ATTACHMENT 2

RELAY SETPOINT CALCULATION

CALCULATION COVER SHEET

PROJECT	JOB NO.	CALC. NO.	SHEET
Turkey Point Units 3 and 4	21701-523	21701-523-E-01	1
SUBJECT: Unit 3 Load Centers Undervoltage Relay Set Points		TOTAL NO. OF SHEETS: 27	LAST SHEET NO.: 27
		DISCIPLINE: Electrical	

CALCULATION STATUS DESIGNATION	PRELIMINARY	COMMITTED	CONFIRMED	SUPERSEDED	CANCELED
►	[ ]	[ ]	[X]	[ ]	[ ]

COMPUTER PROGRAM	SCP	MAP	NCP	NONE	PROGRAM NO.(S)	VERSION/RELEASE NO.
►	[ ]	[ ]	[ ]	[X]		

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No.	Reason for Revision	By	Date	Checked	Date	Approved	Date	Accepted	Date
0	Issued for Use	RRL	3/27/92	[illegible]	3/27/92	LC	3/27/92		

REVISIONS

GA-2704 Rev. 12/89 (ED-21)

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	2

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Srink	3/27/92

1.0 PURPOSE:

This calculation determines the set points for the 3A, 3B, 3C & 3D Load Center undervoltage relays (Non SI). The degraded voltage relay protection scheme consists of an ITE 27N 10 to 100 sec. definite time delay relay combined with a GE IAV55C inverse time characteristic relay. There are two of these relay combinations per load center. The ITE relay will be used to protect the system for sustained low voltages and the IAV relay will be used to protect the system from severe low voltages for a short duration. This calculation is in support of PC/M 91-128.

2.0 BASES/ASSUMPTIONS:

2.1 The undervoltage relay set points will be based on the Technical Specification required setpoints (Reference 3.1).

2.2 Additional setpoint characteristics, for steady state pickup voltage and ride through transient voltages, will be based on relay coordination study FLO 53-20.5004 (Reference 3.2) and Calculation EC-145 (Reference 3.3).

2.3 The maintenance and testing equipment tolerances will be based on the information provided by the Plant Electrical Maintenance Department (see Attachment 1).

2.4 The undervoltage relays repeatability will be based on the vendor catalog information and additional correspondence with the vendor (see Attachments 2 & 3).

2.5 The inaccuracies of the ITE potential transformer will be based on the vendor information provided in Attachment 4.

2.6 The relay set points will be determined based on the "Square-Root-Sum-of-the-Squares" (SRSS) methodology per Standard IC-3.17 (Reference 3.4). The setting tolerances will not be included in the SRSS formula. These tolerances will be determined based on the allowable setpoint margins.

2.7 The margin for the steady state and transient voltages as provided in study FLO 53-20.5004 (Reference 3.2) will be neglected.

2.8 Cable resistances will be considered at 55°C.

2.9 Contact resistances for all control circuits and devices will be accounted for by increasing the cable lengths by 10%. Resistances of control circuit fuses are considered negligible. The potential transformers and the cable ties for the sub-panels are located in

the same compartment of the load center. Therefore, the resistance of the internal jumper wiring of the load centers will be considered negligible due to their short lengths.

3.0 REFERENCES:

3.1 Turkey Point Unit 3 & 4, Technical Specifications, Amendment 151/146 Table 3.3-3, "Engineering Safety Features Actuation System Instrumentation Trip Setpoints".

3.2 Report No. FLO 53-20.5004, "Emergency Power System Enhancement Project, Relay Coordination Study", Rev. 11.

3.3 Calculation EC-145, "PSB-1 Voltage Analysis for Electrical Auxiliary System", Rev. 5.

3.4 FPL Standard No. IC-3.17, "Instrument Setpoint Methodology for Nuclear Power Plants", Rev. 2.

3.5 PC/Ms 90-070 & 90-071, "Load Center and Switchgear Rooms Chilled Water Air Conditioning System", Rev. 1, Attachment 7, "FSAR Change Package".

3.6 "Switchgear and Control Handbook", by Robert W. Smeaton, McGraw-Hill, Inc., 1977.

3.7 Drawing 5613-E-28, Sh. 13A, Rev. 2, "Electrical Auxiliaries, Metering and Relaying, 480V Load Center 3A".

3.8 Drawing 5613-E-28, Sh. 13B, Rev. 2, "Electrical Auxiliaries, Metering and Relaying, 480V Load Center 3B".

3.9 Drawing 5613-E-28, Sh. 13C, Rev. 2, "Electrical Auxiliaries, Metering and Relaying, 480V Load Center 3C".

3.10 Drawing 5613-E-28, Sh. 13D, Rev. 2, "Electrical Auxiliaries, Metering and Relaying, 480V Load Center 3D".

3.11 St. Lucie PC/M 120-191M, Revision 0, 480 Volt and 4160 Volt Technical Specification Loss of Voltage and Degraded Voltage Relay Setpoint Drawings, dated October 18, 1991.

3.12 Drawing 5177-E-45A/91-128, Rev. 0, "Circuit and Raceway Schedule (Setroute)".

3.13 Drawing 5610-E-9-16, Sh. 1, Rev. 12, "480V Load Center 3A (3B01) Internal Wiring Diagram".

BECHTEL

CALCULATION SHEET

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4.0 CALCULATION:

4.1 Trip Setpoints based on Reference 3.1 Table 3.3-3 Section 7.c (480V Load Centers (Inverse Time Relays) Degraded Voltage):

Load Center	Trip Setpoint	120V Trip Setpoint **
3A	424 ± 5V (60 sec ± 30 sec delay)	106 ± 1.25V (60 sec ± 30 sec delay)
3B	427 ± 5V (60 sec ± 30 sec delay)	106.75 ± 1.25V (60 sec ± 30 sec delay)
3C	437 ± 5V (60 sec ± 30 sec delay)	109.25 ± 1.25V (60 sec ± 30 sec delay)
3D	435 ± 5V (60 sec ± 30 sec delay)	108.75 ± 1.25V (60 sec ± 30 sec delay)

** These numbers are based on a 480/120V potential transformer. (i.e. (424 ± 5V)/4 = 106 ± 1.25V)

4.2 Additional Setpoint Verifications based on Reference 3.2, Attachment 6:

Load Center	(Steady State) Verify relay will not operate at:	(Transient) Verify relay will not operate in seven seconds at:
3A	111.25V +0, -1	* 92.25V +0, -1
3B	113.25V +0, -1	* 96.25V +0. -1
3C	* 110.50V +0, -1	* 91.50V +0, -1
3D	* 110.50V +0, -1	92.75V +0, -1

* Reference 3.2 Attachment 6, was based on Calc. EC-145 Rev. 4, however EC-145 was revised (see Reference 3.3) without revising Reference 3.2. Therefore, these numbers were revised to agree with the values indicated in Reference 3.3.

The actual steady state and transient voltage values were determined by Calc. EC-145 (Ref. 3.3); therefore, these values will be used to set the relays. The -1 volt margin considered in the steady state and transient voltages was to account for the

[illegible]

drifting of the IAV relay setpoint. This margin will be dropped since this calculation will determine the appropriate relay settings based on the applicable relay and equipment inaccuracies.

4.3 Relay Setpoints for the ITE relays based on the restrictions from Section 4.1 & 4.2:

Load Center	Trip Setpoint
3A	106V
3B	106.75V
3C	109.25V
3D	108.75V

4.4 Test Equipment Inaccuracies: (See Attachment 1)

Since the voltage margin between the Technical Specifications and the setpoint verification values is minimal, the best test equipment available must be used, i.e., the HP 34401A.

Voltmeter:

HP 34401A - ± .06% of RDG ± .03% Range

For a temperature range of 28 to 55°C (82.4 to 131°F), the following additional inaccuracies must be accounted for:

± .005% of RDG ± .003% of Range

** Based on Reference 3.5 the design limit for the Load Center Room HVAC System is 104°F.

Therefore, the total inaccuracy of the HP 34401A will be:

± .065% of RDG ± .033% of Range

Timer:

Doble F-2200 - ± .01% of RDG ± 3 LSD
(with F-2010 attachment)

Notes:

1. The 100V range scale will be used for the HP voltmeter. At this range scale, the maximum reading is 120.0000V (see Attachment 1).

[illegible]

2. Device F-2200 is also used as an AC power source. However, the HP voltmeter will be used to measure the voltage. In order to set the relays, two (2) AC power sources, connected in series, are required, both set at the 75V scale. This will allow the appropriate voltage increments to be used when setting the relay. At the 75V scale the voltage can be adjusted by ± .01V.

4.5 Potential Transformer Inaccuracies:

From Attachment 4, a 480/120 potential transformer (PT) has a ± .3% accuracy under burden conditions of categories W (12.5 VA), X (25.0 VA), Y (75.0 VA) and ± 1.2 for a Z (200 VA) burden category. These burden category values were obtained from Reference 3.6, "Switchgear and Control Handbook".

Utilizing the drawings from References 3.7 through 3.10, the worst case burden on the PTs can be calculated.

Device	Burden	Reference
IAV53K1A Relay	17.0 VA (worst case)	Attachment 5
ITE-27H Relay	1.2 VA	Attachment 6
IAV55C Relay	21.6 VA (worst case)	Attachment 3
ITE-27N Relay	.5 VA	Attachment 2
VCC Volt XDCR	4.0 VA	Attachment 7
VCC-252 Voltmeter	.096 VA	Attachment 8

Total: 44.396 VA

Since this worst case burden load falls within the Y burden category the PT's inaccuracy will be ± .3%.

4.6 Tolerance for ITE Relay:

4.6.1 Tap Setting Tolerance

The tolerance for the ITE Relay will be determined from the

repeatability values from Attachment 2 and 4 and the testing inaccuracies from Attachment 1.

ITE Relay repeatability:
± .2% for Temp. range (0°C to 40°C) (32°F to 104°F) **
± .1% for DC Voltage range (100V to 140V)
± .1% for constant temp. and DC voltage

Time delay ± 10% or ± 20 msec, whichever is greater.

** Based on Reference 3.5 the design limit for the Load Center Room HVAC System is 104°F.

Tolerance for the printed dial marking is not used since this tolerance is applicable to factory calibrated relays.

Using the SRSS method of calculating the setting tolerances:

$$TOL_{ITE} = \sqrt{(P.T.\ acc.)^2 + (relay\ acc.)^2 + (relay\ acc.)^2 + (relay\ acc.)^2 + M\&TE^2}$$

$$TOL_{ITE} = \sqrt{.3\%^2 + .2\%^2 + .1\%^2 + .1\%^2 + M\&TE^2}$$

Where M&TE = the inaccuracies due to the Maintenance and Test Equipment.

Converting the M&TE (i.e., HP 34401A voltmeter) inaccuracies into a percentage based on the trip points from Section 4.4:

Per Section 4.4 the inaccuracy of the HP 34401A is ± (.065% of Reading + .033% of range). On the 100V range scale the full range error is 100 X .00033 = .033 volts. Since the full range errors are the largest (on a percentage basis of the voltage reading) at the smallest voltage readings the lowest set point from Section 4.3 will be used to calculate the M&TE.

106V x .00065 + .033V = .1019V

.1019/106 = .096%

Therefore, the worst case inaccuracy of the voltmeter is ±.096%.

Thus, the total tolerance for the ITE relay voltage setpoint for each load center is:

$$TOL_{ITE} = \sqrt{.3\%^2 + .2\%^2 + .1\%^2 + .1\%^2 + .096\%^2} = \underline{\pm .399\%} + Set_{tol}$$

For the ITE relay the relay setting tolerance will be ± .1V.

4.6.2 Time Setting Tolerance

Per Attachment 2 the ITE relay has a tolerance of ±10% or ± 20 msec, which ever is greater, with respect to the time delay feature of the relay.

Per Section 4.1, the relay will be set for a time delay of 60 seconds. Since 10% of 60 is greater than 20 msec, a tolerance of ± 10% will be utilized.

From Section 4.4, the tolerance for the Doble F-2200 timer is ± .01% of RDG ± 3 LSD.

At 60 seconds:
60 x .0001 + .03 = .036 sec = .06%

$TOL_{ITE} = \sqrt{10\%^2 + .06\%^2} = \underline{\pm 10.00\%} + Set_{tol}$

The relay setting tolerance for the ITE time delay will be ± .5 sec.

Therefore, the tolerance for the time delay =

60 sec x 10% + .5 sec = $\underline{\pm\ 6.5\ sec}$

4.7 Tolerance for IAV Relay

The tolerance for the IAV Relay will be determined from the

repeatability values from Attachment 3 and the testing equipment inaccuracies from Attachment 1.

IAV Relay repeatability for field adjusted relays:
±2% for the tap setting voltage
±4% for the vendor published time curves

4.7.1 Tap setting tolerances: (voltage)

The tap setting tolerance consists of the ±2% for the repeatability of the relay, ± .3% for the PT inaccuracies, the tolerance due to the M&TE, plus the set point tolerance.

$TOL_{IAV} = \sqrt{2\%^2 + .3\%^2 + M\&TE^2} + Set_{tol}$

For the IAV relay, the relay setpoint tolerance will be ± .25V.

Per Attachment 3, the IAV relay contacts will go from closed to open (i.e., the relay will pickup) at a voltage no greater than 110% of the tap setting voltage.

(Tap Setting + Tolerances) x 110% $\leq$ steady state

Therefore, the tap setting of the IAV relay should be set to a value less than or equal to the Steady State (margin neglected) value, from Section 4.2, divided by 110%., minus the total tap settings tolerance TOL_{IAV}.

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Since the M&TE value is largest at the lowest setting value, a conservative relay setting value of 95V will be assumed.

$$M\&TE = \frac{95 \times .00065 + .033}{95} = .1\%$$

For LC 3A:

$$\frac{111.25}{110\%} - \sqrt{.3\%^2 + 2\%^2 + .1\%^2} \times \text{tap setting} - Set_{tol} \geq \text{tap setting}$$

$$\frac{111.25}{1.1} - 2.025\% \times \text{tap setting} - .25 \geq \text{tap setting}$$

$$100.886 \geq (1 + 0.02025) \times \text{tap setting}$$

$$\text{Tap setting} \leq 98.88V$$

Therefore, the relay tap setting should be set to a value less than or equal to 98.88 ± .25V.

For conservatism, a tap setting of 98.75 ± .25V will be utilized.

For LC 3B:

$$\frac{113.25}{1.1} - 2.025\% \times \text{tap setting} - .25 \geq \text{tap setting}$$

$$102.705 \geq (1 + .02025) \times \text{tap setting}$$

$$\text{Tap setting} \leq 100.67V$$

Therefore, the relay tap setting should be set to a value less than or equal to 100.67 ± .25V.

For conservatism, a tap setting of 100.50 ± .25V will be utilized.

For LC 3C & LC 3D:

$$\frac{110.50}{1.1} - 2.025\% \times \text{tap setting} - .25 \geq \text{tap setting}$$

$$100.205 \geq (1 + .02025) \times \text{tap setting}$$

$$\text{Tap setting} \leq 98.22V$$

Therefore, the relay tap setting should be set to a value of less than or equal to 98.22 ± .25V.

For conservatism, a tap setting of 98.00 ± .25V will be utilized.

Since the above setpoints are above 95V, the M&TE values utilized to calculate these setpoints are acceptable.

4.7.2 Tap setting tolerances: (time)

± 4% for the relay
± .01% of RDG ± 3 LSD for Doble F-2010 timer

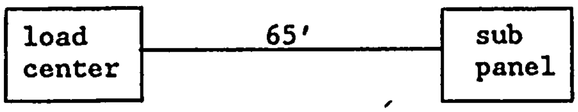
Using the SRSS method the tolerance of the IAV relay time characteristic can be calculated:

$$TOL_{IAV} = \sqrt{4\%^2 + M\&TE^2} + Set_{tol}$$

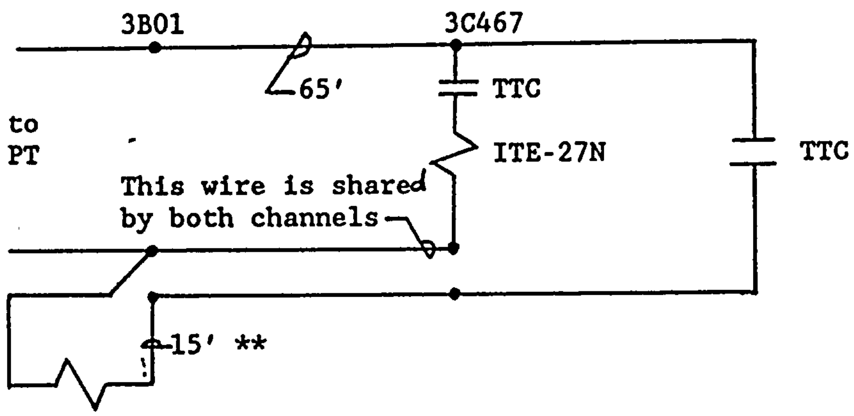
For the IAV relay, the time setting tolerance will be ± .5 sec.

4.8 Voltage drop between load centers and sub-panels:

The following section will determine the additional voltage drop due to the location of the sub-panels.



The following example is for LC3A, others are similar.



IAV

Based on References 3.12 and 3.13, all conductors are #12 AWG wires.

LEGEND:

TTC - Test switch

* - Cable length was based on the (worst case) conduit length from Reference 3.12 in addition to a tail length of 5' at each end of the cable.

** - The IAV relay is located in the next compartment over from the PT. Based on a visual walkdown of the jumper routing within the load centers, 15' will be conservatively assumed.

Burdens

Relay	Burden	Current	Reference
ITE-27N	.5VA @ 120 V	.00416A	Attachment 2
IAV	$6.1\overline{3}$VA @ 115V*	$.05\overline{3}$A	Attachment 3

* This value was determined using linear interpolation based on the worst case IAV tap setting of 98.0V (per Section 4.7).

At lower voltages, these current values will decrease; therefore, for conservatism, these values will be used.

Impedance of Cable

Z = DC resistance (Attach 9, Sh. 1) x AC/DC ratio (Attach 9, Sh. 2) + j reactance (Attach 9, Sh. 3)

For a #12 AWG wire, the AC/DC ratio equals 1.000. Per Reference 3.12 a 1 1/2" conduit will be used. Considering a conservative spacing of 1 1/2" between the conductors, the reactance equals approximately .086 Ω/1000'. This reactance is negligible (X< .1R) when compared to the resistance; therefore, the reactance will be neglected.

Z = 1.92 Ω/1000' x 1 = R = 1.92 Ω/1000'

V_{drop} = 2 x I x ℓ x (R + jX) x (1.1)

Where:
I = current
ℓ = one-way length
R = resistance/1000'
1.1 = 10% contact resistance (per basis 2.9)

4.8.1 V_{drop} for ITE-27N:

$1.1 \times \frac{1.92\Omega}{1000'} \times [.0041\overline{6} \times 65' \times 2 + .05\overline{3} \times 65' + .0041\overline{6} \times 65'$ (from opposite channel)]

V_{drop} = .009V For conservatism .01V will be used.

4.8.2 V_{drop} for IAV:

$$1.1 \times \frac{1.92\Omega}{1000'} \times [.0041\overline{6} \times 65' + .05\overline{3} \times (65' + 15') \times 2]$$

V_{drop} = .019V For conservatism .02V will be used.

4.9 Relay Coordination:

4.9.1 ITE Dropout Voltage Setting

LC 3A:

Setpoint = 106 ± .1V
(Per Sections 4.3 and 4.6.1)
Inaccuracies =
106 x ± .399% = ± .423V

Min Steady State Voltage = 111.25V
(Per Section 4.2)

```
     .423V      .1V       .1V      .423V
 |---------|----------|---------|----------|           |
105.477V            106V              106.523V      111.24V **
```

Tech Specs.

```
          1.25V                     1.25V
|----------------------|----------------------|
104.75V               106V                 107.25
```

** The V_{drop} value calculated in Section 4.8.1 must be subtracted from the Min. Steady State voltage values to ensure the relays will not dropout at the Min. Steady State bus voltages.

LC 3B:

Setpoint = 106.75 ± .1V
Inaccuracies =
106.75 x ± .399% = ± .426V

Min Steady State Voltage = 113.25V

```
     .426V      .1V       .1V      .426V
 |---------|----------|---------|----------|           |
106.224V          106.75V             107.276V      113.24V
```

Tech Specs.

```
          1.25V                     1.25V
|----------------------|----------------------|
105.50V             106.75V                 108V
```

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LC 3C:

Setpoint = 109.25 ± .1V Min Steady State Voltage = 110.50V
Inaccuracies =
109.25 x ± .399% = ± .436V

```
        .436V    .1V       .1V      .436V     110.49V
      |--------|---------|--------|---------|     |
   108.714V           109.25V          109.786V
```

Tech Specs.

```
              1.25V                   1.25V
|-------------------------|-------------------------|
108V                   109.25V                  110.50V
```

LC 3D:

Setpoint = 108.75 ± .1V Min. Steady State Voltage = 110.50V
Inaccuracies =
108.75 x ± .399% = ± .434V

```
     .434V       .1V       .1V      .434V            110.49V
   |------------|---------|--------|----------|          |
108.216V               108.75V           109.284V
```

Tech Specs.

```
              1.25V                   1.25V
  |----------------------|----------------------|
107.50V               108.75V                110.0V
```

4.9.2 ITE Pickup Voltage Setting

The ITE relay pickup should be set below the steady state voltage (tolerance neglected) values as shown in Section 4.2.

Tap setting + tolerances $\leq$ steady state

From Section 4.6.1 the worst case ITE tolerances is ± .399% + Set_{tol}.

For LC 3A:

Min. Steady State Voltage - V_{drop} = 111.24V
(Per Sections 4.2 & 4.8.1)
From Section 4.9.1, the maximum dropout voltage is 106.523V.
Inaccuracies = 111.24 x ± .399% = ± .444V (worst case)

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```
        .444V        Set_tol       .444V
     |-----------|-----------|-----------|
  106.523V    106.967V    110.796V    111.24V
```

Therefore, the pickup voltage range can be set between 106.967V and 110.796V (i.e., 108.882 ± 1.914V)

For conservatism, a setting of <u>108.89 ± 1.9V</u> will be used.

For LC 3B:

Min. Steady State Voltage - V_{drop} = 113.24V
Max. Dropout Voltage = 107.276V
Inaccuracies = 113.24 x ± .399% = ± .452V

```
        .452V        Set_tol       .452V
     |-----------|-----------|-----------|
  107.276V    107.728V    112.788     113.24V
```

Therefore, the pickup setting range is 110.258 ± 2.53V.

For conservatism, a setting of <u>110.26 ± 2.5V</u> will be used.

For LC 3C:

Min. Steady State Voltage - V_{drop} = 110.49V
Max. Dropout Voltage = 109.786V
Inaccuracies = 110.49 x ± .399% = ± .441V

```
        .441V                      .441V
     |-----------|           |-----------|
  109.786V    110.227V    110.049V    110.49V
```

Since these two values overlap, the relay dropout setting value for LC 3C must be shifted more towards the lower end of the Technical Specification value. With a ± .1V relay setting tolerance the maximum pickup value is: 110.49 - .441V - .1V = 109.949V.

For conservatism, a relay pickup value of <u>109.94 ± .1V</u> will be used.

With this pickup value, the maximum dropout value will be: 109.94V - .1V - .441V = 109.399V.

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Based on Section 4.9.1, the max. dropout setting will be:

```
    .436V        .1V          .1V         .436V
|-----------|------------|-----------|-----------|
108.327V              108.863V                109.399V
```

Therefore, the new dropout setpoint should be set to a value less than or equal to 108.863V. For conservatism, the new dropout setting will be 108.85 ± .1V.

```
    .436V        .1V          .1V         .436V
|-----------|------------|-----------|-----------|
108.314V              108.85V                 109.386V
```

This dropout range is still acceptable since it is still within the Tech. Spec. range of 108 to 110.50V.

For LC 3D:

Min. Steady State Voltage - V_{drop} = 110.49V
Max. Dropout Voltage = 109.284V
Inaccuracies = 110.49 x ± .399% = ± .441V

```
    .441V       Set_tol       .441V
|-----------|------------|-----------|
109.284V    109.725V    110.049V    110.49V
```

Therefore, the relay max. pickup setting is 109.887 ± .162V.

For conservatism a pickup setting of 109.89 ± .15V will be used.

Based on the above relay pickup values the 110V tap should be selected and then the pickup potentiometer should be adjusted accordingly. To obtain the desired dropout values, the 90% or 99% (of pickup) dropout tap shall be selected and the dropout potentiometer should be adjusted accordingly.

4.9.3 IAV Coordination

Based on Section 4.8.2 the V_{drop} from the IAV is .02V. When this V_{drop} value is subtracted from the Min. Steady State Voltage values and the IAV tap settings, from Section 4.7.1, are recalculated the following tap settings result:

LC	New Tap Setting	Conservative Setting (Section 4.7.1)
3A	≤ 98.86V	98.75V

3B ≤ 100.63V 100.50V

3C&3D ≤ 98.19V 98.00V

Since the conservative values are still less than the recalculated tap setting values, these conservative setting values are still applicable.

Per Section 4.2 the transient for LC 3A = 92.25V for 7 seconds (neglecting the margin)

The V_{drop} from Section 4.8.2 needs to be subtracted from the transient value to ensure the relays will not drop out at these transient bus voltages (i.e., 92.25 - .02 = 92.23V).

LC 3A tap setting from Section 4.7.1 is 98.75V

92.23/98.75 = 93.4% of tap

For LC 3B
 Transient - V_{drop} = 96.23V
 Tap setting = 100.5V

96.23/100.50 = 95.8% of tap

For LC 3C
 Transient - V_{drop} = 91.48V
 Tap setting = 98.0V

91.48/98.0 = 93.3% of tap

For LC 3D
 Transient - V_{drop} = 92.73V
 Tap setting = 98.0V

92.73/98.0 = 94.6% of tap

From Attachment 3, Inverse Time Characteristic Curves, at seven seconds, the above percent of tap values cannot trip the relay. Since these percent of tap values are greater than 90%, a % tap of 90% will be assumed. At this 90% tap, a time dial of 3 or greater can be used without tripping the relay. However, this does not include any relay tolerances; therefore, a time dial of 4 or greater shall be used. For conservatism, a time dial of 5 will be used for the IAV relays.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
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ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Smink	3/27/92

Inverse Time Characteristic Curves:

For LC 3A:
(From Section 4.7)

Tap Setpoint = 98.75 ± .25V (i.e., 100% of tap)

Inaccuracies = $98.75 \times \pm\sqrt{.3\%^2 + 2\%^2 + .1\%^2} = \pm 2.0V$

```
         2.0V     .25V      .25V     2.0V
       |--------|---------|--------|---------|
     96.50V            98.75V             101.00V
```

% of Tap	Min.	Mid.	Max.
	Voltage Range		
90%	86.85V	88.88V	90.90V
80%	77.20V	79.00V	80.80V
70%	67.55V	69.13V	70.70V
60%	57.90V	59.25V	60.60V
50%	48.25V	49.38V	50.50V
40%	38.60V	39.50V	40.40V
30%	28.95V	29.63V	30.30V
20%	19.80V	19.75V	70.20V
10%	9.65V	9.88V	10.10V
0%	0V	0V	0V

Utilizing Attach. 3 for a Time Dial (TD) setting = 5, the following values and tolerances were obtained:

Time Inaccuracies = $\pm\sqrt{4\%^2 + M\&TE^2}$ (per Section 4.7.2)

Setting Tolerance = ± .5 sec

A new M&TE will be calculated based on the timer inaccuracies from Section 4.4.

$$M\&TE = \frac{Time \times .0001 + .03}{Time}$$

% of Tap	Time	M&TE	Time Inaccuracies	Total Inaccuracies *
90%	13.70 sec	.23%	± 4.01%	± 1.05 sec
80%	8.00 sec	.39%	± 4.02%	± .82 sec
70%	5.70 sec	.54%	± 4.04%	± .73 sec
60%	4.45 sec	.68%	± 4.06%	± .68 sec

BECHTEL

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
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ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Smizik	3/27/92

50%	3.75 sec	.81%	± 4.08%	± .65 sec
40%	3.40 sec	.89%	± 4.10%	± .64 sec
30%	3.19 sec	.95%	± 4.11%	± .63 sec
20%	3.03 sec	1.00%	± 4.12%	± .62 sec
10%	2.98 sec	1.02%	± 4.13%	± .62 sec
0%	2.93 sec	1.03%	± 4.13%	± .62 sec

* This number includes the time inaccuracies converted to seconds, plus the setting tolerance.

For LC 3B:

Tap Setpoint = 100.50 ± .25V
Inaccuracies =

$$100.50 \times \pm\sqrt{.3\%^2 + 2\%^2 + .1\%^2} = \pm 2.035V$$

```
  2.035V    .25V      .25V     2.035V
|---------|---------|---------|---------|
98.215V            100.50V            102.785V
```

% of Tap	Voltage Range Min.	Mid.	Max.
90%	88.39V	90.45V	92.50V
80%	78.57V	80.40V	82.22V
70%	68.75V	70.35V	71.94V
60%	58.93V	60.30V	61.66V
50%	49.11V	50.25V	51.38V
40%	39.29V	40.20V	41.10V
30%	29.46V	30.15V	30.83V
20%	19.64V	20.10V	20.55V
10%	9.82V	10.05V	10.27V
0%	0V	0V	0V

For LC 3C & LC 3D:

Tap Setpoint = 98.00 ± .25V

Inaccuracies = $98.00 \times \pm\sqrt{.3\%^2 + 2\%^2 + .1\%^2} = \pm 1.984V$

```
  1.984V    .25V      .25V     1.984V
|---------|---------|---------|---------|
95.766V            98.00V             100.234V
```

% of Tap	Voltage Range Min.	Mid.	Max.
90%	86.19V	88.20V	90.21V
80%	76.61V	78.40V	80.19V
70%	67.04V	68.60V	70.16V
60%	57.46V	58.80V	60.14V
50%	47.88V	49.00V	50.12V
40%	38.31V	39.20V	40.09V
30%	28.73V	29.40V	30.07V
20%	19.15V	19.60V	20.05V
10%	9.58V	9.80V	10.02V
0%	0V	0V	0V

See Appendix 1 for the ITE & IAV relay coordination curves for the above relay voltage values.

4.10 Relay Check Points

These check points will be used to verify that the IAV relay is following its inverse time characteristic curve. These check points will be at approximately 85%, 70% and 30% of the tap settings.

When the relays are tested, the potential transformers are no longer utilized. Therefore, the tolerance due to the PT's inaccuracies can be deleted from the total inaccuracy of the relay.

For LC 3A:

Voltage-Setting:

Tap Setting = 98.75 ± 25V (per Section 4.7.1)

M&TE = .1%

Inaccuracies = $98.75 \times \pm \sqrt{2\%^2 + .1\%^2} = \pm 1.977V$

```
  1.977V    .25V     .25V     1.977V
|--------|---------|--------|---------|
96.523V           98.75V            100.977V
```

To make the checking easier, whole numbers will be used for the check points.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	20

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Smink	3/27/92

% of Tap	Voltage Range Min.	Mid.	Max.
85.06%	82.106V	84.00V	85.894V
69.87%	67.444V	69.00V	70.556V
30.38%	29.323V	30.00V	30.677V

To account for the M&TE when the relays are checked, the M&TE must be subtracted off of the Min. & Max. values determined above.

@ 84V, M&TE = $\frac{84 \times .00065 + .033}{84}$ = .104% = ± .087V

@ 69V, M&TE = .113% = ± .078V
@ 30V, M&TE = .175% = ± .053V

84.00 ± 1.894 - ± 087 = 84 ± 1.807V

69.00 ± 1.556 - ± .078 = 69 ± 1.478V

30.00 ± .677 - ± .053 = 30 ± .624V

For ease in using these checkpoints, the values will be rounded off to two places after the decimal.

Time setting:

From Attachment 3, based on the previously determined tap percentages, the following times were obtained:

% of Tap	Time
85.06%	10.35 sec.
69.87%	5.70 sec.
30.38%	3.20 sec.

Time inaccuracies = $\pm \sqrt{4\%^2 + \text{M\&TE}^2}$ (Section 4.9.3)
Setting tolerance = ± .5 sec

However, when the relays are being checked, the M&TE value needs to be subtracted off of the total time band. Therefore:

at 85.06%
Total time band = 10.35 sec. x ± 4% ± .5 sec. = ± .91 sec.

at 69.87%
Total time band = 5.70 sec. x ± 4% ± .5 sec. = ± .73 sec.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
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ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Snizek	3/27/92

at 30.38%
Total time band = 3.20 sec. x ± 4% ± .5 sec. = ± .63 sec.

From the above analysis, the following checkpoints were obtained:

% of Tap	Voltage	Time
85.06%	84 ± 1.81V	10.35 ± .91 sec.
69.87%	69 ± 1.48V	5.70 ± .73 sec.
30.38%	30 ± .62V	3.20 ± .63 sec.

For LC 3B:

Voltage Setting:

Tap Setting = 100.50 ± .25V

Inaccuracies = 100.50 x $\pm\sqrt{2\%^2 + .1\%^2}$ = ± 2.012V

```
  2.012V    .25V     .25V    2.012V
|---------|---------|--------|---------|
98.238V          100.50V          102.762V
```

% of Tap	Voltage Range Min.	Mid.	Max.
84.58%	83.087V	85.00V	86.913V
69.65%	68.424V	70.00V	71.576V
29.85%	29.325V	30.00V	30.675V

@ 85V, M&TE = .104% = ± .088V
@ 70V, M&TE = .112% = ± .078V
@ 30V, M&TE = .175% = ± .053V

85.00 ± 1.913 - ± .088 = 85 ± 1.825V
70.00 ± 1.576 - ± .078 = 70 ± 1.498V
30.00 ± .675 - ± .053 = 30 ± .622V

Time Setting:

% of Tap	Time (per Attach 3)	Total Time Band *
84.58%	10.10 sec.	± .90 sec.
69.65%	5.60 sec.	± .72 sec.
29.85%	3.17 sec.	± .63 sec.

* Based on the same method used for LC 3A.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	22

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Snizek	3/27/92

For LC 3C & 3D:

Voltage Setting:

Tap Setting = 98.00 ± .25V

Inaccuracies = $98.00 \times \pm\sqrt{2\%^2 + .1\%^2} = \pm 1.962V$

```
  1.962V    .25V     .25V     1.962V
|--------|---------|--------|---------|
95.788V           98.00V          100.212V
```

% of Tap	Min.	Mid.	Max.
	Voltage Range		
84.69%	81.127V	83.00V	84.873V
70.41%	67.443V	69.00V	70.557V
29.59%	28.345V	29.00V	29.655V

@ 83.00V, M&TE = .105% = ± .087V
@ 69.00V, M&TE = .113% = ± .078V
@ 29.00V, M&TE = .179% = ± .052V

83.00 ± 1.873 - ± .087 = 83 ± 1.786V
69.00 ± 1.557 - ± .078 = 69 ± 1.479V
29.00 ± .655 - ± .052 = 29 ± .063V

Time Setting:

% of Tap	Time (per Attach 3)	Total Time Band *
84.69%	10.20 sec.	± .91 sec.
70.41%	5.75 sec.	± .73 sec.
29.59%	3.15 sec.	± .63 sec.

* Based on the same method used for LC 3A.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	23

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Snizik	3/27/92

5.0 Conclusions:

Based on the above calculations the following setpoints have been determined:

Relay Set Points:

LC 3A:

ITE Relay
Pickup
Tap set to 108.89 ± 1.9V
Dropout
Tap set to 106 ± .1V
60 ± .5 sec time delay

IAV Relay
Tap set to 98.75 ± .25V
Time Dial set to 5

LC 3B:

ITE Relay
Pickup
Tap set to 110.26 ± 2.5V
Dropout
Tap set to 106.75 ± .1V
60 ± .5 sec time delay

IAV Relay
Tap set to 100.50V ± .25V
Time dial set to 5

LC 3C:

ITE Relay
Pickup
Tap set to 109.94 ± .1V
Dropout
Tap set to 108.85 ± .1V
60 ± .5 sec time delay

IAV Relay
Tap set to 98.00V ± .25V
Time dial set to 5

LC 3D:

ITE Relay
Pickup
Tap set to 109.89 ± .15V
Dropout
Tap set to 108.75 ± .1V
60 ± .5 sec time delay

IAV Relay
Tap set to 98.00V ± .25V
Time dial set to 5

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	24

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Smiski	3/27/92

Relay Check Points:

Load Center	Voltage	Time
3A	84.00 ± 1.81V	10.35 ± .91 sec.
	69.00 ± 1.48V	5.70 ± .73 sec.
	30.00 ± .62V	3.20 ± .63 sec.
3B	85.00 ± 1.83V	10.10 ± .90 sec.
	70.00 ± 1.50V	5.60 ± .72 sec.
	30.00 ± .62V	3.17 ± .63 sec.
3C & 3D	83.00 ± 1.79V	10.20 ± .91 sec.
	69.00 ± 1.48V	5.75 ± .73 sec.
	29.00 ± .60V	3.15 ± .63 sec.

The following summarizes the results of this calculation

For LC 3A:

Per Section 4.1, the trip setting of the degraded voltage relay scheme is 106 ± 1.25V (60 ±30sec). The setting of the ITE relay including all tolerances is 106 ± .523V (60 ± 6.5 sec), per Section 4.9.1. Since the relay setting is within the Technical Specification setting tolerances the relay setting is acceptable. The IAV relay will not operate until the voltage drops to at least 101.00V, per Section 4.9.3, the worst case tap setting of the relay. Therefore, at the Tech. Spec. trip values only the ITE relay is involved.

Per Section 4.2 the degraded voltage relay scheme should not operate at a steady state bus voltage of 111.25V. As shown in Appendix 1 and Section 4.9.1, the highest possible voltage at which the ITE relay will trip is 106.523V. The IAV relay will not trip because the worst case tap setting for this relay is 101.00V. Since these values are well below 111.25V, the tap settings are acceptable.

Also per Section 4.2 the relay scheme should not operate if the bus voltage drops to 92.25 for 7 seconds. From the plotted curves on Appendix 1 the IAV relay will not trip before a time of at least 14 seconds at 92.25V. At this voltage the ITE relay will operate however the contacts will not close until at least 53.5 seconds due to the 60 second time delay (see Section 4.7). Since the trip time for these relays are greater than 7 seconds the tap settings values are acceptable.

[illegible]

For LC 3B:

Per Section 4.1, the trip setting of the degraded voltage relay scheme is 106.75 ± 1.25V (60 ± 30 sec). The setting of the ITE relay including all tolerances is 106.75 ± .526V (60 ± 6.5 sec), per Section 4.9.1. Since the relay setting is within the Technical Specification setting tolerances the relay setting is acceptable. The IAV relay will not operate until the voltage drops to at least 102.785V per Section 4.9.3, the worst case tap setting of the relay. Therefore, at the Tech. Spec. trip values only the ITE relay is involved.

Per Section 4.2, degraded voltage relay scheme should not operate at a steady state bus voltage of 113.25V. As shown in Appendix 1 and Section 4.9.1, the highest possible voltage at which the ITE relay will trip is 107.276V. The IAV relay will not trip because the worst case tap setting for this relay is 102.785V. Since these values are well below 113.25V, the tap settings are acceptable.

Also per Section 4.2, the relay scheme should not operate if the bus voltage drops to 96.25 for 7 seconds. From the plotted curves on Appendix 1 the IAV relay will not trip before a time of at least 14 seconds at 96.25V. At this voltage the ITE relay will operate however the contacts will not close until at least 53.5 seconds due to the 60 second time delay. Since the trip time for these relays are greater than 7 seconds the tap settings values are acceptable.

For LC 3C:

Per Section 4.1, the trip setting of the degraded voltage relay scheme is 109.25 ± 1.25V (60 ± 30 sec). The setting of the ITE relay including all tolerances is 108.85 ± .536V (60 ± 6.5 sec) per Section 4.9.2. Since the relay setting is within the Technical Specification setting tolerances the relay setting is acceptable. The IAV relay will not operate until the voltage drops to at least 100.234V per Section 4.9.3 the worst case tap setting of the relay. Therefore, at the Tech. Spec. trip values only the ITE relay is involved.

Per Section 4.2 the degraded voltage relay scheme should not operate at a steady state bus voltage of 110.50V. As shown in Appendix 1 and Section 4.9.2, the highest possible voltage at which the ITE relay will trip is 109.386. The IAV relay will not trip because the worst case tap setting for this relay is 100.234V. Since these values are well below 110.50V, the tap settings are acceptable.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	26

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Snink	3/27/92

Also per Section 4.2 the relay scheme should not operate if the bus voltage drops to 91.50 for 7 seconds. From the plotted curves on Appendix 1 the IAV relay will not trip before a time of at least 14 seconds at 91.50V. At this voltage the ITE relay will operate however the contacts will not close until at least 53.5 seconds due to the 60 second time delay. Since the trip time for these relays are greater than 7 seconds the tap settings values are acceptable.

For LC 3D:

Per Section 4.1, the trip setting of the degraded voltage relay scheme is 108.75 ± 1.25V (60 ± 30 sec). The setting of the ITE relay including all tolerances is 108.75 ± .534 (60 ± 6.5 sec) per Section 4.9.1. Since the relay setting is within the Technical Specification setting tolerances the relay setting is acceptable. The IAV relay will not operate until the voltage drops to at least 100.234V, per Section 4.9.3, the worst case tap setting of the relay. Therefore, at the Tech. Spec. trip values only the ITE relay is involved.

Per Section 4.2 the degraded voltage relay scheme should not operate at a steady state bus voltage of 100.50V. As shown in Appendix 1 and Section 4.9.1, the highest possible voltage at which the ITE relay will trip is 109.284V. The IAV relay will not trip because the worst case tap setting for this relay is 100.234V. Since these values are well below 110.50V, the tap settings are acceptable.

Also per Section 4.2 the relay scheme should not operate if the bus voltage drops to 92.75 for 7 seconds. From the plotted curves on Appendix 1 the IAV relay will not trip before a time of at least 14 seconds at 92.75V. At this voltage the ITE relay will operate; however, the contacts will not close until at least 53.5 seconds due to the 60 second time delay. Since the trip time for these relays are greater than 7 seconds the tap settings values are acceptable.

In addition, per Sections 4.7 and 4.9.2 the IAV and ITE relays will pick up at a voltage less than the applicable load center's steady state bus voltage level.

Based on the above calculation the degraded voltage protection scheme will operate correctly at the above stated relay setpoints.

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	27

ORIGINATOR	DATE	CHECKED	DATE
R. Larsen	3/27/92	Paul J. Snijek	3/27/92

NOTE: The results of this calculation are only applicable if the Maintenance and Test Equipment as stated in Section 4.4 are used. In addition, the test equipment manufacturers stipulated requirements, to obtain the specified accuracies, must be observed.

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CALCULATION SHEET

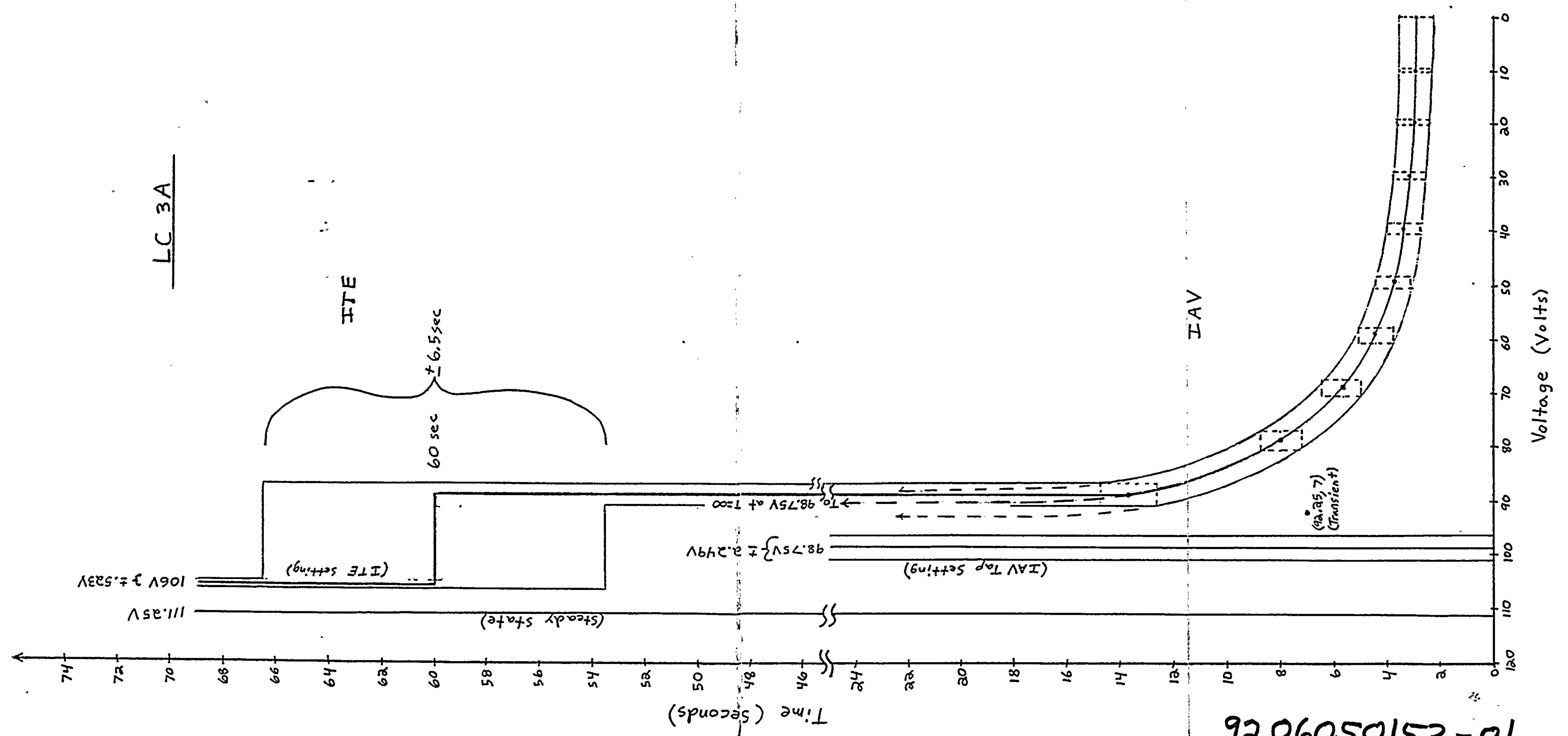
JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	N/A

ORIGINATOR	DATE	CHECKED	DATE
R. Lewin	3/27/92	Paul J. Sniyk	3/27/92

APPENDIX 1
JOB 21701-523
CALC. 21701-523-E-01
SHT 1 OF 4

SI
APERTURE
CARD

Also Available On
Aperture Card



9206050153-01

EPD-2705 10/85

BECHTEL

CALCULATION SHEET

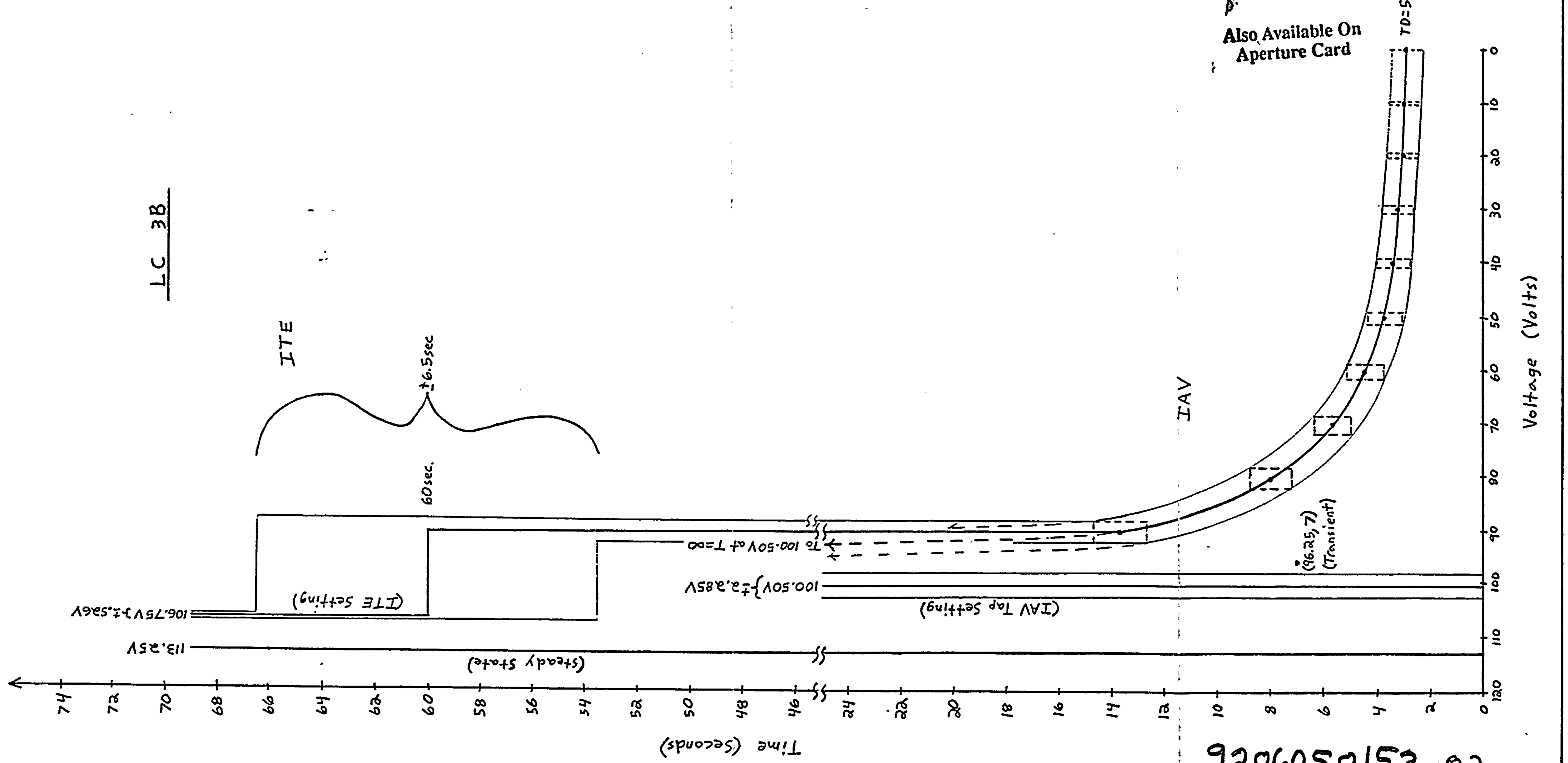
JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	N/A

ORIGINATOR	DATE	CHECKED	DATE
K. Larsen	3/27/92	Paul J. Snink	3/27/92

APPENDIX	1
JOB	21701-523
CALC.	21701-523-E-01
SHT	2 OF 4

SI
APERTURE
CARD

Also Available On
Aperture Card



9206050153-02

BECHTEL

CALCULATION SHEET

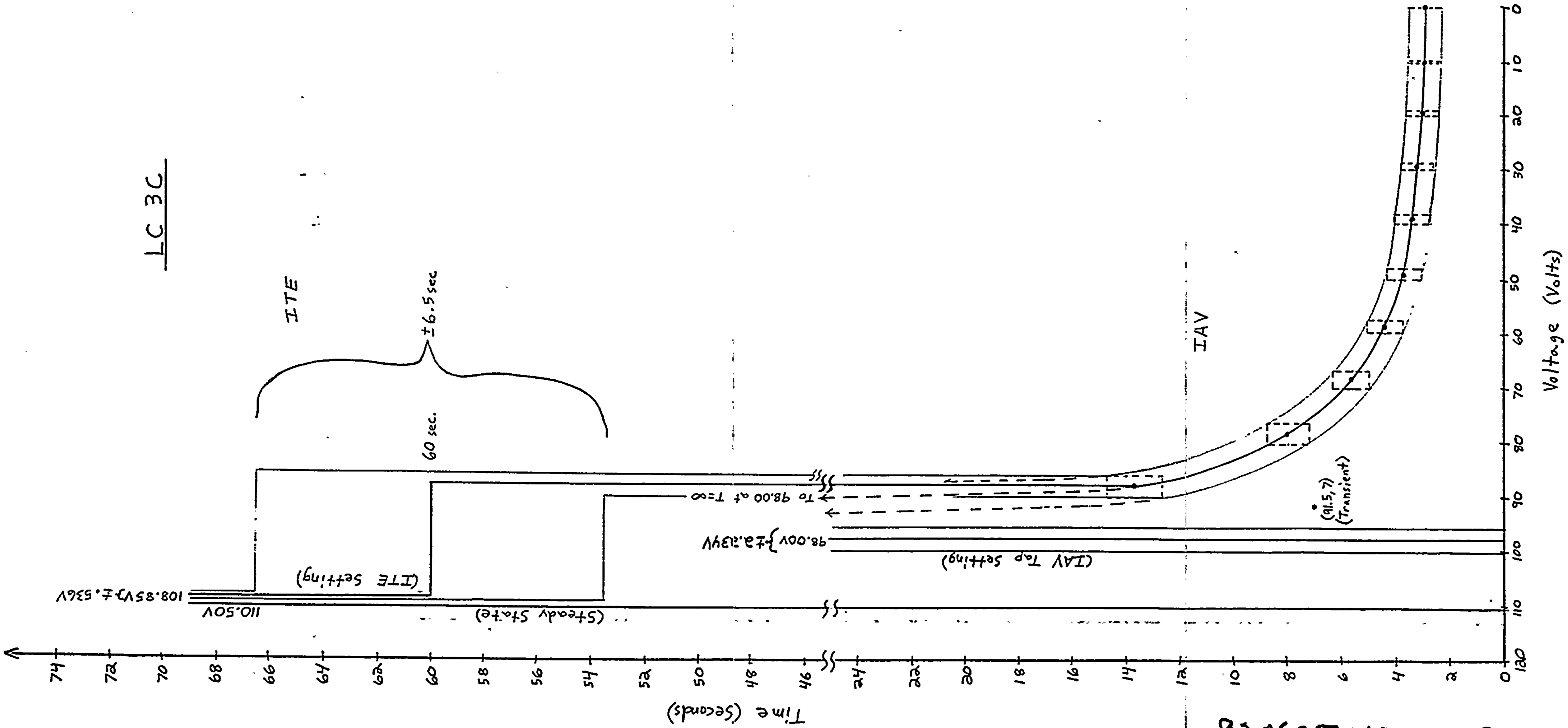
JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	N/A

ORIGINATOR	DATE	CHECKED	DATE
T. Imdin	3/27/92	Paul J. Snink	3/27/92

APPENDIX 1
JOB 21701-523
CALC. 21701-523-E-01
SHT 3 OF 4

SI
APERTURE
CARD

Also Available On
Aperture Card



9206050153-03

BECHTEL

CALCULATION SHEET

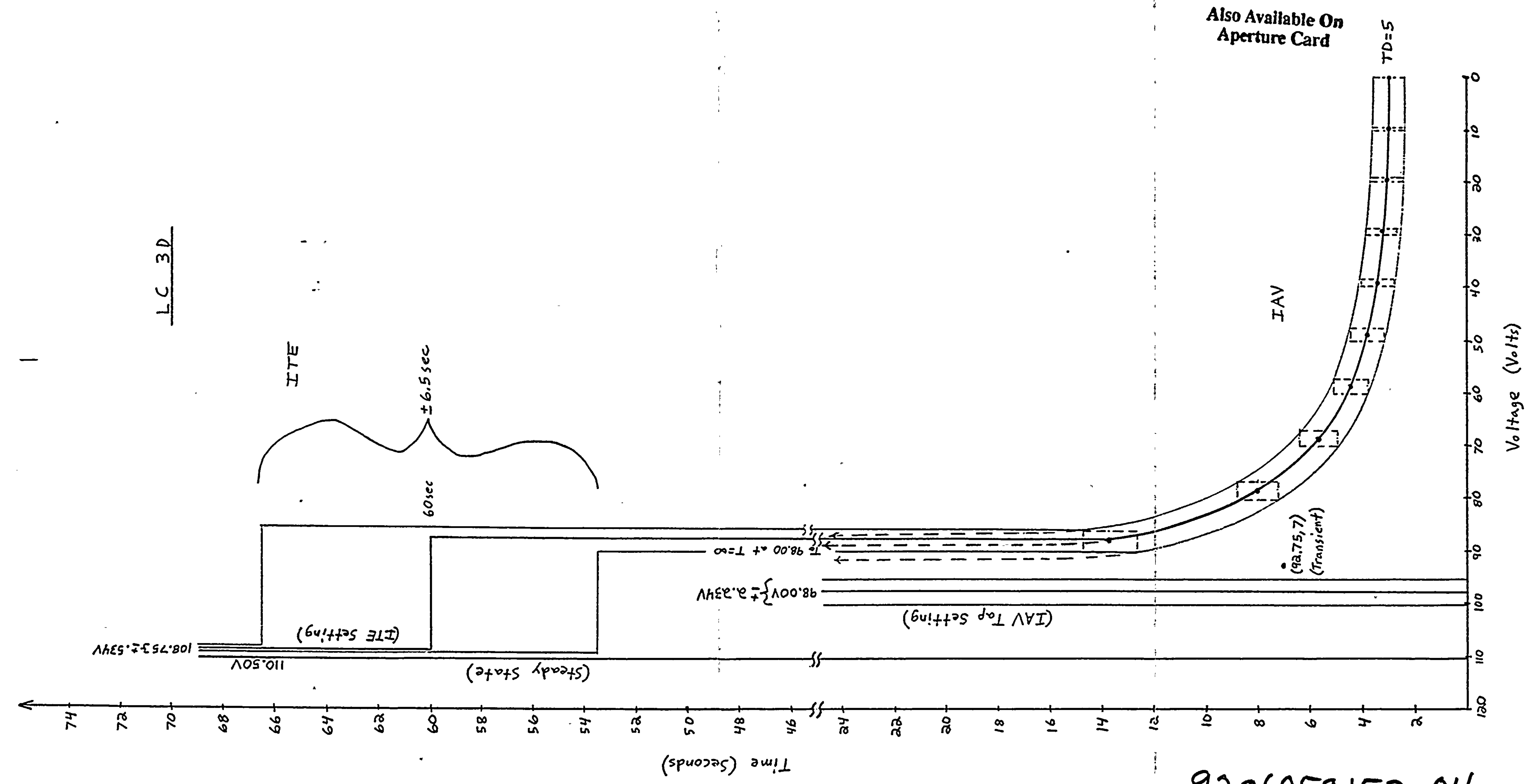
JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
21701-523	21701-523-E-01	0	N/A

ORIGINATOR	DATE	CHECKED	DATE
[illegible signature]	3/27/92	Paul J. Smink	3/27/92

APPENDIX 1
JOB 21701-523
CALC. 21701-523-E-01
SHT 4 OF 4

SI APERTURE CARD

Also Available On Aperture Card



9206050153-04

FPL

Attachment No.	1
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
Sht. 1 of 6	

P.O. Box 14000, Juno Beach, FL 33408-0420

JPN-PTN-91-1011

December 23, 1991

Bechtel Power Corporation
NorthCorp Center, Suite 5001
3950 RCA Boulevard
Palm Beach Gardens, Florida 33410

Attn: Mr. R. E. Gallagher, Project Manager

TURKEY POINT UNITS 3 & 4
MODIFICATION TO LOAD CENTER
UNDERVOLTAGE RELAY SCHEME
I/S MOD: 1341; TOP 20 ITEM 11
FILE: TPN-87-015-2, PCM 91-128

Reference: 1) Memorandum from Michael Powers to D. P. Koennicke dated 12-13-91

Gentlemen:

The Ref. 1 letter notified Nuclear Engineering of the existing and proposed calibration instrument accuracy for the test equipment used in the calibration of underfrequency relays in the 480V degraded voltage relaying scheme. Ref 1 is attached for your information and use in preparation of PCM 91-128.

Should you have any questions, please call D. P. Koennicke at 694-3805 or W. J. Harris at 694-3110.

Very truly yours,

W. J. Harris
FOR S. T. Hale
PTN Engineering Manager

cc:	H. S. Bowles	PEG/PBG
	File Room Copy	JPN/JB
	R. S. Kundalkar	JPNS/PTN
	M. Pearce	PTN/PLT
	M. Powers	PTN/PLT
	L. J. McCullough	JNE/JB
	S. J. Pleasure	JPN/JB

FPL

Inter Office Correspondence

Attachment No.	1
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
Sht.	2 of 6

TO: Doug Koennicke DATE: December 13, 1991

FROM: Michael E. Powers DEPARTMENT: P&CS-PTN

SUBJECT: Calibration Instrument Accuracy for the 480 V Degraded Voltage Relaying Scheme, PC/M 91-128.

Following is a list of the test equipment with associated accuracy presently used in the calibration of underfrequency relays in the 480 V degraded voltage relaying scheme:

1. Multimeter (for use as an A.C. voltmeter only.)
   (Accuracy +/- 0.5% of full scale, or better)
   Fluke 8060A
   Data Precision 2480R, or 1455
2. Timer (Accuracy +/- 0.1% of reading, or better)
   Doble F-2200 with F-2010 attachment (for use as a timer only, voltage output is measured by the multimeter.)

An HP 34401A voltmeter is on order and will be added to the list of multimeters above. It has the following specifications associated with it:

Basic A.C. Accuracy
1 V to 750 V A.C. Ranges at 10 Hz to 20 KHz
Range Scales of 100 mV, 1 V, 10 V, 100 V, and 750 V
0.06% of Reading
0.03% of Range

For temperatures of 28 to 55 degrees Celsius additional factors must be considered:
0.005% of Reading
0.003% of Range

JAB

Michael E. Powers
Protection & Control Supv.
Turkey Point Nuclear Plant

Bechtel

NorthCorp Center, Suite 5001
3950 RCA Boulevard
Palm Beach Gardens, Florida 33410
(407) 694-8400

Attachment No. 1
Job 21701-523
Calc No. 21701-523-E-01
Rev. No. 0
Sht. 3 of 6

January 13, 1992

Mr. S. T. Hale
PTN Engineering Project Manager
Florida Power & Light Company
Post Office Box 3088
Florida City, FL 33034

Attention: Mr. W. J. Harris

Turkey Point Units 3 & 4
REA 87-015 DWA 942808 IS Mod. No. 1341 System 006 PC/M 91-128
<u>Modification to 480V Undervoltage Scheme (Top 20, Rank 11)</u>
Letter No. N-92-0011 Job No. 21701-523 Files: 0112, S-21701-523

Reference: N/A

Dear Mr. Hale:

Enclosed for your information are Conference Notes No. 92-001 documenting the January 3, 1992 meeting between FPL and Bechtel, held at the Turkey Point Plant. The meeting was held to determine the relay testing sequence, review the schematic changes, determine the relay trip flag requirement, and determine the relay setting tolerance.

Action Summary: Items requiring action are as described in the enclosed Conference Notes.

Sincerely,

CLWeaver

C. L. Weaver
Project Engineer

RRL:mtm

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Conference Notes No. 92-001

A question was brought up at this time; by what increments can the voltage source be adjusted. After looking at the voltage source, at the 150V scale, the voltage can be adjusted by ±.1V. At the 75V scale the voltage can be adjusted to ±.01V. In order to set the relays the voltage has to adjustable for ±.01V. Therefore, two voltage sources will be used in series, one set at the 150V scale and the other set at the 75V scale.

5. A discrepancy was noted between the M&TE value for the timer given by FPL letter JPN-PTN-91-1011 and a value previously obtained. The actual inaccuracy is ±.01% of RDG ±3LSD not ±.1% as noted in the letter. Therefore, the relay setting calculation will use this latest tolerance value not the value given by the FPL letter.

   During a telephone conversation on January 7, 1992, M. Powers also informed R. Larsen that the output range of the timer is from 0 to 999.99 seconds. Therefore, the worst case tolerance for the ±3LSD (least significant digit) tolerance refers to the 100th decimal place.

6. After the meeting a walkdown was performed by R. Mines, R. Larsen & R. Maxwell to verify that sufficient terminal points were available for this modification. The inspection confirmed that adequate spare terminal points were available. R. Maxwell advised us to make sure the conduit routing does not interfere with the removal of the load center breakers.

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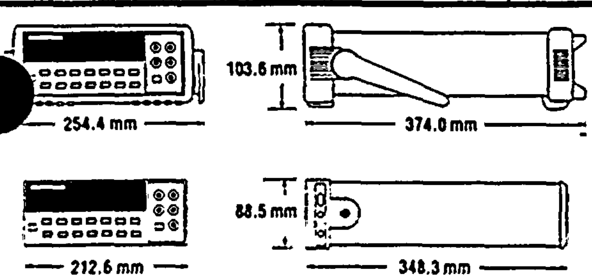
Accuracy Specifications ±(% of reading + % of range)[1]

Function	Range[3]	Frequency, etc.	24 Hour[2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient 0°C – 18°C 28°C – 55°C
DC Voltage	100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005	0.0005 + 0.0001
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	1000.000 V		0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010	0.0005 + 0.0001
True RMS AC Voltage[4]	100.0000 mV	3 Hz - 5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz - 10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz - 20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
		20 kHz - 50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.04	0.011 + 0.005
		50 kHz - 100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz - 300 kHz[6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
	1.000000 V to 750.000 V	3 Hz - 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
		5 Hz - 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
		10 Hz - 20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003 ←
		20 kHz - 50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz - 100 kHz[5]	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz - 300 kHz[6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
Resistance[7]	100.0000 Ω	1 mA Current Source	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	100.0000 kΩ	10 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5.0 μA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA // 10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
DC Current	10.00000 mA	<0.1 V Burden Voltage	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.002 + 0.0020
	100.0000 mA	<0.6 V	0.010 + 0.004	0.030 + 0.005	0.050 + 0.005	0.002 + 0.0005
	1.000000 A	<1 V	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.005 + 0.0010
	3.00000 A	<2 V	0.100 + 0.020	0.120 + 0.020	0.120 + 0.020	0.005 + 0.0020
True RMS AC Current[4]	1.000000 A	3 Hz - 5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz - 10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
		10 Hz - 5 kHz	0.10 + 0.04	0.10 + 0.04	0.10 + 0.04	0.015 + 0.006
	3.00000 A	3 Hz - 5 Hz	1.10 + 0.06	1.10 + 0.06	1.10 + 0.06	0.100 + 0.006
		5 Hz - 10 Hz	0.35 + 0.06	0.35 + 0.06	0.35 + 0.06	0.035 + 0.006
		10 Hz - 5 kHz	0.15 + 0.06	0.15 + 0.06	0.15 + 0.06	0.015 + 0.006
Frequency or Period[8]	100 mV to 750 V	3 Hz - 5 Hz	0.10	0.10	0.10	0.005
		5 Hz - 10 Hz	0.05	0.05	0.05	0.005
		10 Hz - 40 Hz	0.03	0.03	0.03	0.001
		40 Hz - 300 kHz	0.006	0.01	0.01	0.001
Continuity	1000.0 Ω	1 mA Test Current	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
Diode Test	1.0000 V	1 mA Test Current	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002



[1] Specifications are for 1 hr warm-up and 6½ digits, Slow ac filter. ←
[2] Relative to calibration standards.
[3] 20% over range on all ranges except 1000 Vdc and 750 Vac ranges. ←
[4] For sinewave input >5% of range. For inputs from 1% to 5% of range and < 50 kHz, add 0.1% of range additional error.
[5] 750 V range limited to 100 kHz or 8×10^7 Volt-Hz.
[6] Typically 30% of reading error at 1 MHz.
[7] Specifications are for 4-wire ohms function or 2-wire ohms using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire ohms function.
[8] Input >100 mV. For 10 mV inputs multiply % of reading error x10.

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Attachment No. 2
Job 21701-523
Calc No. 21701-523-E-01
Rev. No. 0
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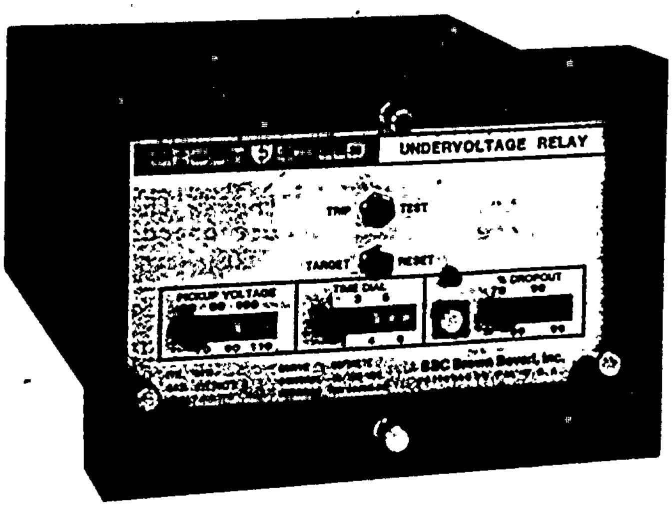
INSTRUCTIONS

Single Phase Voltage Relays

Type 27N HIGH ACCURACY UNDERVOLTAGE RELAY

Type 59N HIGH ACCURACY OVERVOLTAGE RELAY

Type 27N	Catalog Series 211T	Standard Case
Type 27N	Catalog Series 411T	Test Case
Type 59N	Catalog Series 211U	Standard Case
Type 59N	Catalog Series 411U	Test Case



ASEA BROWN BOVERI

HEWLETT PACKARD

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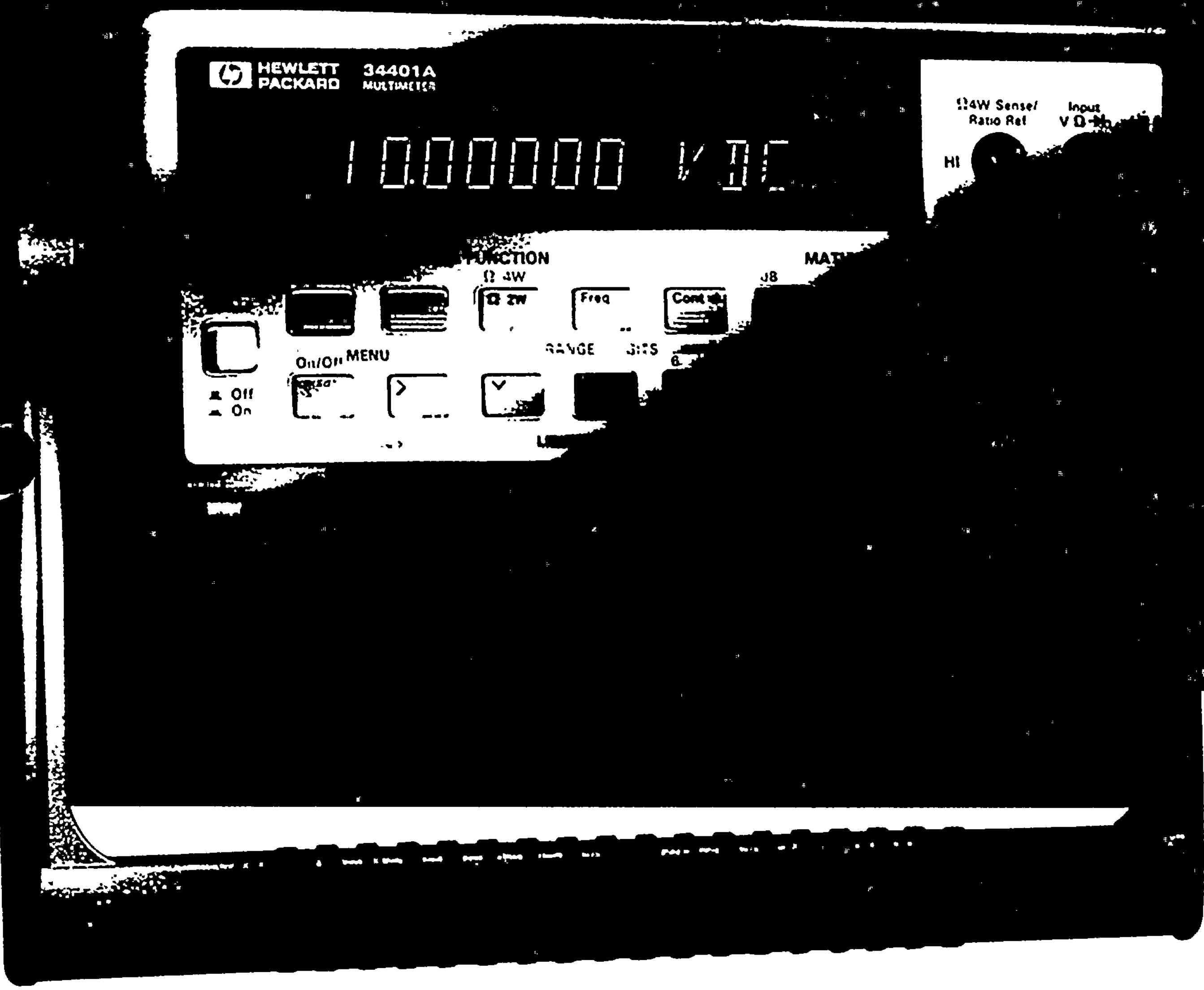
HP 34401A Multimeter



Within Budget. Without Compromise.

Attachment No. 2
Job 21701-523
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SPECIFICATIONS

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	Allowable variation:	
48/125 vdc @ 0.05 A max.	48 vdc nominal	38- 58 vdc
48/110 vdc @ 0.05 A max.	110 vdc "	88-125 vdc
220 vdc @ 0.05 A max.	125 vdc "	100-140 vdc
250 vdc @ 0.05 A max.	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, repeatablility 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)

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Addendum to IB 7.4.1.7-7(D)

INSTRUCTIONS

High-Accuracy Undervoltage Relay

INTRODUCTION

This addendum covers two models with the Definite-Long-Time delay characteristics.

These models are identified by catalog numbers that have the digit "5" or "7" directly following the letter "T" in the catalog number; i.e.: catalog numbers of the form 411T5xxx or 411T7xxx.

TIMING CHARACTERISTIC

The time-voltage characteristic is definite-time as shown on page 8 of the main instruction book, with the time-delay values versus time-dial selection as follows:

Time Dial Tap Pin Position	Nominal Delay Time - Seconds 411T5xxx	Nominal Delay Time - Seconds 411T7xxx
# 1	2 seconds	10 seconds
# 2	4	20
# 3	6	30
# 4	10	50
# 5	14	70
# 6	20	100

CATALOG NUMBERS and CHARACTERISTICS

Type	Pickup Range	Dropout Range	Time Delay Pickup	Time Delay Dropout	Catalog No.
27N	60-110v	70-99%	Inst	2-20sec	411T5175
	70-120v	70-99%	Inst	2-20sec	411T5375
	60-110v	70-99%	Inst	10-100sec	411T7175
	70-120v	70-99%	Inst	10-100sec	411T7375 ←

Catalog numbers shown are for drawout-test-case models, which are preferred for new applications.

Units in the standard-case, catalog series 211Txxxx would have the same electrical characteristics.

Rev 1 (3/92)

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Job 21701-523
Calc No 21701-523-E-01
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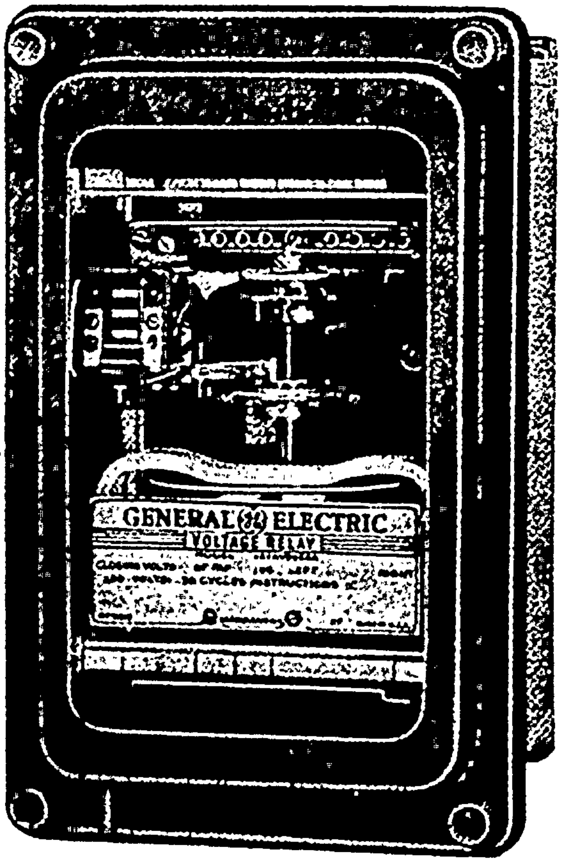
INSTRUCTIONS

UNDERVOLTAGE RELAYS

TYPES:

IAV54E IAV55C
IAV54F IAV55F
IAV54H IAV55H
IAV55J



GE Meter and Control
205 Great Valley Parkway
Malvern, PA 19355-0715

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel-drilling dimensions are shown in Figure 12.

CONNECTIONS

The internal connection diagrams are shown in Figures 5, 6 and 7. Typical external connections are shown in Figure 8.

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B&S gage copper wire or its equivalent.

ADJUSTMENTS

Target and Seal-in Unit

For trip coils that operate on currents ranging from 0.2 up to 2 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2 ampere tap.

The tap plug is the screw holding the right-hand stationary contact of the seal-in unit. To change the tap setting, first remove the connecting plugs. Then take a screw from the left-hand stationary contact and place it in the desired tap. Next, remove the screw from the other (right hand) tap, and place it in the left-hand contact. Following this procedure prevents the right-hand stationary contact from getting out of adjustment. Screws should never be left in both taps at the same time.

Voltage Settings

The contact-operating voltage may be changed by the position of the tap plug in the tap block at the top of the relay. The range of this adjustment is from 55 to 140 volts on the 115 volt ratings, from 110 to 280 volts on the 230 volt rating, and from 220 to 560 on the 460 volt ratings. Screw the tap plug firmly into the tap marked for the desired voltage (i.e., above which the relay is not to operate).

The tap settings indicate voltage values at which the contacts will close. A spring-adjusting ring is provided for a sensitive adjustment of relay operation. If the factory adjustment has been disturbed, the desired operating value may be obtained by inserting a tool in the notches around the edge of the ring (see Figure 10) and turning the ring to the desired position. This adjustment also permits any desired setting between the taps. The relay has been adjusted at the factory to close its contacts from any time-dial position at a voltage within 5% of the tap-plug setting. For example: If the tap-plug setting is 55 volts, the contacts will close when the voltage is reduced from a higher value down to 55 volts. The relay contacts will open again at no more than 110% of the tap setting. For the 55 volt tap setting, the contacts will open when the voltage is increased to a value greater than 55 but less than 61 volts.

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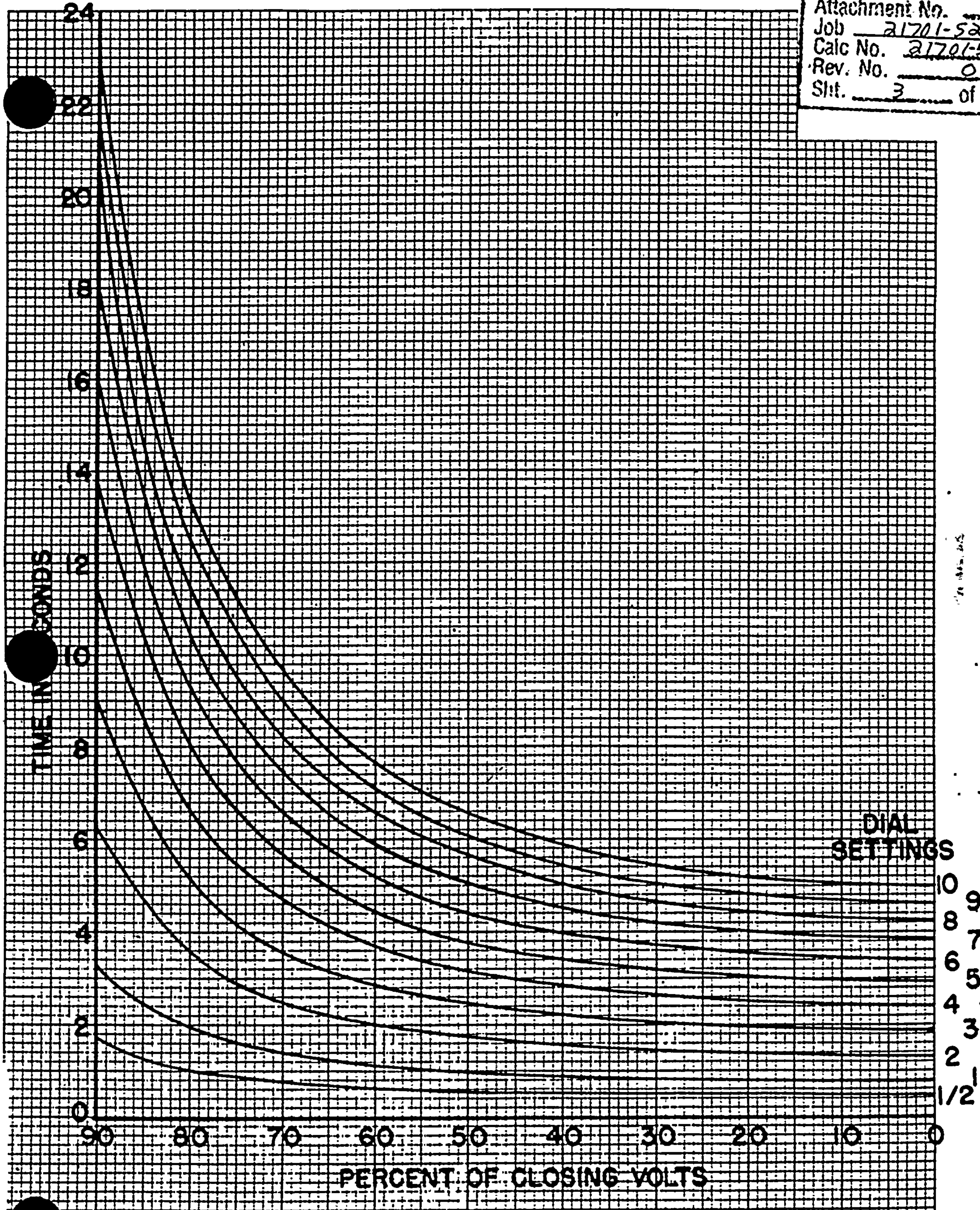

*Figure 2 (0362A0648-2) Time-Voltage Curves for Type IAV54E and IAV55C Relays

* Revised since last issue

FPL

P.O. Box 14000, Juno Beach, FL 33408-0420

JPN-PTN-92-5122

Bechtel Power Corporation
NorthCorp Center, Suite 5001
3950 RCA Boulevard
Palm Beach Gardens, Florida 33410

MAR 1 0 1992

Attn: Mr. R. E. Gallagher, Project Manager

Attachment No.	3
Job	21701-523
Calc No.	21701-523-E-01
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TURKEY POINT UNITS 3 & 4
480V UNDERVOLTAGE SCHEME MODIFICATION
I/S MOD: 1341; REA NO: TPN 87-015
PC/M: 91-128; TOP 20 ITEM 11
FILE NO: PC/M 91-128

Reference: 1) FPL Letter No. JPN-PTN-91-0958, dated December 5, 1991, from S. T. Hale to Peter Kotus of General Electric Company; Accuracy and repeatability information on IAV-55C relays.

2) Telecon between Ted Schiffley (OSM), Roy Bleeker (OSM), and Fred Flugger (Staff) on March 4, 1992 regarding acceptability of design input from the Original Equipment Manufacturer (OEM) of the IAV-55C relays.

Gentlemen:

The referenced letter requested that GE provide written confirmation of the information regarding the accuracy and repeatability of the GE IAV-55C inverse time undervoltage relay given to your Bob Larsen by L. Scharf of GE during a telecon on October 8, 1991. Mr. Peter Kotus of GE has responded to our request and has issued a letter dated January 3, 1992 confirming the subject information. The IAV relays are part of original equipment supplied by General Electric. The information has been provided by the original equipment manufacturer and, per the referenced telecon, may be used as design input. The letter is attached for your use and should be included as an attachment to the design document in which it is being referenced.

If you have any questions, please contact Roy A. Bleeker at (407) 775-6077.

Very truly yours,

P. C. Higgins *for*
PTN Production Engineering Manager

PCH/FPS/RAB:jrk

Enclosure

cc:	P. W. Black	PEG/RCA
	R. A. Bleeker	PEG/RCA
	C. M. Douglas w/encl	PEG/RCA
	J. A. Porter	JPNS/PLT
	M. C. Weeks	PEG/RCA
	FILE: PTN-OSM-92-05	

Attachment No. 3
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Calc No. 21701-523-E-01
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Attachment to
JPN-PTN-92-5122

GE Meter & Control

Attachment No.	3
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
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January 3, 1992

Mr. S.T. Hale
PTN - Eng. Proj. Mgr.
Florida Power & Light Co.
P.O. Box 3088
Florida City, FL 33034
ATTN.: Mr. W.J. Harris

RE: Your December 5, 1991, letter to P. Kotos regarding telecon from B. Larsen (Bechtel) to L. Scharf GE on October 8, 1991, on the accuracy and repeatability of the GE IAV55C relay

Dear Mr. Harris:

Per your request, this letter confirms the information noted below which was provided on the subject telecon:

If the frequency and ambient temperature are held constant, then the following apply:

1. The accuracy of the IAV55C relay will be ±7% of the published curve if the factory settings are not disturbed. For example, for any particular voltage, within the range of the published curve, the relay will dropout within ±7% of the corresponding time as indicated by the relay curves. If the relay was field adjusted, the repeatability of the relay will be within ±4% of the associated time as depicted on the published inverse time curve.

2. The tap setting voltage accuracy of the IAV55C relay will be ±5% if the factory tap settings have not been disturbed. If the tap settings were field adjusted, the repeatability of the relay will be within ±2% of the tap setting.

Sincerely,

Kotos

Peter A. Kotos
PAK/dbm

cc: J. Teague

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The 2 ampere tap should be used with trip coils that take 2 amperes or more at the minimum control voltage, provided the tripping current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes, an auxiliary relay should be used. The auxiliary relay should be connected so that the tripping current does not pass through the contacts or the target and seal-in coil of the protective relay.

BURDENS

The burdens for the various relay types at rated voltage are shown in Table 2.

TABLE 2

Relay	Tap Settings 115V Coil	230V Coil	460V Coil	Rated Frequency	At Rated Voltage Volt-amps	Power Factor	Watts
IAV54E &	140	280	560	60	3.0	0.26	0.78
IAV55C	120	240	480	60	4.0	0.26	1.0
	105	210	420	60	5.2	0.26	1.4
(Burdens for	93	186	372	60	6.8	0.28	1.9
IAV54F & IAV55F	82	164	328	60	8.9	0.28	2.5
are approxi-	70	140	280	60	12.4	0.29	3.6
mately 60% of	64	128	256	60	15.1	0.30	4.5
these values)	55	110	220	60	21.6	0.31	6.7
(Burdens for	140	280	560	50	2.5	0.28	0.70
IAV54H & IAV55H	120	240	480	50	3.3	0.28	0.92
& IAV54J							
are approxi-	105	210	420	50	4.3	0.28	1.2
mately 40% of	93	186	372	50	5.7	0.28	1.6
these values)	82	164	328	50	7.4	0.28	2.1
	70	140	280	50	10.3	0.29	3.0
	64	128	256	50	12.6	0.30	3.8
	55	110	220	50	18.0	0.31	5.6
	140	280	560	25	2.3	0.26	0.60
	120	240	480	25	3.1	0.26	0.81
	105	210	420	25	4.0	0.27	1.1
	93	186	372	25	5.2	0.28	1.5
	82	164	328	25	6.8	0.28	1.9
	70	140	280	25	9.5	0.30	2.8
	64	128	256	25	11.6	0.30	3.5
	55	110	220	25	16.5	0.31	5.1

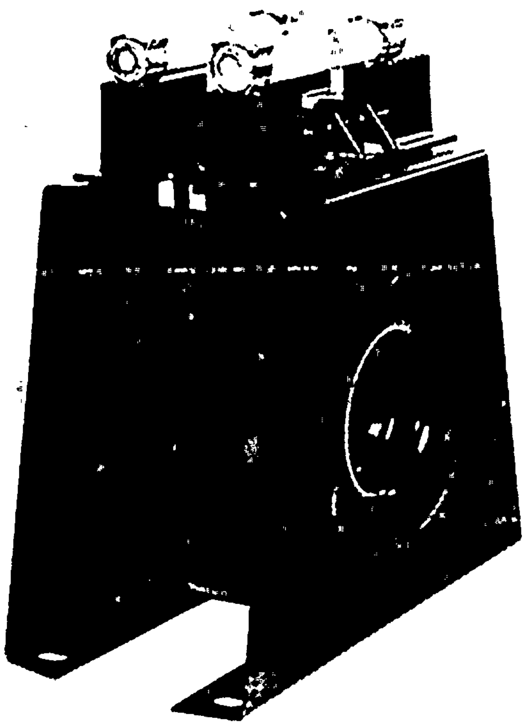
RECEIVING, HANDLING AND STORAGE

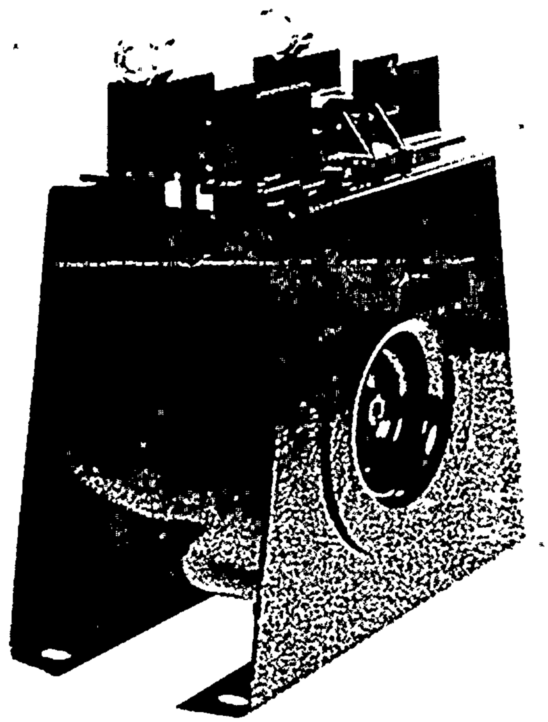
These relays, when not included as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If damage resulting from

POTENTIAL TRANSFORMERS

240 TO 600 PRIMARY VOLTS INSULATION, CLASS—0.6 KV—50/60 HERTZ

TYPE PT-6





DESCRIPTION

The I-T-E Instrument Transformers are designed to the high accuracy required to meet present day metering problems.

These transformers conform to the accuracy for metering as established in the standard set up for the potential transformers by the American Standards Association.

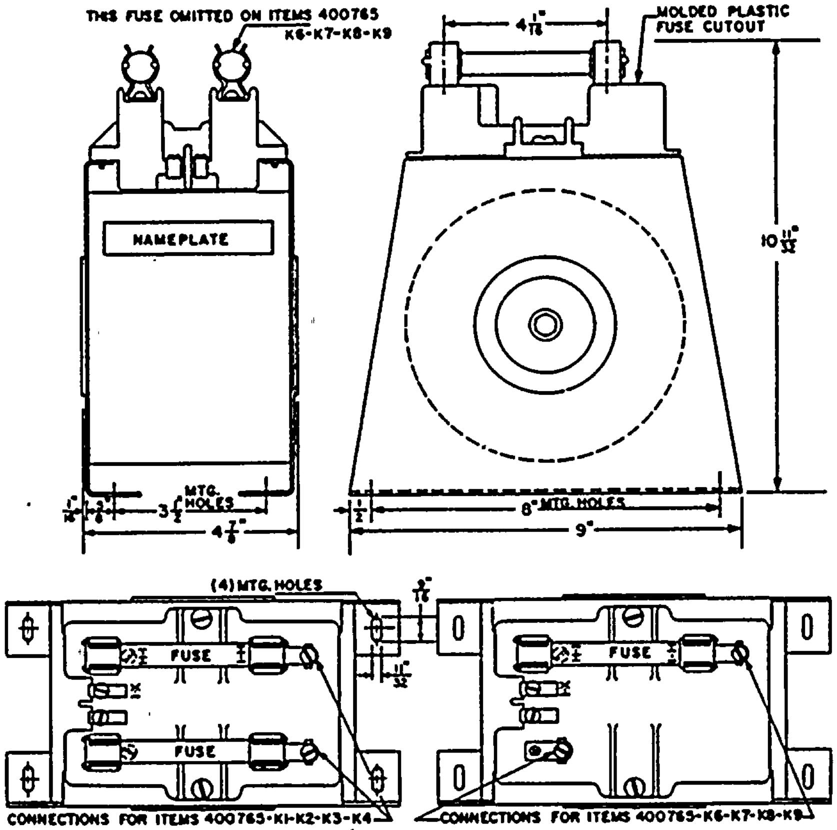
These transformers utilize the wound-core construction well known for its excellent magnetic properties. The highest grade of oriented-grain silicon steel is used and annealing is done in a carefully controlled atmosphere in order to minimize core losses.

Controlled reactance is employed to minimize ratio and phase angle errors, and is accomplished by a precision winding technique. A machine especially designed for toroidal winding is used for winding both primary and secondary coils. The result is exceptional uniformity of performance. The windings are vacuum impregnated with a polymerizing varnish to protect against winding damage due to moisture and vibration. Additional protection against vibration damage is provided by the use of neoprene cushions.

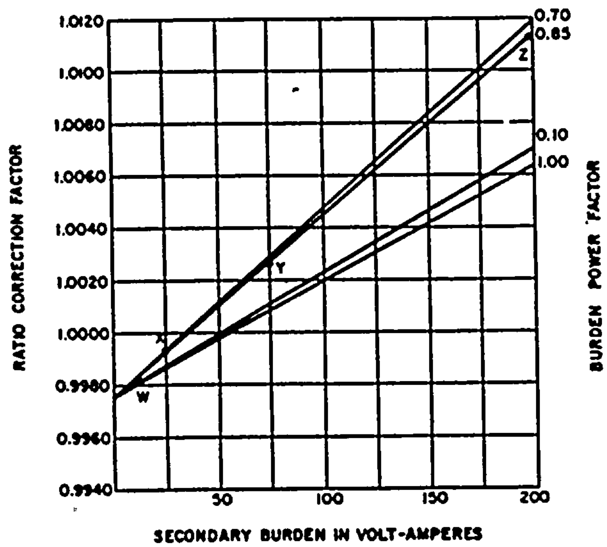
For net price multiplier and applicable price adjustment clause, see Catalog Section A.1.5.0, Page 1.
Prices subject to change without notice. Terms and Conditions of Sale—see Catalog Section A.1.5.1, Page 1 and 2.

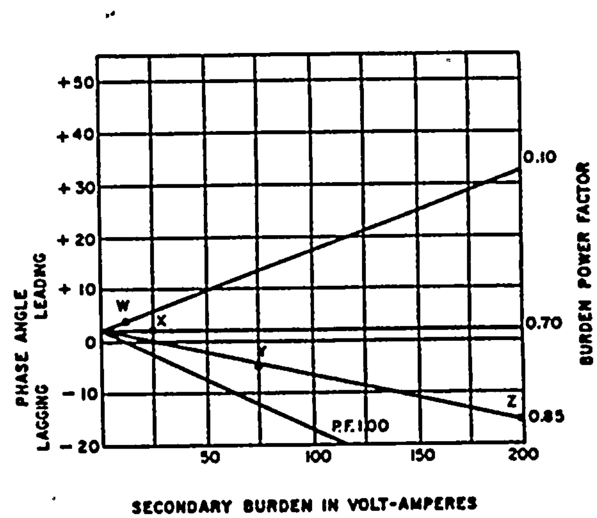
POTENTIAL TRANSFORMERS

TYPE PT-6



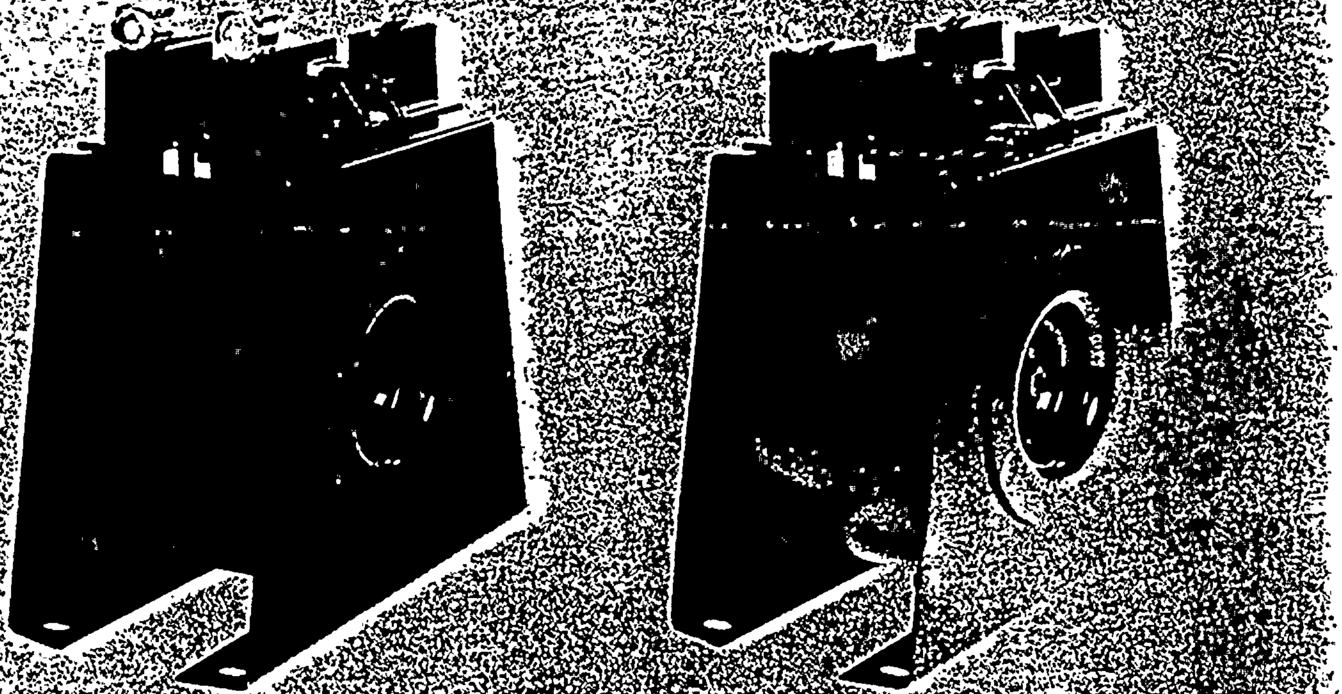
TYPICAL PERFORMANCE CURVES FOR 480/120 VOLT, 60 HERTZ





240 TO 600 PRIMARY VOLTS INSULATION, CLASS—0.6 KV—50/60 HERTZ

TYPE PT-6



PRICES

Ordering Number	Ratio	Fuses	Metering Accuracy at 60 Hertz W	X	Y	Z	List Price
400765-K1	240/120	2	.3	.3	.3	1.2	$170.00
400765-K2	288/120	2	.3	.3	.3	1.2	170.00
400765-K3	480/120	2	.3	.3	.3	1.2	170.00
400765-K4	600/120	2	.3	.3	.3	1.2	170.00
400765-K6	240/120	1	.3	.3	.3	1.2	165.00
400765-K7	288/120	1	.3	.3	.3	1.2	165.00
400765-K8	480/120	1	.3	.3	.3	1.2	165.00
400765-K9	600/120	1	.3	.3	.3	1.2	165.00

$310 [illegible]

For net price multiplier and applicable price adjustment clause, see Catalog Section A.1.5.0, Page 1.
Prices subject to change without notice. Terms and Conditions of Sale—see Catalog Section A.1.5.1; Page 1 and 2.

[illegible] [illegible]

Attachment No.	4
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
Sht.	4 of 5

Bechtel

NorthCorp Center, Suite 5001
3950 RCA Boulevard
Palm Beach Gardens, Florida 33410
(407) 694-8400

November 25, 1991

Mr. Donald Hamrock
ABB Power Distribution Inc.
5444 Bay Center Drive, Room 123
Tampa, FL 33609-3402

Turkey Point Units 3 and 4
Type PT-6 Potential Transformers
Letter No. V-91-062 Job No. 21701-523 Files: 0116, S-21701-523

Reference: N/A

Dear Mr. Hamrock:

We are preparing an undervoltage relay setpoint calculation for the 480V Load Centers at Turkey Point. One of the variables needed is the inaccuracies of the potential transformers.. The 480/120V PT's installed were manufactured by ITE; however, the type/model can not be determined from the design documents. We believe they are ITE Type PT-6 but there is no documentation to verify this assumption.

Please verify and confirm that the potential transformers installed in the 480V Load Centers at Turkey Point are ITE Type PT-6. These PTs are installed in Load Centers 3A, 3B, 3C, 3D, 4A, 4B, 4C and 4D and were supplied by ITE under Shop Order # 3342503.

Please respond via a letter to the following address:

Mr. S. T. Hale
PTN Engineering Project Manager
Florida Power & Light Company
Post Office Box 3088
Florida City, FL 33034

Attention: Mr. W. J. Harris

In addition, please send a copy of the letter to Bechtel Corporation, at our above address.

Sincerely,

CWeaver

C. L. Weaver
Project Engineer

RRL:mtm

ABB
ASEA BROWN BOVERI

Attachment No.	4
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
Sht.	5 of 5

December 5, 1991

Mr. S. T. Hale
PTN Engineering Project Manager
Florida Power & Light Company
P.O. Box 3088
Florida City, Fl. 33034

Attention: Mr. W. J. Harris

Subject: Turkey Point Units 3 and 4
Type PT-6 Potential Transformers
Letter No. V-91-062
Job No. 21701-523
Files: 0116, S-21701-523

Gentlemen:

This letter is to advise that these are PT6 per our records.

If we can be of further service, please advise.

Very truly yours,

ABB POWER DISTRIBUTION INC.

Donald J. Hamrock
Regional Sales Manager

DJH/ba

ABB Power Distribution Inc.

ABB Power Distribution Inc.
5444 Bay Center Drive, Room 123
Tampa, FL 33609-3402

Telephone:
813 286-7459

Telefax:
813 286-1285

INSTRUCTIONS

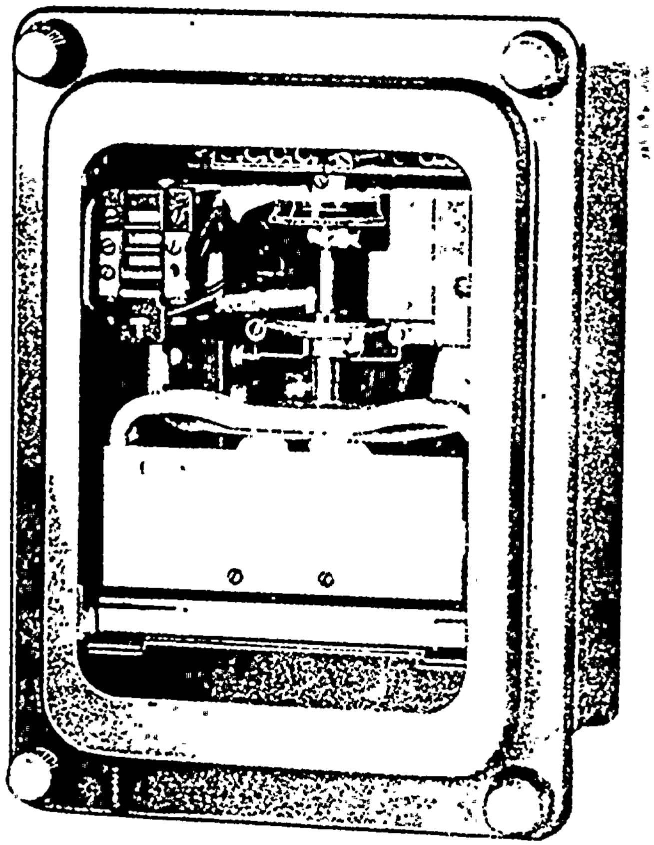
GEH-1814F
Supersedes GEH-1814E

Attachment No. 5
Job 21701-523
Calc No. 21701-523-E-01
Rev. No. 0
Sht. 1 of 3

VOLTAGE RELAYS

TYPES

IAV51A	IAV53D
IAV52A	IAV53K
IAV53A	IAV53L
IAV53B	IAV53M
IAV53C	IAV53N



GENERAL ELECTRIC

Attachment No.	5
Job	21701-523
Calc No.	21701-523-E-01
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TABLE III (Con't.)

RELAY TYPES	VOLTAGE RATING	TAP ** SETTING	VOLT-AMPS	POWER FACTOR	WATTS
25 - CYCLE BURDENS (Con't.)					
IAV53A & IAV53B	115	140	1.7	0.32	0.5
		120	2.3	0.30	0.7
		105	2.9	0.30	0.9
		93	4.2	0.30	1.3
		82	5.3	0.32	1.7
		70	7.5	0.34	2.6
		64	9.5	0.34	3.3
		55	12.9	0.39	5.0
IAV53C	115	NO TAPS	4.2	0.38	1.6

**Minimum pickup volts.

CHARACTERISTICS

The Type IAV51A is an overvoltage relay with single-circuit closing contacts which close when the voltage increases to pickup value as set on the tap block. The time delay in closing the contacts is determined by the setting of the time dial at the top of the shaft. The time-voltage characteristics of this relay are shown in Fig. 12.

The IAV52A relay is similar in every respect to the IAV51A relay except that it has additional contacts for closing a second circuit. The time-voltage characteristics are shown in Fig. 12.

The IAV53A relay is an under-and overvoltage relay with double-throw contacts. The left-hand contacts close as the voltage increases to some predetermined value. The right-hand contacts close when the voltage [illegible]ases to some lower value. Between these two voltage values both contacts are open. Time-voltage [illegible]cteristics are shown in Fig. 13.

The Type IAV53B relay differs from the Type IAV53A relay in that it does not have seal-in elements. Time-voltage characteristics are shown in Fig. 13.

The Type IAV53C relay is similar to the Type IAV53A relay except that there are no taps on the coil. The relay is adjusted to close its right contacts in 10 seconds when the voltage is reduced from 58 percent rated voltage to zero voltage; with this calibration the relay closes its left contacts in approximately 10 seconds when the voltage is increased from 58 percent of rated voltage to rated voltage. These relays are used connected line-to-ground so that under normal conditions the relay receives 58 percent of rated phase-to-phase voltage and both relay contacts are open. If the phase to which the relay is connected is grounded, the relay voltage goes to zero and the right-hand contacts close in 10 seconds. If either of the other two phases are grounded, the relay voltage increases to rated voltage and the left-hand contacts close in approximately 10 seconds.

The IAV53D relay is similar to the Type IAV53B relay except that it has a shorter time curve. Time-voltage characteristics are shown in Fig. 14.

The Type IAV53K is similar to the Type IAV53A, IAV53L to IAV53B, IAV53M to IAV53C and IAV53N toIAV53D. All four relays are in the double-end case with contacts connected between the upper and lower blocks and operating coils connected to both blocks. The purpose of this is to avoid false tripping of the breaker if the connecting plugs are removed and subsequently reinserted with the relay in the reset position, i.e., circuit opening contacts closed. Insertion of either plug causes the relay to pick up; both plugs must be in place before the contact circuits are completed. See internal connections Fig. 6-8 for coil and contact * circuits, and Fig. 11 for external connections.

CONSTRUCTION

These relays are of the induction disk construction. The disk is actuated by a potential operating coil on a laminated U-magnet. The disk shaft carries the moving contact, which completes the trip or alarm circuit when it touches the stationary contact or contacts. The disk shaft is restrained by a spiral spring [illegible]ve the proper contact closing voltage, and its motion is retarded by permanent magnets acting on the [illegible] to give the correct time delay.

There is a seal-in unit mounted to the left of the shaft as shown in Fig. 15. This unit has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close, the

* Indicates revision

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REPRESENTATIVE

Burdens for the various relay types are given in Table III.

TABLE III

RELAY TYPES	VOLTAGE RATING	TAP** SETTING	VOLT-AMPS	POWER FACTOR	WATTS
60 - CYCLE BURDENS					
IAV51A & IAV52A	115	140 120 105 93 82 70 64 55	1.3 1.8 2.4 3.1 3.9 5.4 6.6 9.2	0.34 0.35 0.34 0.33 0.32 0.31 0.31 0.35	0.4 0.5 0.7 0.9 1.2 1.7 2.1 3.2
IAV53A, IAV53B, & IAV53D	115	140 120 105 93 82 70 64 55	2.2 3.0 4.0 5.4 7.0 9.9 12.0 17.0	0.32 0.30 0.31 0.31 0.32 0.34 0.36 0.39	0.7 0.9 1.2 1.7 2.2 3.4 4.3 6.6
IAV53C	115	NO TAPS	5.7	0.29	1.7
50 - CYCLE BURDENS					
IAV51A & IAV52A	115	140 120 105 93 82 70 64 55	1.2 1.6 2.1 2.8 3.6 5.1 6.2 8.2	0.34 0.34 0.34 0.38 0.36 0.34 0.34 0.34	0.4 0.5 0.7 1.9 1.3 1.7 2.1 2.9
IAV53A & IAV53B	115	140 120 105 93 82 70 64 55	1.9 2.5 3.4 4.6 6.0 8.4 12.9 13.2	0.32 0.30 0.29 0.31 0.32 0.35 0.29 0.35	0.6 0.8 1.0 1.4 1.9 2.9 3.7 4.6
IAV53C	115	NO TAPS	4.8	0.32	1.6
25 - CYCLE BURDENS					
IAV51A & IAV52A	115	140 120 105 93 82 70 64 55	1.1 1.5 2.1 2.7 3.4 4.8 5.8 8.2	0.50 0.49 0.49 0.47 0.49 0.49 0.49 0.49	0.5 0.8 1.0 1.2 1.7 2.4 2.9 4.0

**Minimum pickup volts.

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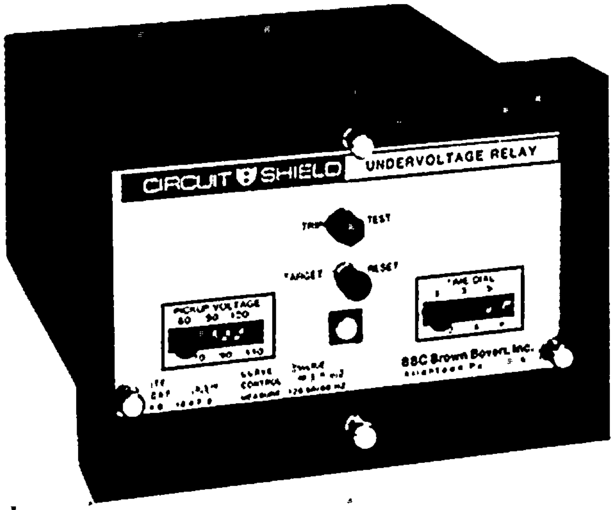
ASEA BROWN BOVERI

Protective Relays
Drawout

Types 27, 27D, 27H
Types 59, 59D, 59H

Undervoltage and Overvoltage Relays



Application

Circuit-Shield Voltage Relays provide a wide range of protective functions, including undervoltage protection of motors, overvoltage protection, and automatic bus transfer. Inherently high seismic and transient immunity allow the use of these relays in generating stations or substations where the performance of electromechanical or other types of static relays is marginal.

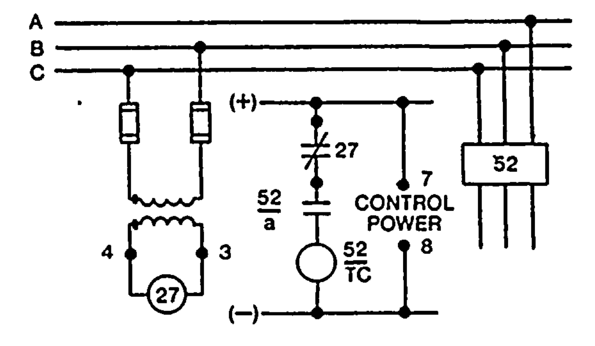
All types are frequency compensated for reliable operation from 20 to 400 Hz, and have a dual nominal frequency rating of 50 or 60 Hz.

The unique design of the output circuit does not require seal-in contacts, allowing simplification of bus-transfer schemes. Operation indicators, however, are provided as standard features on all types.

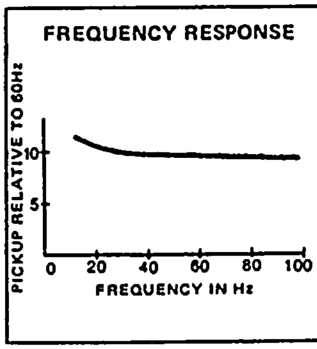
The operating characteristic of each relay in this series is indicated as follows: H suffix for high speed; D suffix for definite time; no suffix for inverse time.

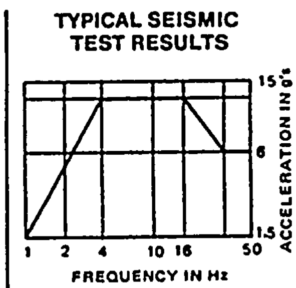
Features

- Frequency compensation to 20 Hz
- Inverse, definite time, or high speed
- Accurate, repeatable characteristics
- Low burden
- Seismic capability to 6g ZPA
- Transient immunity
- Drawout construction



TYPICAL CIRCUIT SHIELD UNDERVOLTAGE RELAY APPLICATION





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Attachment No. 6
Job 21701-523
Calc No. 21701-523-E-01
Rev. No. 0
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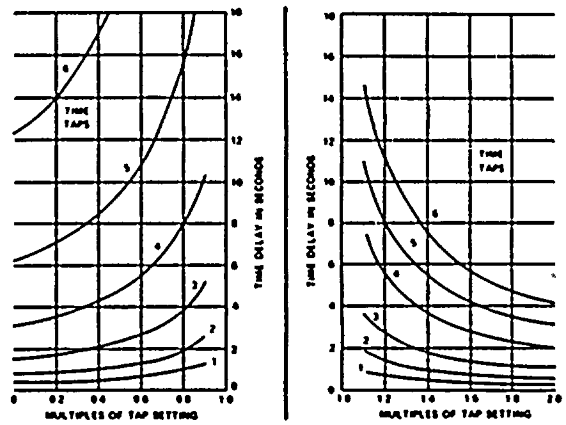
Undervoltage and Overvoltage Relays
Types 27, 27D, 27H, 59, 59D, 59H

Specifications

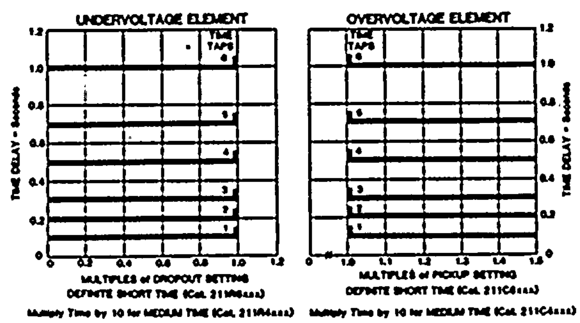
	Type 27 Type 27D Type 27H	Type 27H	Type 59 Type 59D Type 59H
PICKUP TAPS (volts)			100 110 120 130 140 150
DROPOUT TAPS (volts)	60 70 80 90 100 110	30 35 40 45 50 55	

Input Circuit Rating: 160V, 50/60 Hz continuous
Burden: 1.2 VA, 1.0 P.F. at 120V
Control Power: 48/125 Vdc, dual rated, .08A max; 24/32 Vdc, 0.08A max.
Output Circuit Rating: @ 125 Vdc 30 Amps Tripping Duty
5 Amps Continuous
1 Amp, Opening Resistive
0.3 Amp, Opening Inductive
Temperature: Minus 20° to plus 70°C
Seismic Capability: More than 6g ZPA biaxial broad-band multifrequency vibration without damage or malfunction (ANSI/IEEE C37.98)
Transient Immunity: More than 2500V, 1 MHz bursts at 400Hz repetition rate, continuous (ANSI C37.90a SWC); fast transient test; EMI test
Operating Time: models available:
- high speed
- inverse time delay (see curves)
- definite time delay, ranges 0.1 - 1.0 seconds, and 1.0 - 10 seconds



TYPE 27 TYPE 59
TIME-VOLTAGE CHARACTERISTICS

TIME VOLTAGE CHARACTERISTICS



How To Specify

Voltage relay shall be Asea Brown Boveri Type 27, 59 or approved equal, drawout case, capable of withstanding up to 6g ZPA seismic stress without damage or malfunction, at minimum voltage and time settings. A magnetic operation indicator shall be provided which retains position on loss of control power. Built-in means shall be provided to allow operational tests without additional equipment.

Additional Information

Instruction Book	IB 18.4.7-2
Relay Selection Sheet	7.4.0.3

How To Order

For a complete listing of available versions of single and three phase voltage relays see selection sheet 7.4.0.3.

Models are available for 24, 32, 48 or 125 Vdc control power. For 120 Vac potential applications, and other control voltages contact the nearest District Office.

To place an order, or for further information, contact the nearest District Office, or the Sales Manager, Protective Relays.

ABB Power Transmission, Inc.
Protective Relay Division
35 N. Snowdrift Road, Allentown, PA 18106
Telephone (215) 395-6888
FAX 215-395-1055

Supersedes Issue D Printed In U.S.A. 0189

Attachment No.	7
Job	21701-523
Calc No.	21701-523-E-01
Rev. No.	0
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BECHTEL

		REV.
PURCHASE ORDER NO.		
REQUISITION NO.	5177-158-E-866	2

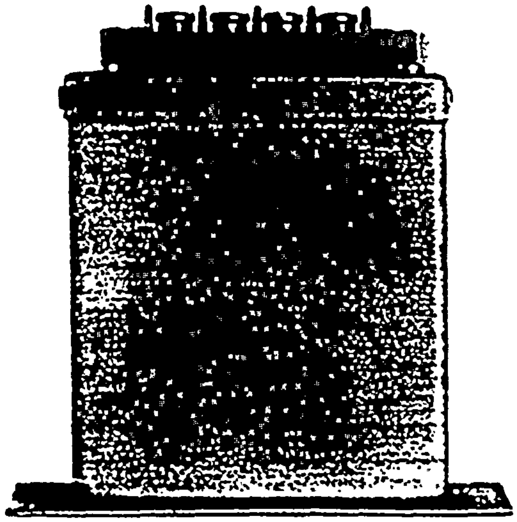
ITEM NO.	QUANTITY	DESCRIPTION	CODE OR EQUIP. NO.	UNIT PRICE	EXTENSION
		Furnish and deliver FOB jobsite the following electrical items:		$	$
1	35 ea (33 used, 2 spare)	Voltage Transducer, Rochester Series VCC rated for 0-150 Vac, 60 Hz input and 1-5 Vdc output. The unit shall be capable of being powered by the Buyer's 120 Vac supply. The transducers shall be seismically qualified to levels encompassing the curve shown on Appendix C. The transducers shall be labeled with the tag numbers listed below: Rochester Model No.: VCC-1B-P1-E1-X (1-5 Vdc) - F60-Z0-A1-G1-S Tag Nos.: V-XDCR/3AB1, V-XDCR/3BB1, V-XDCR/4AB1, V-XDCR/4BB1, V-XDCR/3DG1, V-XDCR/4DG1, V-XDCR/3AB2, V-XDCR/3BB2, V-XDCR/3CB1, V-XDCR/3DB1, V-XDCR/4AB2, V-XDCR/4BB2, V-XDCR/4CB1, V-XDCR/4DB1, V-XDCR/3AB3, V-XDCR/3BB3, V-XDCR/3CB2, V-XDCR/DB1, V-XDCR/4AB3, V-XDCR/4BB3, V-XDCR/4CB2, V-XDCR/3AI1, V-XDCR/ASI1, V-XDCR/4AI1, V-XDCR/3BI1, V-XDCR/BSI1, V-XDCR/4BI1, V-XDCR/3CI1, V-XDCR/CSI1, V-XDCR/4CI1, V-XDCR/3DI1, V-XDCR/DSI1, V-XDCR/4DI1, V-XDCR/Q-Spare 1, V-XDCR/Q-Spare 2 Drawing No.: 5177-158-E-16 — Subjob/PC/M: 158/81-157, 81-158			
2	17 ea (16 used, 1 spare)	Current Transducer, Rochester Series CCC rated for 0-5A, 60 Hz input and 1-5 Vdc output. The unit shall be capable of being powered by the Buyer's 120 Vac supply. The transducers shall be seismically qualified to levels encompassing the curve shown on Appendix C. The transducers shall be labeled with the tag numbers listed below: Rochester Model No.: CCC-1B-C5-E1-X (1-5 Vdc) - F60-Z0-A1-G1-S Tag Nos.: C-XDCR/3DG3, C-XDCR/3DG4, C-XDCR/4DG3, C-XDCR/4DG4, C-XDCR/3AI1, C-XDCR/ASI1, C-XDCR/4AI1, C-XDCR/3BI1, C-XDCR/BSI1, C-XDCR/4BI1, C-XDCR/3CI1, C-XDCR/CSI1, C-XDCR/4CI1, C-XDCR/3DI1, C-XDCR/DSI1, C-XDCR/4DI1, C-XDCR/Q-Spare 1 Drawing No.: 5177-158-E-16 — Subjob/PC/M: 158/81-157, 81-158			

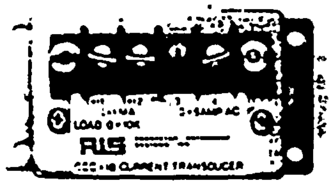
Attachment No. 7
Job 21701-523
Calc No. 21701-523-E-01
Rev. No. 0
Sht: 2 of 3

ROCHESTER INSTRUMENT SYSTEMS **CURRENT & VOLTAGE TRANSDUCERS**

CCC, VCC, & VCX CURRENT & VOLTAGE TRANSDUCERS

- Used and Approved Worldwide
- High Accuracy
- Outstanding Overload and Temperature Performance
- Excellent Long-Term Stability
- Meets ANSI C37.90.1-1974 (IEEE SWC) and BEAMA No. 219 Tests
- Wide Selection of Input/Output Ranges
- Process Outputs (4-20 mA)





APPLICATIONS

- closed loop process control element
- motor overload protection
- substation line and bus monitoring
- distribution circuit monitoring
- supervisory control and data acquisition
- improved precision of dynamic network models

The Rochester Instrument Systems CCC Current Transducer and VCC Voltage Transducer are compact instruments designed to accept an AC current or voltage input and provide a proportional DC current output. The VCX Voltage Transducer is a suppressed zero unit that provides the same type of output signal. These transducers are designed to respond to the average value of the input signal, but all models are calibrated to indicate the rms of a pure sinusoid. All models are constructed with an ultra-linear transformer input stage isolating the input from the solid-state output amplifier.

Like all Rochester Instrument Systems transducers, these current and voltage units incorporate state-of-the-art electrical and mechanical design. Only the highest quality components, latest production techniques and most advanced test equipment and procedures are used in their manufacture. All models are designed to meet the ANSI SWC (surge withstand capability) test and BEAMA Test No. 219, to assure reliable performance in the field.

CCC, VCC and VCX transducers are housed in rugged drawn-steel enclosures with welded-on mounting plates. The entire circuitry may be pulled by removing two easily-accessible screws without dismounting the enclosure from the panel.

For more information on current and voltage transducers, application assistance on a special project, or simply to place an order consult your nearest RiS Sales Office or any of the factory locations listed on the back page.

[illegible]

Attachment No.	7
Job	21701-523
Calc No.	21701-523-E-01
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CCC-1B CURRENT TRANSDUCERS
VCC-1B VOLTAGE TRANSDUCERS
VCX-1B SUPPRESSED ZERO VOLTAGE TRANSDUCERS

CURRENT TRANSDUCER OPTIONS & STANDARD CALIBRATION (TABLE NO. 1)

OPTIONS	CURRENT INPUT		OVERLOAD WITHSTAND			
	RANGE (O-F.S.) STANDARD CALIBRATION	OVER RANGE WITH FULL ACCURACY	CONTINUOUS @ 65°C		3 SEC./HOUR	1 SEC./HOUR
			X1 X5, XA, X	X10, X20		
C1	0-1 amps	0-1.5 amps	10 amps	10 amps	20 amps	50 amps
C2	0-2 amps	0-3.0 amps	10 amps	10 amps	40 amps	100 amps
C5	0-5 amps	0-7.5 amps	20 amps	10 amps	100 amps	250 amps
C10	0-10 amps	0-15 amps	20 amps	10 amps	250 amps	400 amps

VOLTAGE TRANSDUCER INPUT OPTIONS & STANDARD CALIBRATION (TABLE NO. 2)

OPTIONS	POTENTIAL INPUT		OVERLOAD WITHSTAND	
	RANGE (O.F.S.) STANDARD CALIBRATION	OVER RANGE WITH FULL ACCURACY	CONTINUOUS @ 65°C	1 SEC./HOUR
P1	0-150 volts	0-200 volts	1.5×F.S.	2×F.S.
P2	0-250 volts	0-330 volts	1.5×F.S.	2×F.S.
P3	0-550 volts	0-600 volts	1.5×F.S.	2×F.S.

POWER SUPPLY OPTIONS (TABLE NO. 3)

OPTIONS		EXTERNAL POWER SUPPLY	
		RANGE	BURDEN (MAXIMUM)
E0 Self-powered	Note: P2-X5, C10-X5, and any combinations including XA, X20 or P3 options, require an external power supply	—	—
E1		85-150 V AC	4 VA
E2		170-300 V AC	4 VA
E3		300-550 V AC	4 VA

OUTPUT OPTIONS, CURRENT & VOLTAGE TRANSDUCERS (TABLE NO. 4)

OPTIONS	OUTPUT			INPUT BURDEN (MAXIMUM @ 50-60 Hz)		
	RANGE	LOAD	CURRENT LIMITING	CURRENT TRANSDUCERS		VOLTAGE TRANSDUCERS
				Self-Powered	Externally-Powered	
X1	0-1 mADC	0-10KΩ	—	0.5 VA	0.5 VA	2.0 VA
X5	0-5 mADC	0-3KΩ	—	1.0 VA	0.5 VA	2.0 VA
X10	0-10 mADC	0-1.5KΩ	15-20 mADC	1.5 VA	0.5 VA	2.5 VA
X20	0-20 mADC	0-750Ω	30-40 mADC	2.0 VA	0.5 VA	3.0 VA
XA	4-20 mADC	0-750Ω	30-40 mADC	—	0.5 VA	3.0 VA
X ( )*	0-dc volts	Consult factory	—	—	0.5 VA	

*Example: X (0-10 VDC)

Attachment No. 8
Job 21701-523
Calc No. 21701-523-E-01
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FPL TURKEY POINT NUCLEAR PLANT TOTAL EQUIPMENT DATA BASE

UNIT: 03 PAGE NO. 1
COMPONENT TAG #: 30101 ASSOC: C04-VM

DESC: 480 V LC A VOLTMETER
SYSTEM: 480 VOLT SWITCHGEAR SYSTEM CODE: 006
LOCATION DESC: CONTROL ROOM, VERTICAL PANEL
LOCATION CODE: 360 STARTUP SYSTEM CODE:
RWP: N IST: N SAFETY CLASS: QR
NPRDS: Y QBASIS:
GEMS MAJOR CODE: EF52 QGROUP:
GEMS MAJOR MFTR: WES QLEVEL:
GEMS ID CODE: EQ REQD: N
GEMS MINOR CODE: SCEW: N/A
GEMS MINOR MFTR: PCM:
ACCOUNT CODE: 531 SPEER: N/A
EQUIPMENT MFTR: WESTINGHOUSE ELECT. SURV MAINT NOTE: N/A
MODEL NO: TYPE:VC-252; STYLE:G-9589 DOC PAC: N/A
SEISMIC CAT: ENGRG DATA REF:
HEAR PROTECTION: REMARKS: N/A

DRAWING NUMBER	SHEET #	PURCHASE ORDERS
5610-E-28	13	5610-M-301
5610-E-5	1	

PROCEDURES	PROCEDURE TITLE
AP 0190.28	POST MAINTENANCE TESTING

Note:

Other load centers have the same type of voltmeter.

Westinghouse Electric Corporation
Relay-Instrument Division,
Newark, N.J. 07101

43-252 D WE A
Descriptive Bulletin

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March, 1976
Supersedes DB 43-252 dated August, 1972
E, D, C/2036/DB

Type 252, 4½" Scale Length
1½% Accuracy

Edgewise *tbi*® Switchboard Instrument

Application
Type 252 edgewise instruments were designed specifically for the nuclear power industry for use on control panels. However, they are well suited to any use where high reliability and efficient use of space are important considerations.

These instruments incorporate into edgewise instruments the same taut-band suspension system which is used in the highest quality Westinghouse portable and switchboard instruments.

They are available in types for direct measurement of standard electrical quantities, or in combination with transducers for measuring any other electrical or mechanical quantity capable of being converted into a proportional electrical quantity.

Standards
There is no published requirement in ANSI C391-1972 for instruments of this type, however they specifically meet the switchboard instrument requirements therein. The type 252 instruments meet the flamability requirements of IEEE Standard 420-1973 and they pass the seismic qualification tests under IEEE Standard 344-1971 (Rev. 5 dated 9-23-74)

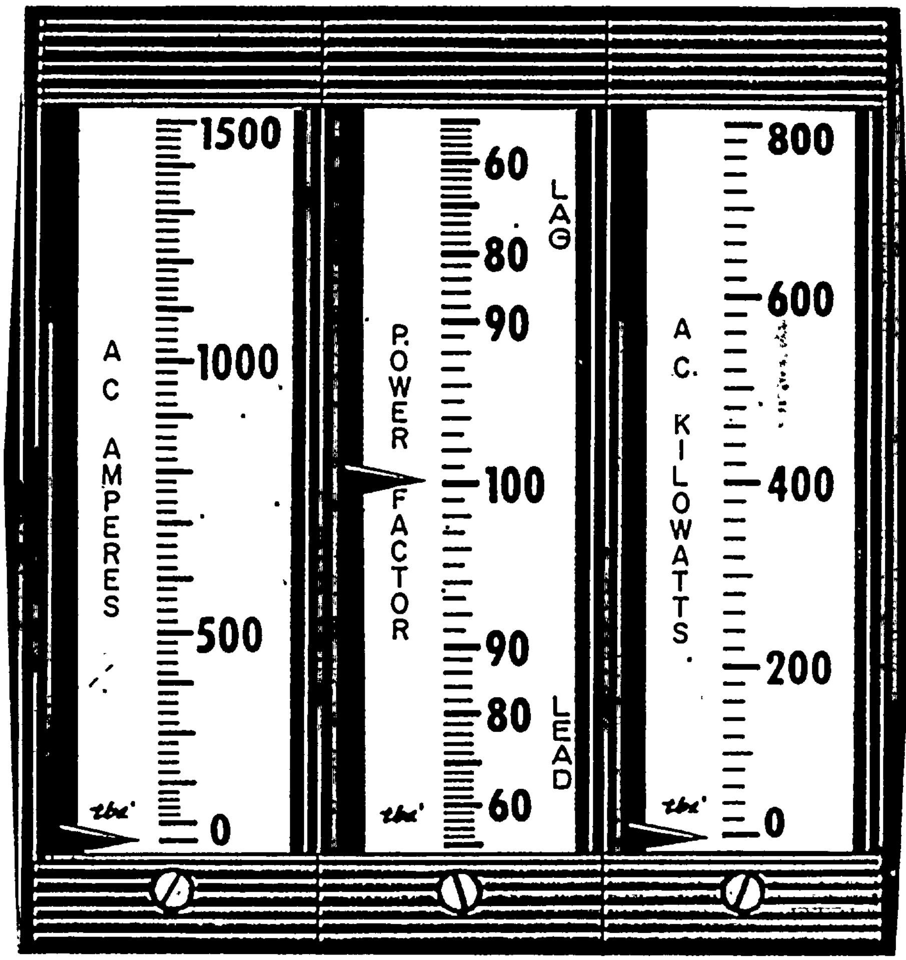
Specifications

Accuracy	1½% of full scale deflection, horizontal or vertical; ±1% on special order
Waveform Compensation	To 15% of third harmonic content
Instantaneous Overload Capacity	Ac–35 Times Rating Dc–100 Times Rating
Working Voltage to Ground	1200 volts dc, 800 volts ac
Shielding	Magnetically shielded
Scale Length	4.5 inches (11.43 cm)
Net Weight	1½ pounds
Shipping Weight	2½ pounds

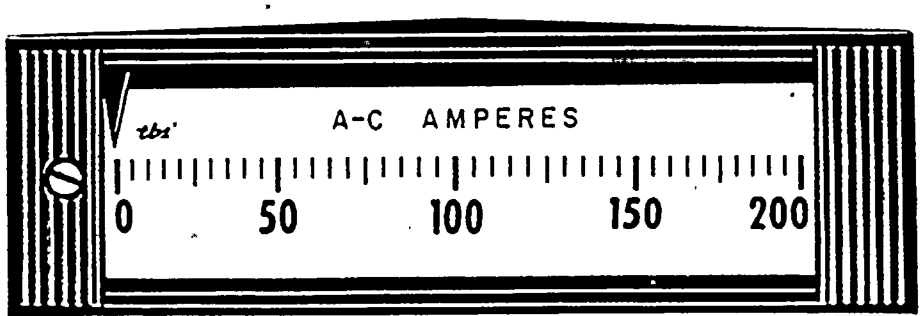
Ratings (Self-Contained)
Dc: 20 microamperes to 50 amperes
50 millivolts to 800 volts

Ac: 10 milliamperes to 20 amperes
5 volts to 600 volts

Transducer-type frequency meters, varmeters, wattmetters.



Vertical Type (Grouped)



Horizontal Type

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Construction

All components are mounted on a plastic drawer which slides into a plastic case with a clear, curved window. The entire assembly is treated to be static free. The plastic is polycarbonate (ASTM D635) for impact strength and flame retardance.

Mechanism

The dc instrument is of the permanent-magnet moving-coil type in a core magnet construction.

For ac measurement the same mechanism is used, but rectifiers and an rms network are added. This design permits the ac instrument to have a linear scale, to compensate for wave form distortion, and to be practically immune to the effects of magnetic fields from adjacent conductors regardless of their orientation.

Suspension

All type 252 instruments use the Westinghouse perfected taut-band suspensions. Instruments incorporating this feature are identified by the trademark *tbs*. The absence of friction in taut-band instruments creates the advantages of perfect repeatability, reduced …ntenance, and lower electrical burdens. …herent ruggedness of the design makes …p performer under adverse conditions …hock or vibration.

Dials

Pointer edge and dial markings are on the same arc that there is no parallax error.

Mounting

Instruments may be stacked horizontally or vertically. Eight edgewise vertical instruments will occupy the same panel width as three conventional instruments. Trim strips, furnished with each instrument, finish off the edge of each instrument or array. Dial cards may be interchanged to adapt from horizontal to vertical mounting or to change scales.

Modifications Available

Internal illumination with low-voltage lamp and translucent dial.

External rear illumination with clear-case and translucent dial.

Non-glare window

Dual scale or rating

Straight fine tubular pointer

Offset, center, or suppressed zero

Gasketed construction

Further Information

…s: Price List 43-200

…tions: Instruction Leaflet 43-252

…sducers: Descriptive Bulletin 43-861

Burden Characteristics at 60 Hertz

Burdens on Current Transformers at 5 Amps

Instrument Rating	Impedance: Ohms	Resistance: Ohms	Reactance: Ohms	Volt-Amperes	Percent Power Factor
5 amp	.024	.013	.020	.6	54

Burden on Potential Transformers at 120 Volts

Instrument Rating	Volt-Amperes	Watts	Vars	Percent Power Factor
150 volts	.096 ←	.096	0	100

Lamps

Lamp Type	Volts	Amps
46	6.3	0.25

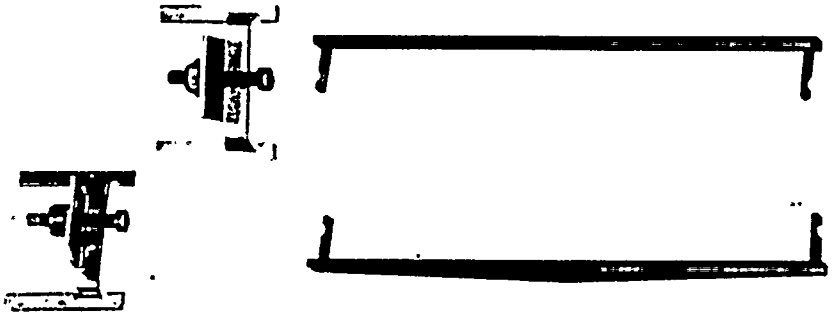

Figure 1

Outline and Panel Cutout Dimensions, In Inches (Centimeters)

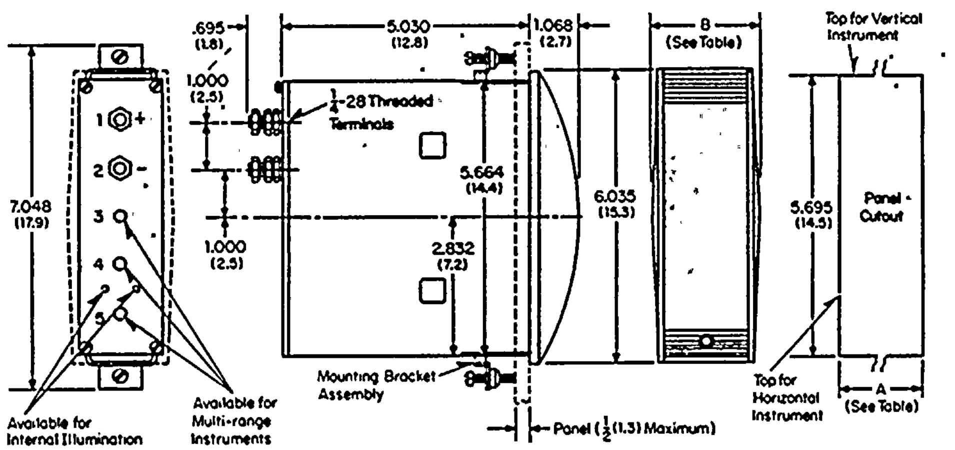

Figure 2

410C100

Mounting

Figure 1 shows the two bracket assemblies and two trim strips which are supplied with each 252 instrument. Figure 2 illustrates how these parts are used.

Two trim strips are needed to trim either a single instrument or a stacked array.

No. of Instruments	Dimensions A	Dimensions B
1	1.770 (4.3)	2.166 (5.5)
2	3.510 (8.9)	3.896 (9.9)
3	5.250 (13.3)	5.620 (14.3)
4	6.990 (17.8)	7.356 (18.7)
5	8.730 (22.2)	9.086 (23.1)
6	10.470 (26.6)	10.816 (27.5)
7	12.210 (31.0)	12.546 (31.9)
8	13.950 (35.4)	14.276 (36.3)

Printed in USA

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*WIRE TABLE

DC Resistance - ohms/1000 ft

STANDARD CLASS B
ANNEALED COATED COPPER
ANNEALED ALUMINUM

CONDUCTOR SIZE AWG or kcmil	25°C		55°C		90°C	
	CU	AL	CU	AL	CU	AL
14	2.73	-	3.044	-	3.41	-
12	1.72	2.70	1.92	3.024	2.15	3.397
10	1.08	1.70	1.20	1.904	1.35	2.139
9	0.857	1.35	0.96	1.512	1.071	1.698
8	0.679	1.07	0.76	1.198	0.849	1.346
7	0.539	-	0.60	-	0.674	-
6	0.427	0.674	0.476	0.755	0.534	0.848
5	0.339	-	0.378	-	0.424	-
4	0.269	0.424	0.300	0.475	0.336	0.533
3	0.213	-	0.237	-	0.266	-
2	0.169	0.267	0.1884	0.299	0.211	0.336
1	0.134	0.211	0.149	0.236	0.168	0.265
1/0	0.106	0.168	0.118	0.188	0.133	0.211
2/0	0.0843	0.133	0.094	0.149	0.1054	0.167
3/0	0.0668	0.105	0.0745	0.1176	0.0835	0.132
4/0	0.0525	0.0836	0.0585	0.0936	0.0656	0.105
250	0.0449	0.0708	0.05	0.0793	0.056	0.0891
300	0.0374	0.0590	0.0417	0.0661	0.04675	0.0742
350	0.0320	0.0505	0.0357	0.0566	0.04	0.0635
400	0.0278	0.0442	0.031	0.0495	0.0348	0.0556
500	0.0222	0.0354	0.02475	0.0396	0.0278	0.0445
600	0.0187	0.0295	0.02085	0.033	0.0234	0.0371
750	0.0148	0.0236	0.0165	0.0264	0.0185	0.0297
1000	0.0111	0.0177	0.01238	0.0198	0.0139	0.0223

For Other Temperatures:

$$R_T = R_{25}(234.5 + T) \times 0.0038536 \text{ for Copper}$$
$$= R_{25}(228.1 + T) \times 0.003951 \text{ for Aluminum}$$

*Adapted from Okonite Bulletin EHB-81, Engineering Data, Copper and Aluminum Conductor Electrical Cables, Tables 1-3 and 1-4

General Conductor Information
ac/dc Ratios

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To determine effective 60-Hertz ac resistance, multiply dc resistance values corrected for proper temperature, by the ac/dc resistance ratio given below. These apply to the following specific conditions.

Use Columns 1 and 2 for:
(a) Single-conductor non-metallic sheathed cables — in air or non-metallic conduit.
(b) Single-conductor metallic-sheathed cables with sheaths insulated — in air or separate non-metallic conduits.
(c) Multiple-conductor non-metallic sheathed cables — in air or non-metallic conduit.

NOTE: Columns 1 and 2 include skin effect only. For close spacing such as multi-conductor cables or several cables in the same conduit, there will be an additional apparent resistance due to proximity loss.

This varies with spacing (insulation thickness) but for most purposes can be neglected without serious error.

Use Column 3 for:
(a) Multiple-conductor metallic-sheathed cable.
(b) Multiple-conductor non-metallic sheathed cables in metal conduit.
(c) Two or more single-conductor non-metallic sheathed cables in same metallic conduit.

ac/dc resistance ratios for copper and aluminum conductors 60 Hertz (65C)

Table 1-5

Conductor Size AWG or kcmil	1 Standard Conductor		2 Segmental Conductor		3 All Strandings	
	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
Up to 3	1.000	1.000	–	–	1.00	1.00
2 and 1	1.000	1.000	–	–	1.01	1.00
0	1.001	1.000	–	–	1.02	1.00
00	1.001	1.001	–	–	1.03	1.00
000	1.002	1.001	–	–	1.04	1.01
0000	1.004	1.001	–	–	1.05	1.01
250	1.005	1.002	–	–	1.06	1.02
300	1.006	1.003	–	–	1.07	1.02
350	1.009	1.004	–	–	1.08	1.03
400	1.011	1.005	–	–	1.10	1.04
500	1.018	1.007	–	–	1.13	1.06
600	1.025	1.010	–	–	1.16	1.08
700	1.034	1.013	–	–	1.19	1.11
750	1.039	1.015	–	–	1.21	1.12
800	1.044	1.017	–	–	–	1.14
1000	1.067	1.026	1.010	1.005	–	1.19
1250	1.102	1.040	1.018	1.008	–	1.27
1500	1.142	1.058	1.028	1.012	–	–
1750	1.185	1.079	1.038	1.016	–	–
2000	1.233	1.100	1.052	1.020	–	–
2500	1.326	1.142	1.078	1.028	–	–

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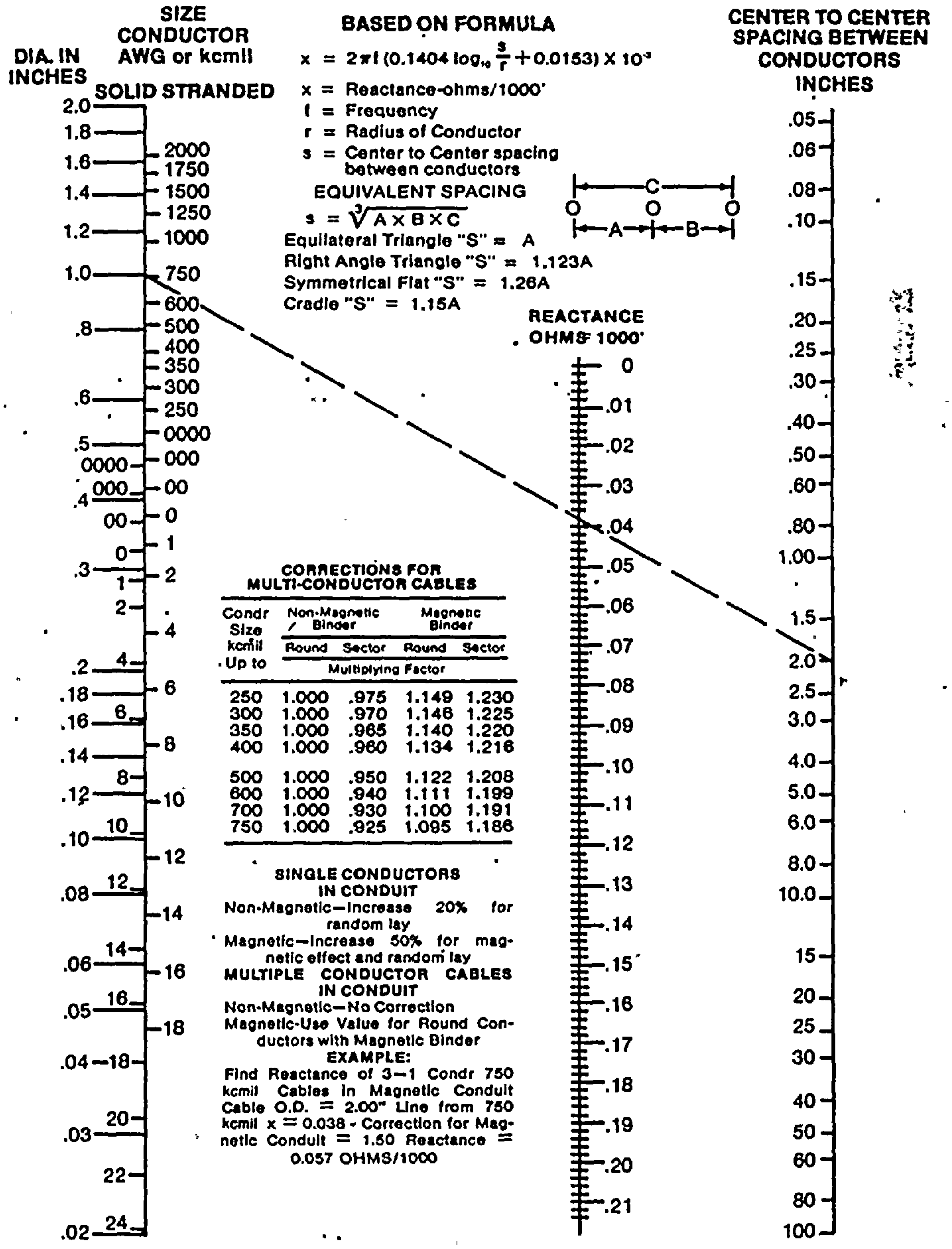
Voltage Regulation

Reactance of conductors at 60 Hz (Series inductive reactance to neutral)

Table 3-1



BASED ON FORMULA

$x = 2\pi f\,(0.1404 \log_{10} \frac{s}{r} + 0.0153) \times 10^{-3}$

x = Reactance-ohms/1000'
f = Frequency
r = Radius of Conductor
s = Center to Center spacing between conductors

EQUIVALENT SPACING

$s = \sqrt[3]{A \times B \times C}$

Equilateral Triangle "S" = A
Right Angle Triangle "S" = 1.123A
Symmetrical Flat "S" = 1.26A
Cradle "S" = 1.15A

CORRECTIONS FOR MULTI-CONDUCTOR CABLES

Condr Size kcmil Up to	Non-Magnetic Binder		Magnetic Binder	
	Round	Sector	Round	Sector
	Multiplying Factor			
250	1.000	.975	1.149	1.230
300	1.000	.970	1.146	1.225
350	1.000	.965	1.140	1.220
400	1.000	.960	1.134	1.216
500	1.000	.950	1.122	1.208
600	1.000	.940	1.111	1.199
700	1.000	.930	1.100	1.191
750	1.000	.925	1.095	1.186

SINGLE CONDUCTORS IN CONDUIT
Non-Magnetic—Increase 20% for random lay
Magnetic—Increase 50% for magnetic effect and random lay

MULTIPLE CONDUCTOR CABLES IN CONDUIT
Non-Magnetic—No Correction
Magnetic-Use Value for Round Conductors with Magnetic Binder

EXAMPLE:
Find Reactance of 3—1 Condr 750 kcmil Cables in Magnetic Conduit Cable O.D. = 2.00" Line from 750 kcmil x = 0.038 - Correction for Magnetic Conduit = 1.50 Reactance = 0.057 OHMS/1000