rated Current		10% Rated Current		
	Minimum	Maximum	Minimum	Maximum	
1.2	0.988	1.012	0.976	1.024	0.6-1.0
0.6	0.994	1.006	0.988	1.012	0.6-1.0
0.3	0.997	1.003	0.994	1.006	0.6-1.0
0.5	*0.995	*1.005	0.995	1.005	0.6-1.0

* These values also apply to 150 percent rated current.

TABLE 11-15—ASA STANDARD BURDENS FOR CURRENT TRANSFORMERS AT 60 CYCLES

Designation of Burden	Burden Characteristics		Secondary Burden at 60 Cycles and 5-Amp Secondary Current		
	Resistance, Ohms	Inductance, Millihenries	Impedance, Ohms	Volt-Amperes	Power Factor
B-0.1	0.09	0.116	0.1	2.5	0.9
B-0.2	0.18	0.232	0.2	5.0	0.9
B-0.5	0.45	0.580	0.5	12.5	0.9
B-1	0.5	2.3	1.0	25.0	0.5
B-2	1.0	4.6	2.0	50.0	0.5
B-4	2.0	9.2	4.0	100.0	0.5
B-8	4.0	18.4	8.0	200.0	0.5

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SPECIFICATIONS

Input Circuit:

Rating: 160V, 50/60 Hz. continuous.
300V, 10 seconds.

Burden: 1.2 VA, 1.0 pf at 120 volts.

Taps: available models include:

Types 27, -27D, -27H :	60, 70, 80, 90, 100, 110v
Types 27D, -27H:	30, 35, 40, 45, 50, 55v
	15, 18, 21, 24, 27, 30v
Types 59D, -59H:	100, 110, 120, 130, 140, 150v
	60, 65, 70, 75, 80, 90v

Differential between Operate and Reset Voltages:
Type 27: less than 0.5 percent.
Types 27D, -27H, ITE-59D, -59H: approximately 3 percent.

Operating Time: See Time-Voltage characteristic curves that follow.

Output Circuit:
Each contact @ 125 Vdc: 30 ampere tripping duty.
5 ampere continuous.
0.3 ampere break.

Operating Temperature Range: -30 to +70 deg. C.

Control Power:
Models available for 48/125 vdc @ 0.08 A max.
48/110 vdc @ 0.08 A max.
24/ 32 vdc @ 0.08 A max.
120 vac 50/60 Hz. @ 0.08 A.

Allowable variation:

24vdc	nominal:	19- 25 vdc
32vdc	"	25- 38
48vdc	"	38- 58
110vdc	"	88-125
125vdc	"	100-140
120vac	"	95-135 vac

Tolerances: Operating voltage: +/- 5%
Operating Time: +/-10%

These tolerances are based on the printed dial markings. By using the calibration procedures given later in this book, the relay may be set precisely to the desired values of operating voltage and delay with excellent repeatability.

Repeatability: variation in operating voltage for a 10 volt variation in control voltage: 0.2 volt, typical.

variation in operating voltage over the temperature range 20-40 deg C: 0.5 volt, typical.

Dielectric Strength:
1500 vac, 50/60 Hz., all circuits to ground.

Seismic Capability:
More that 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction. (ANSI C37.98-1978)

ATTACHMENT 5

SPECIFICATIONS 27N RELAYS

Input Circuit: Rating: type 27N 150v maximum continuous.
type 59N 160v maximum continuous.

Burden: less than 0.5 VA at 120 vac.

Frequency: 50/60 Hz.

Taps: available models include:
Type 27N: pickup - 60, 70, 80, 90, 100, 110 volts.
70, 80, 90, 100, 110, 120 volts.
dropout- 60, 70, 80, 90, 99 percent of pickup.
30, 40, 50, 60 percent of pickup.

Type 59N: pickup - 100, 110, 120, 130, 140, 150 volts.
dropout- 60, 70, 80, 90, 99 percent of pickup.

Operating Time: See Time-Voltage characteristic curves that follow.
Instantaneous models: 3 cycles or less.

Reset Time: 27N: less than 2 cycles; 59N: less than 3 cycles.
(Type 27N resets when input voltage goes above pickup setting.)
(Type 59N resets when input voltage goes below dropout setting.)

Output Circuit: Each contact

@ 120 vac	@ 125 vdc	@ 250 vdc	
30 amps.	30 amps.	30 amps.	tripping duty.
5 amps.	5 amps.	5 amps.	continuous.
3 amps.	1 amp.	0.3 amp.	break, resistive.
2 amps.	0.3 amp.	0.1 amp.	break, inductive.

Operating Temperature Range: -30 to +70 deg. C.

Control Power: Models available for
48/125 vdc @ 0.05 A max.
48/110 vdc @ 0.05 A max.
220 vdc @ 0.05 A max.
250 vdc @ 0.05 A max.

Allowable variation:		
48 vdc	nominal	38- 58 vdc
110 vdc	"	88-125 vdc
125 vdc	"	100-140 vdc
220 vdc	"	176-246 vdc
250 vdc	"	200-280 vdc

Tolerances: (without harmonic filter option, after 10 minute warm-up)

Pickup and dropout settings with respect to printed dial markings (factory calibration) = +/- 2%.

Pickup and dropout settings, repeatability at constant temperature and constant control voltage = +/- 0.1%. (see note below)

Pickup and dropout settings, repeatability over "allowable" dc control power range: +/- 0.1%. (see note below)

Pickup and dropout settings, repeatability over temperature range:
-20 to +55°C +/- 0.4% -20 to +70°C +/-0.7%
0 to +40°C +/- 0.2% (see note below)

Note: the three tolerances shown should be considered independent and may be cumulative. Tolerances assume pure sine wave input signal.

Time Delay: Instantaneous models: 3 cycles or less.
Definite time models: +/- 10 percent or +/-20 millisecs. whichever is greater.

Harmonic Filter: (optional) All ratings are the same except:
Pickup and dropout settings, repeatability over temperature range:
0 to +55°C +/- 0.75% -20 to +70°C +/-1.5%
+10 to +40°C +/- 0.40%

Dielectric Strength: 2000 vac, 50/60 Hz., 60 seconds, all circuits to ground.

Seismic Capability: More than 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction. (ANSI C37.98-1978)

ATTACHMENT 5

4065.3

WARNING

Because of possible shock or fire hazards, connection of this instrument should be performed in compliance with the National Electrical Code (ANSI C1) and/or any other requirements applicable to the User.

Installation, operation, and maintenance should be performed only by qualified personnel.

REV. 2

TM-102403

TECHNICAL MANUAL OPERATION AND MAINTENANCE INSTRUCTIONS FOR POWER SYSTEM POLYMETER MODEL 325

1 APRIL 1980

ATTACHMENT 5
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Revised 1 March 1983

DA-EE-93-006-08

DRANETZ

DRANETZ TECHNOLOGIES, INC.
1000 New Durham Road, CN-91, Edison, N.J. 08818

Table 1-1. MODEL 826 POLYMETER SPECIFICATIONS

VOLTAGE MEASUREMENT (Both sections)

Input ranges	0-1.5, 15, 150, and 600 volts RMS** Full Scale
Accuracy	±0.3% of reading: ±0.05% Full Scale down to 5% Full Scale
Frequency Range	47 to 450 Hz
Frequency Range for rated accuracy	47-63 Hz*
Input resistance	5000 ohms/volt (transformer isolated) all ranges
Readout display	5 Digits

AC CURRENT MEASUREMENT (Both sections)

Input ranges	0-0.15, 1.5, 15, and 100 Amperes RMS Full Scale
Accuracy	±0.3% of reading: ±0.03% Full Scale down to 3% Full Scale
Frequency Range	47 to 450 Hz
Frequency Range for rated accuracy	47-63 Hz*
Insertion resistance	0.001 ohm maximum (transformer isolated) all ranges
Readout Display	5 Digits

TIME MEASUREMENT (Left section only)

Time interval range	0 to 999.99 seconds (0.01-second increments) 0 to 99.999 seconds (0.001-second increments) 0 to 9999.9 cycles (periods) of power line frequency (0.1-cycle increments)
Accuracy	±0.003% of reading ±1 L.S.D. (Least significant digit)

*Normally adjusted and calibrated at 60 Hz unless otherwise specified.

**Operation between 600 volts RMS and 1000 volts RMS is possible with no degradation of accuracy. However, operation above 600 volts RMS does not conform with safety specification ANSI-C39.5.

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Table 1-1. MODEL 325 POLYMETER SPECIFICATIONS (cont)

FREQUENCY MEASUREMENT (Option 101)

([illegible] input to left channel displays on right channel only.)

Operating mode	Updates after each measurement at a rate of every 1.25 seconds (.8 Hz) or 0.2 seconds (5 Hz). Holds last reading on stop trigger command.
Frequency range	20.000 to 450.000 Hz
Resolution	0.01 Hz, 0.1 second measuring time 0.001 Hz, 1.0 second measuring time
Accuracy	±0.002 Hz ±1 L.S.D.

MEASURING MODES (Apply to V-I measurements)

Trigger/Normal/Maximum	(Selectable by panel pushbutton switches, controlling both sections)
Trigger	Measurement is started and stopped by trigger signal applied to front panel START and STOP input jacks Requires DC step voltage change: ±10 volt minimum ±300 volt maximum or AC voltage 10-220 volts RMS or external contact closure Input impedance is approximately 30K ohms Can also be controlled by START/STOP/RESET pushbuttons at bottom of front panel. Eight readings per second are displayed in this mode
Normal	Measurements are made continuously, 2 readings per second are displayed
Maximum	A "maximum-value" circuit stores the highest value of AC measured during a measurement interval and displays that value in the digital readout

ATTACHMENT 5

F2000
OPERATING MANUAL

Doble Engineering Company
85 Walnut Street, Watertown, MA 02172

ATTACHMENT 5

OPERATING MANUAL

DOBLE F2000 FAMILY

of

POWER SYSTEM PROTECTION APPARATUS

TEST & CALIBRATION EQUIPMENT

DOBLE ENGINEERING COMPANY, 85 Walnut Street, Watertown, MA 02172, U.S.A. (617) 926-4900

OPERATING MANUAL

DOBLE F2000 FAMILY
of
POWER SYSTEM PROTECTION APPARATUS TEST & CALIBRATION EQUIPMENT

NOTICE

This manual describes all members of the F2000 family of Protection Apparatus Test & Calibration Equipment equipped with and/or controlled by F2000 Firmware version r2.00 or higher. All F2100, F2200, F2500, and F2350 Test Instruments must be equipped with version r2.00 or higher for proper operation when connected to other F2000 instruments in a multiunit system. The F2000 Slave Sources will not operate properly if their controlling Test Instrument has a lower version. Verify each Test Instrument's Firmware revision level by pressing its SLAVE switch. The revision number is displayed in Source 1's AMPLITUDE window. Contact Doble's Customer Service Department at (617)926-4900, extension 321 for updated Firmware.

Firmware version r2.00 only provides 0.01A resolution on the 5A range of the F2350, not 0.001A as listed in this manual. The higher resolution will be made available in a later revision that will be sent to all registered owners.

Firmware Revision R2.00 does not support IP with the F2500 source 1. This facility will be made available in a later revision that will be sent to all registered users.

SECTION VI
SPECIFICATIONS

*

SYSTEM CONTROLS

RAMP/SET .... SET: sets each amplitude/phase angle digit individually;

RAMP: increments/decrements amplitude/phase angle value continuously. (at different rates).

SYSTEM OUTPUT .... turns every source that has been 'Enabled' on (lighted) or off (dark).

ZERO X .... SOURCE (amplitude changes occur at each source's zero crossing);

SYSTEM (amplitude changes occur simultaneously at system's reference).

FREQUENCY .... LINE SYNCH (tracks power line); XTAL (crystal reference).

FREQUENCY

Base Frequency .... 50 or 60 Hertz, crystal or line synchronized.

Selectable Frequencies ...... 2nd through 10th harmonic of BASE FREQ.

Accuracy .... standard crystal = ±0.01%; precision crystal = ±0.0005%.

Line Synchronization .... signal frequency tracks line frequency for variations of ± 1 Hz on nominal base frequency (50 or 60 Hz).

Variable Frequency Options . F2010 Minicontroller, ProTesT II. 25.00 to 99.99 and 100.0 to 600.0 Hz.

Resolution .... 0.01 Hz from 25.00 to 99.99 Hz; 0.1 Hz from 100.0 Hz to 600.0 Hz.

SOURCE CONTROLS

SOURCE 1 .... F2100/F2200: selects voltage source designation;

F2350: left selects High or Low Power Mode, right selects source designation.

F2500: left selects voltage or current mode, right selects source designation.

SOURCE 2 .... F2100: selects current source designation;

F2200/F2500: left selects voltage or current mode, right selects source designation.

Value Switches .... up increments, down decrements;

individually (SET mode) or continuously (RAMP mode).

ON/ENABLE .... ON: turns source on or off individually.

ENABLE: enables/disables on/off control by SYSTEM OUTPUT.

HERTZ/RANGE .... right: cyclicly selects ranges and AutoRange mode;

left: selects 1st through 10th harmonic of base frequency.

OUTPUTS

AC Voltage (F2100/F2200/F2500)

Designations .... standard: VA, VB, VC; VM (F2825 option).
extended: VR, VS, VT, VR, VY, VB.

Ranges .... three: 75/150/300 volts @ 80 VA.
75 volts: 0.01–75.00 V rms to 1.066 A rms (≥70.31 Ω)
150 volts: 0.1–150.0 V rms to 0.533 A rms (≥281.2 Ω)
300 volts: 0.1–300.0 V rms to 0.266 A rms (≥1.125K Ω)

Accuracy .... 10–100% of range: ±0.25% of setting typical,
±0.5% of setting maximum @ 20–30°C;
±1% of setting absolute maximum @ 0–50°C.
0–10% of range: ±0.1% of range.

Resolution .... 75 V range = 0.01 V, 150 and 300 V ranges = 0.1 V

Load Power .... 80 VA continuous at maximum range at 50 or 60 Hz.

Load Power Factor .... 0–1, leading or lagging.

Deratings .... power and voltage decreases linearly to 50% of specifications from 45 down to 25 Hz, and for input voltages less that 105/210 V.

Total Harmonic Distortion .... 1% typical; 2% maximum, at 50 or 60 Hz.

Phase Angle .... 0 to ±359.9°.

Phase Accuracy .... ±0.2° typical; ±0.5° maximum, @ 50/60 Hz.

Error Detection .... >1% amplitude and phase, >2% distortion audible beeper and blinking ER message.

Output Protection .... short circuit proof, current limiting.

High Voltage Alarm .... blinking red indicator when output ≥20 V.

DC Voltage (F2410)

Designation (in Master's SOURCE) ... DV.

Ranges (in Master's RANGE) .... three: 75/150/300 volts @ 80 W.

Amplitude (in Master's AMPL) ..... 75 volts: 7.5–75.00 V (≥70.31 Ω)
150 volts: 15–150.0 V (≥281.2 Ω)
300 volts: 30–300.0 V (≥1.125K Ω)

Accuracy .... ±1% of setting and ±1 V.

Resolution .... 75 V range = 0.01 V, 150 and 300 V ranges = 0.1 V.

Load Power .... 80 W continuous at maximum range.

Ripple .... ≤5% of range peak-to-peak @ maximum load.

AC Current (F2100/F2200/F2300/F2300A/F2350/F2500)

Designations .... F2100/F2200/F2500: standard = I1, I2, I3, IP; IM (F2825 option);
extended = IR, IS, IT; IR, IY, IB.

F2300/F2300A/F2350: standard: low power = L1, L2, L3;
LM (2825 option);
high power=H1, H2, H3; HM (2825 option).
extended: low power = LR, LS, LT; LR, LY, LB;
high power=HR, HS, HT; HR, HY, HB.

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Category 14.1

ELECTRIC LABORATORY & TELECOMMUNICATIONS

Reviewed ______

TEST PROCEDURE

TEST DATE ______ ASSIGNMENT ______

LTP- 2000 REV. 1

EFFECTIVE DATE As Approved

LABORATORY TEST PROCEDURE FOR:

Doble F2000 Series Test Instrument Calibrations

CONTROLLED DOCUMENT

REVIEWED BY [signature]

DATE 1/30/97

APPROVED FOR USE

Gerald V. Bricks

SUPERVISOR, ELECTRIC TEST LABORATORY

1/22/97

DATE

This procedure contains 7 pages.

ATTACHMENT 5

DA-EE-93-006-08 page 12 of 19 rev. 2

1.0 **SUBJECT:**

1.1 This procedure is to be used for certifying the Doble Type F2000 series test system to accuracies as specifed in the manufacturers reference.

2.0 **REFERENCES:**

2.1 Manufactures Operating Manual, 72A-0000, Rev. 1.

3.0 **PROCEDURE:**

3.1 Notify surveillance personnel of this activity. ________

3.2 Verify that personnel performing this activity are qualified per LIS-1102. ________

3.3 Remove certification sticker from instrument, if any. ________

3.4 Allow a warm-up time of, at least, one hour at 25°C ±5°C, for all equipment. ________

3.5 Verify that standards used are certified per LIS-1201 to an accuracy of, at least, ±.125% AR for voltage/currents, ±0.125 degree for phase angles, ±0.0025 Hz for frequency, and ± 0.25% total harmonic distortion sensitive at the base frequency (60 Hz). ________

3.6 Enter the heading information on the attached Data Sheets and perform the certification tests as indicated on Data Sheets, recording the "AS FOUND" data, on the Data Sheet. (N/A tests that don't apply) ________

NOTE: Record LAG Phase angles as negative, LEAD Phase angles as positive values. A LAG angle equals the LEAD angle minus 360 degrees.

3.7 Compare the "AS FOUND" data with the given tolerances, and initial the applicable line, N/A the remaining line.

Data in tolerance: transfer results to the "AS LEFT" column or make adjustments for better accuracy and enter the final in-tolerance values in the "AS LEFT" column. ________

Data out of tolerance: Advise customer of "out of tolerance" condition and attach a HOLD tag describing "out of tolerance" condition. DUT may be recalibrated as directed by the customer. If repairs are performed, save all parts and notes of problems found and work done (enter this information on data sheet(s) as comments on this procedure). Record "AS LEFT" data in appropriate column on data sheet(s). ________

3.8 Complete a new certification sticker; indicate a due date of twelve months, an accuracy of manufacturer's specifications (SEE DATA SHEETS), indicate test date and Serial number, and mark "QA APPROVED". ________

COMMENTS: (Indicate any maintenance performed)

4.0 RECORDS:

4.1 Give this completed procedure to a record reviewer, who will submit a copy to Ginna Central Records, after review.

Record Reviewer:________________________________

Date Sent to GCR:________________________________