Attachment 1 to GNRO-2013/00088

JC-Q1P81-90024 Rev. 3 "Division III Degraded Bus Voltage Setpoint"

☐ ANO-1	☐ ANO-2	☒ GGNS	☐ IP-2	☐ IP-3	☐ PLP
☐ JAF	☐ PNPS	☐ RBS	☐ VY	☐ W3	
☐ NP-GGNS-3	☐ NP-RBS-3				

CALCULATION COVER PAGE	(1) **EC #** 39554	(2) **Page 1 of** 75

(3) Design Basis Calc. ☐ YES ☒ NO	(4) ☒ CALCULATION ☐ EC Markup
(5) **Calculation No:** : JC-Q1P81-90024	(6) **Revision:** 003
(7) **Title:** Division III Degraded Bus Voltage Setpoint Validation (T/S 3.3.8.1)	(8) **Editorial** ☐ YES ☒ NO
(9) **System(s):** P81 / E22	(10) **Review Org (Department):** NPE (I&C Design)

(11) **Safety Class:**	(12) **Component/Equipment/Structure Type/Number:**	
☒ **Safety / Quality Related**	1E22S004	1A701-127-2A
☐ **Augmented Quality Program**	1A701-162-1	1A701-127-2B
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REVIEWS

(15) Name/Signature/Date	(16) Name/Signature/Date	(17) Name/Signature/Date
Mary Coffaro / M. Coffaro 11/8/13	Robin Smith / [signature] 11/8/13	/
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☒ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

Revision	Record of Revision
0	Original issue.
1	General Revision
2	Added Reset Point Eval.
3	Extended calibration interval of relays to 24 months + 25%, incorporated results of drift calculations JC-Q1111-09004, JC-Q1111-09005 and JC-Q1111-09022. Updated M&TE for the time delay relay to agree with the current revision of the referenced document. Added Doble F2250 specifications to attachments. Recalculated loop calibration errors based on current revision of JS09. Incorporated new Analytical limits based on the current revision to the referenced documents. Provided recommended lower allowable values for undervoltage voltage trip and time delay based on calculated values and performed LER avoidance check using these values. Added TSTF section 7.0. Updated references and performed general maintenance.

CALCULATION REFERENCE SHEET	CALCULATION NO: JC-Q1P81-90024 REVISION: 003

I. EC Markups Incorporated **NONE**

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. JS09	0	001	☒	☐		
2. E100.0	0	007	☒	☐		
3. 06-EL-1P81-R-0001	--	102	☒	☐		
4. 07-S-12-71	--	006	☒	☐		
5. 07-S-12-83	--	002	☒	☐		
6. 460003606	0	300	☒	☐		
7. SDC10	0	000	☒	☐		
8. A0630	0	012	☒	☐		
9. E0010	0	011	☒	☐		
10. E0121	017	000	☒	☐		
11. E1009	0	009	☒	☐		
12. E1188	017	009	☒	☐		
13. J0501D	0	001	☒	☐		
14. 304A3871	0	000	☒	☐		
15. 945E475	001A	001	☒	☐		
16. 169C9488	001	015	☒	☐		
17. 169C9488	002	015	☒	☐		
18. JC-Q1111-09022	0	000	☒	☐		
19. JC-Q1111-09004	0	000	☒	☐		
20. JC-Q1111-09005	0	000	☒	☐		
21. EC-Q1111-90028	0	006	☒	☐		
22. JC-Q1P81-90027	0	002	☐	☒		
23. MPGE86-0031	--	0	☒	☐		
24. 3758	013	001	☒	☐		
25. 3779	005	001	☒	☐		
26. 3779	004	001	☒	☐		
27. 3779	001	007	☒	☐		
28.			☐	☐		
29.			☐	☐		
30.			☐	☐		
31.			☐	☐		
32.			☐	☐		
33.			☐	☐		

III. CROSS REFERENCES:

1. GGNS Technical Specifications, Section 3.3.8.1
2. Asset Suite Equipment Data Base (EDB)
3. AEIC-EEI-NEMA Standard for Instrument Transformers for Metering Purposes, 15KV and Less (EEI PUB. No. MSJ-11 & NEMA PUB. No. EI 21-1973)
4. ISA RP67.04, Part II, Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation
5. Mathematical Handbook of Formulas and Tables, Murray R. Spiegel, 1968
6. GGNS Technical Requirements Manual, Section TR3.3.8.1
7. SOER 99-01: Loss of Grid
8. IB 7.4.1.7-7 – Instruction Bulletin for ITE Undervoltage Relays

IV. SOFTWARE USED:

Title: N/A Version/Release: ____ Disk/CD No. ____

V. DISK/CDS INCLUDED:

Title: N/A Version/Release ____ Disk/CD No. ____

VI. OTHER CHANGES:

Related references removed from the calculation:
470009582-3, WO00134224, WO00165833, WO00193811, MAI00254979, MAI00280516, 460000936

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1.0 PURPOSE AND DESCRIPTION

1.1 The purpose of this calculation is to validate the Technical Specification Allowable Value and TRM Nominal Trip Setpoint for the 4160 V Division III Degraded Bus Voltage trip function.

1.2 The incoming breakers for the Div. III switchgear are automatically tripped on a degraded bus voltage condition after a time delay. The degraded bus voltage condition is detected by sensors employing a one-out-of-two-twice logic. An undervoltage between 88% and 73% of nominal is considered a 'Degraded Voltage'. (Ref. 2.13)

1.3 The time delay for a bus 'Degraded Voltage' condition is long enough to provide for the preferred power source (offsite power) to recover. This time delay duration is dependent upon the presence (or absence) of a LOCA signal. (Ref. 2.13)

1.4 The upper and lower analytic limits for the Division III degraded voltage setpoints and time delays are derived from the station specific load flow and voltage drop calculation (EC-Q1111-90028), Byron Jackson HPCS Pump Test Curve (#PC 741-S-1404), GE HPCS Motor Time Current Heating Curve (# 455HA550), GE HPCS Motor Efficiency and Power Factor Vs. Load Curves (# 455HA549), NEDO 10905-1, and GE HPCS Motor Outline Dwg. (#992C937CF).

The lower analytic limit for the voltage sensors is based on the capacity to start and operate required Class 1E loads under accident conditions with degraded voltage levels present on the distribution system. Voltage sensing is performed by potential transformers located within the 4160 V switchgear for the division, and each potential transformer has a 4200 V/ 120V ratio. The HPCS system is designed to start and accelerate the HPCS Pump with 75% of 4000 V motor voltage (3000 V), per NEDO 10905-1. In order to continue operation indefinitely at the lower analytic voltage limit, motor heating must be limited to that imposed by curve #455HA550, which equates to rated current of the motor @ 434 A. Per PC 741-S-1404, the maximum power point for the HPCS Pump is less than 3100 Hp. At this operating point, the efficiency is 0.935, and the Power Factor is 0.93, per Curve #455HA549. Therefore, at the maximum power point, with the motor drawing 434 A, the terminal voltage at the motor would be 3538 V. Per EC-Q1111-90028, the voltage drop is very conservatively calculated to be 5.41 V. This places the 4160 V bus at 3543.41 V for a sustained undervoltage condition limit. This correlates to a voltage of 101.24 V on a 120 V basis, and is the lower analytic limit (Reference 2.27).

The upper analytic limit for the voltage sensors is based on prevention of unnecessary separation of the Class 1E buses, under anticipated minimum voltage conditions of the offsite sources. Entergy System Planning Services performed, "Report on the Analysis of Potential for Sustained Degraded Voltage on the Off-Site Electric Grid at the Grand Gulf Nuclear Power Plant", dated November 9, 1990. This report provided the expected grid performance of the GGNS Offsite Sources under severe contingencies. The results of this study determined that the 500 KV switchyard voltage could be as low as 0.994 Per-Unit, and the 115 KV switchyard voltage could be as low as 0.976 Per-Unit.

Calculation EC-Q1111-90028, then conservatively analyzed the Class 1E loads with the 500kV Offsite source at 0.975 Per-Unit and the 115kV Offsite source at 0.9675 Per-Unit. It was determined that the Class 1E system required loads would be adequately supported with 0.975 Per-Unit switchyard voltage available for the 500kV system and 0.9675 Per-Unit for the 115kV system. Therefore, it is appropriate that the upper analytic limit for the degraded voltage setpoint determinations be based on the corresponding voltage available at the respective 4160 V Class 1E buses, with 0.975 Per-Unit 500kV system driving voltage or 0.9675 Per-Unit 115kV system driving voltage in each switchyard, under accident conditions. The lowest available transient voltage on the Division III 4160 V bus under these conditions has been calculated to be 3359.2 V, which occurs during the start of the HPCS pump, with bus voltage recovery to 3880.9 V within 5 seconds. This condition provides an initial terminal voltage at the HPCS pump motor of 3329.25 V, with voltage increasing as the motor accelerates. The second lowest transient voltage step is 3846.34 V, with bus voltage recovery to 3904.16 V, within 5 seconds. This interval is after the HPCS pump motor is already started, therefore the acceleration time of this load is not a factor. All other bus voltage steps are calculated to remain above 3880.9 V. The recovery voltages referenced include the start demand of the next sequence interval, therefore actual recovery voltages at the end of each step following load acceleration and prior to the next sequence would be above these values. Therefore, if the HPCS motor can accelerate its load at the minimum transient voltage within the allowable time delay band, the recovery voltage predicted would form the upper analytic limit for degraded voltage considerations during the sequence when the HPCS pump motor starts. For all successive intervals, using the lowest available bus voltage step will ensure that other equipment sequencing will not inadvertently actuate the Division III bus degraded voltage sensors. As stated above, this correlates to a bus voltage of 3846.34 V. This value would bound all required conditions for the HPCS system to remain connected to offsite power, without prematurely separating from this source, provided that the time delay is set sufficiently to account for HPCS motor start time. Therefore, the overall bounding upper analytic limit is 3846.34 V (109.89 V on a 120 V basis), and the appropriate sensor time delay interval will also be based on this value (Reference 2.27).

Division III has two distinct time delays associated with degraded voltage sensing. One time delay is active when no accident signal is present, and the other is active when a safety injection signal is present for Division III.

The lower analytic limit for the safety injection condition time delay is based on providing the capability to successfully start the HPCS pump at the lower analytic limit of the degraded voltage sensors without segregating from the offsite source. This requires that the time delay be of sufficient duration to allow for acceleration of the

HPCS pump motor under these conditions. Using the previously established minimum HPCS motor starting voltage available from a viable offsite source of 3329.25 V, the acceleration time for the HPCS pump motor has been determined to be no more than 3.28 Seconds. This condition conservatively bounds the acceleration time required at the lower analytic limit bus voltage of 3543.41 V. Therefore, 3.28 seconds is the lower analytic limit for the safety injection condition degraded voltage time delay.

The upper analytic limit for the safety injection condition degraded voltage time delay is derived from the required time response for the HPCS system to achieve necessary injection flow within 27 Seconds of accident initiation. This further requires that the HPCS system be connected to a viable power source within 10 seconds to achieve this goal. The limiting case for this upper limit is when offsite power is available but degraded (i.e, above the Loss of Voltage settings, but below the lower analytic limit for the degraded voltage sensors), with an accident signal present. This is because the degraded voltage function trips the incoming source only, therefore requiring the subsequent sensing and time delay from the Loss of Voltage function to connect the Emergency Diesel Generator (EDG) to the bus. The EDG receives a separate safety injection signal, so the EDG start time and the total voltage sensing sequence described will occur concurrently. This limits the allowed combined sense and actuate times for the degraded voltage and loss of voltage functions to no more than 10 seconds total. It is desirable that the degraded voltage time delay be of a longer duration than the loss of voltage time delay, based on original system design. Therefore, a 6 Second upper analytic limit is allocated to the degraded voltage time delay. Correspondingly, a 4 Second upper analytic bound is thus established for the loss of voltage time delay by this selection.

The design for the Division III Degraded Voltage detection was provided by GE under FDDR JB1-2099. The applicable setpoints were determined by this design document, without providing GGNS with documented basis justification at the time. Subsequently, per GGNS request, GE provided a summary of an evaluation that was performed to justify the nominal 5 minute degraded voltage time delay, no LOCA setpoint (MPGE-86/031). The actual evaluation resides with GE, and was not provided to GGNS. This evaluation was based on nominal setpoint values, with no apparent consideration for uncertainties.

GE did not provide a Design Specification Data Sheet for the Degraded voltage function, possibly due to the unique application, i.e., the function did not meet the conventional "instrument loop" configuration. Because no Design Specification Data Sheet was generated, no definitive Analytic Limit determinations were provided to GGNS.

The appropriate method to determine an upper Analytic Limit for this parameter is to determine a minimum that the bus voltage could degrade to, and evaluate the maximum permissible time that the system could sustain this voltage without causing equipment damage or loss of function due to protective device actuations, such as circuit breaker or thermal protection trips. This is to ensure that the system will maintain the capability to automatically respond to a subsequent LOCA signal, without incurring functional impairment due to the offsite source degradation. While the capability to provide uninterrupted functional capability due to offsite source degradation has been a relevant consideration from original system design, the inherent historical assumption has been to consider the level of degradation that would be expected, and assume a loss of the offsite source completely below that point. This almost certainly formed the basis for the original system settings. During the Electrical Distribution System Functional Inspections performed by the NRC in the early 1990's, certain utilities received questions relating to system performance if the voltage theoretically degraded below this level, but remained above the loss of voltage setpoint. Apparently, the transmission systems for some plants may have been marginally configured such that voltage degradation to sustainable values at the transmission system level could represent an extremely degraded value in the plant Switchyard. This consideration is further discussed as it relates to GGNS.

For GGNS, the existing time delay settings are acceptable, provided that the degraded voltage remains sufficiently high to start the HPCS loads. This correlates to a motor terminal voltage of 75% of the motor base voltage for HPCS system motors. Review of calculation EC-Q1111-90028, has determined that the bounding percent voltage drop from the offsite source to the HPCS pump motor is considerably less than 15%, even under the motor start demand conditions. A 15% drop will be conservatively assumed for this discussion. The HPCS system motors are designed to start with 75% of motor rated voltage. This is 3000 V for the HPCS pump motor. 3000 V is less than 73% of rated bus voltage (4160 V). Therefore, the HPCS pump motor would be expected to start for offsite source degraded voltage conditions down to 88% of rated offsite source voltage (73% + 15% = 88%). The remaining consideration for continued relay timing limitations would be the motor heating limits once the motor has started. Motor heating must be limited to that imposed by curve #455HA550. Per PC 741-S-1404, the maximum power point for the HPCS Pump is less than 3100 Hp. At this operating point, the efficiency is 0.935, and the Power Factor is 0.93, per Curve #455HA549. Therefore, at the maximum power point, with 3000 V available at the motor, the current would be 511.83A (1.18 PU) under these conditions.

Per the motor heating curve, operation at this current level can continue in excess of 600 seconds, which is significantly longer than the present time delay settings require. Thus, the present settings are justified for offsite source degradation levels down to at least 88% of rated.

A discussion of the practical operating limits for the Entergy Transmission system and system generators, provides confirmation of the adequacy of this anticipated degradation level. The Entergy Transmission Planning Guidelines impose the requirement that substation bus voltage capabilities be maintained at no less than 92% of rated, even under severe contingency analysis conditions. In fact, this represents an extreme case for system voltage level degradation limits, because the generation facilities generally are forced to reduce generation (including reactive generation for voltage support) at about 95% of rated voltage, to protect individual generators from thermal damage due to over-excitation. In the case of severe sustained degraded voltage conditions, this would almost certainly lead to load isolation or system voltage collapse. In either case, loss of the offsite source or system voltage recovery to acceptable levels for continued generation would be an expected consequence in very short order. Additionally, GGNS is located within the system such that transmission system voltage levels very closely match generation station Switchyard output voltages. GGNS 500 KV Switchyard nominal voltage is 1.02 PU. Thus any degradation seen in the GGNS Switchyard would also be seen by the supporting generation. Therefore, sustained degraded grid conditions below about 95% would not be expected to occur for GGNS, and System Planning Analyses ensure the capability to maintain at least 92% Substation voltage under severe contingency considerations.

With these considerations, it would be appropriate to select 600 seconds (10 min.) as the upper analytic limit for the Division III Time Delay, No LOCA. For additional conservatism, this limit will be set at 360 seconds (6 min.). This provides adequate time for voltage recovery to above the degraded voltage set-point, while ensuring the continued automatic availability of the system, should a subsequent LOCA signal be received. The lower analytic limit for this parameter should be based on a reasonable period to allow time for recovery. It is to be selected to provide an equivalent margin from the nominal trip setpoint as the margin allowed from the setpoint to the upper analytic limit (i.e. 1 min.). Therefore, the lower analytic limit for the Time Delay, No LOCA is 4 minutes.

1.5 The design consideration for the subject instrumentation is: Degraded Grid Voltage

1.6 This calculation is performed in accordance with the methodology of GGNS-JS-09, which is based on the 'square root sum of the squares' (SRSS) technique for combining statistically independent uncertainty components.

2.0 REFERENCES (* denotes EDMS Relational References)

2.1 GGNS JS09, Methodology for the Generation of Instrument Loop Uncertainty and Setpoint Calculations

2.2 ISA RP67.04, Part II, Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation

2.3 * GGNS E100.0, Environmental Parameters for GGNS

2.4 * GGNS Technical Specifications, Section 3.3.8.1

2.5 * GGNS Technical Requirements Manual, Section TR3.3.8.1

2.6 * 06-EL-1P81-R-0001, Surveillance Procedure

2.7 07-S-12-71, General Maintenance Instruction Time Delay Relays

2.8 07-S-12-83, General Maintenance Instruction Undervoltage Relays

2.9 IB 7.4.1.7-7, Instruction Bulletin for ITE Undervoltage Relays (attached)

2.10 460003606, Instruction Manual for Fluke 45 Multimeter

2.11 Not Used

2.12 AEIC-EEI-NEMA Standard for Instrument Transformers for Metering Purposes, 15KV and Less (EEI PUB. No. MSJ-11 & NEMA PUB. No. EI 21-1973)

2.13 SDC10, System Design Criteria ESF Div. III Power Distribution System

2.14 Mathematical Handbook of Formulas and Tables, Murray R. Spiegel, 1968

2.15 A0630, Control Building Fire Protection Plan

2.16 E0010, Sychronizing Diagram ESF Buses 15AA, 16AB, 17AC

2.17 * E0121-017, Summary of Relay Settings 4.16 KV Bus 17AC & D.G. 13

2.18 E1009, One Line Meter and Relay Diagram Bus 17AC

2.19 E1188-017, HPCS Power Supply Schematic

2.20 J0501D, Control Building Plan at Elev. 111'

2.21 304A3871, Equipment Summary E22-S004

2.22 945E475-001A, Metal Clad Switchgear Assembly

2.23 169C9488-001 and 169C9488-002, Purchase Part Drawing, Time Delay Relay

2.24 JC-Q1111-09022, Drift Calculation For Agastat Time Delay Relays

2.25 JC-Q1111-09004, Drift Calculation For ITE 211T4175 Undervoltage Time Delay Relays (Undervoltage Function)

2.26 JC-Q1111-09005, Drift Calculation For ITE 211T4175 Undervoltage Time Delay Relays (Time Delay Function)

2.27 EC-Q1111-90028, AC Electrical Power System Calculation

2.28 Not Used

2.29 SOER 99-01, Loss of Grid

2.30 MPGE86-0031, High Pressure Core Spray Second Level Under Voltage Protection Time Delay Setpoint Justification

2.31 3758 sheet 013, Performance Curve (PC 741-S-1404)

2.32 3779 sheet 004, Time Current Heating Curve (455HA549)

2.33 3779 sheet 005, Efficiency & Power Factor VS Load Curves (455HA550)

2.34 3779 sheet 001, Outline Induction Motor (992C937CF)

3.0 GIVEN

3.1 Under voltage time delay relays:

3.1.1 Manufacturer / model # - ITE / 211T4175 (Ref. 2.17)

3.1.2 Location: (Ref. 2.15, 2.18, 2.20)

component	room	panel
127-1A	0C210	1E22-S004
127-1B	0C210	1E22-S004
127-2A	0C210	1E22-S004
127-2B	0C210	1E22-S004

3.1.3 Environment: (Ref. 2.3)

Normal & Accident Environment (N-055)

pressure: 0.1 to 1.0 in. wg.

expected temperature: 104°F

temperature range: 58°F to 120°F

relative humidity range: 10% to 60%

radiation: gamma (TID): $1.8 * 10^2$ Rads

3.1.4 Uncertainty Effects – Undervoltage time delay relay (Voltage Setting): (Ref. 2.9)

- Reference Accuracy (RA) ± 0.2% Setting
- Temp. Effect (TE) ± 0.20% Setting
- Humidity Effects (HE) Negligible – Reference Section 4.2
- Radiation Effects (RE) Negligible – Reference Section 4.2
- Power Supply Effects (PS) ± 0.20% Setting
- Seismic Effects (SE) Negligible – Reference Section 4.3
- Static Pressure Effects (SPE) N/A for instrument type
- Overpressure Effects (OVP) N/A for instrument type
- Drift (DR) ± 1.460 VAC for 30 months – Reference 2.25
- Temp. Drift (TD) N/A – Reference Section 4.4

3.1.5 Uncertainty Effects – Undervoltage time delay relay (Time Delay Setting): (Ref. 2.9)

- Reference Accuracy (RA) — ± 10% Setting
- Temp. Effect (TE) — Negligible – Reference Section 4.10
- Humidity Effects (HE) — Negligible – Reference Section 4.2
- Radiation Effects (RE) — Negligible – Reference Section 4.2
- Power Supply Effects (PS) — Negligible – Reference Section 4.10
- Seismic Effects (SE) — Negligible – Reference Section 4.3
- Static Pressure Effects (SPE) — N/A for instrument type
- Overpressure Effects (OVP) — N/A for instrument type
- Drift (DR) — ± 0.327 sec for 30 months – Reference 2.26
- Temp. Drift (TD) — N/A – Reference Section 4.10

3.2 Time delay relays:

3.2.1 Manufacturer / model # - Agastat / ETR14D3N002 (Ref. 2.17)

3.2.2 Location: (Ref. 2.15, 2.17, 2.20)

component	room	panel
162-1	0C210	1E22-S004
162-2	0C210	1E22-S004

3.2.3 Environment: (Ref. 2.3)

Normal & Accident Environment (N-055)

pressure: 0.1 to 1.0 in. wg.

expected temperature: 104°F

temperature range: 58°F to 120°F

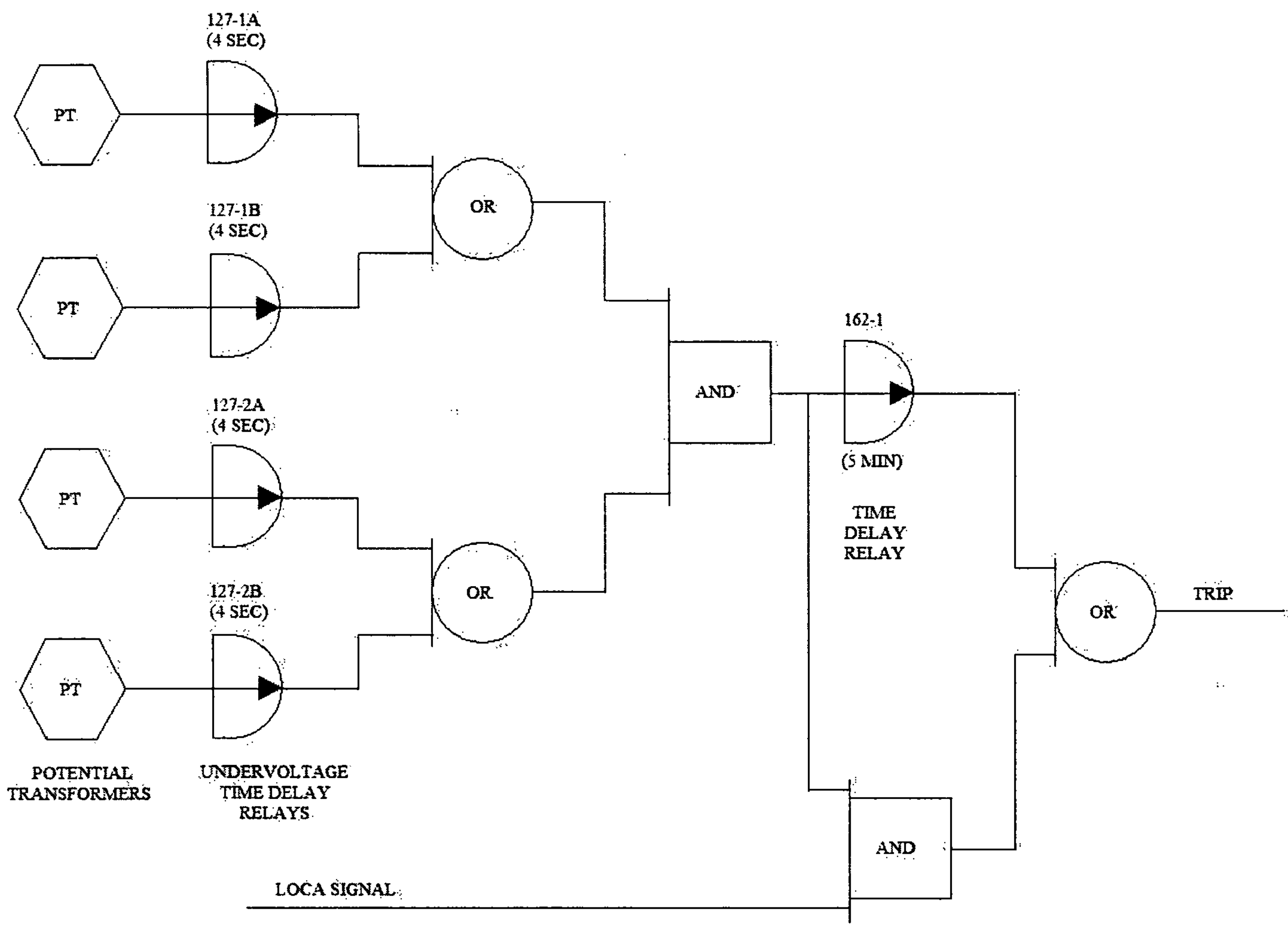
relative humidity range: 10% to 60%

radiation: gamma (TID): $1.8 * 10^2$ Rads

3.2.4 Uncertainty Effects – Time Delay Relay: (Ref. 2.23)

- Reference Accuracy (RA) ± 5.0% Time Delay Setting
- Temp. Effect (TE) Negligible – Reference Section 4.8
- Humidity Effects (HE) Negligible – Reference Section 4.2
- Radiation Effects (RE) Negligible – Reference Section 4.2
- Power Supply Effects (PS) Negligible – Reference Section 4.9
- Seismic Effects (SE) Negligible – Reference Section 4.3
- Static Pressure Effects (SPE) N/A for instrument type
- Overpressure Effects (OVP) N/A for instrument type
- Drift (DR) ± 26.725 sec for 30 months – Reference 2.24
- Temp. Drift (TD) Negligible – Reference Section 4.8

3.3 Typical Loop Block Diagram: (Ref. 2.19)



3.4 Operating Limits (Ref. 2.4, 2.5, Section 1.4)

Voltage Trip

Upper Analytic Limit: 3846.34 V (109.89 V)

Upper Allowable Value: ≤ 3763.5 V (≤ 107.53 V)

Plant Setpoint: 3661 V (104.6 V)

Lower Allowable Value*: ≥ 3605.0 V (≥ 103.00 V)

Lower Analytic Limit: 3543.41 V (101.24 V)

Time Delay – LOCA

Upper Analytic Limit: 6 seconds

Upper Allowable Value: ≤ 4.4 seconds

Plant Setpoint: 4 seconds

Lower Allowable Value*: ≥ 3.85 seconds

Lower Analytic Limit: 3.28 seconds

Time Delay – No LOCA

Upper Analytic Limit: 6.0 minutes

Upper Allowable Value: ≤ 5.5 minutes

Plant Setpoint: 5 minutes

Lower Allowable Value: ≥ 4.5 minutes

Lower Analytic Limit: 4.0 minutes

*Recommended Values

4.0 ASSUMPTIONS

4.1 Assume all uncertainties given are to two standard deviations (2σ) unless otherwise specified.

4.2 Assume Radiation Effects (RE) and Humidity Effects (HE) for the undervoltage and time delay relays are negligible. These components are located in a mild environment. (Ref. Section 3.1.3 and 3.2.3)

4.3 Assume Seismic Effects (SE) are negligible for both the undervoltage and time delay relays. The relays are seismically qualified per GGNS QP 425.00 Vol. 1, Rev. 1.

4.4 Assume Temperature Drift (TD) is encompassed by the Temperature Effect (TE) for the undervoltage relays.

4.5 Insulation Resistance Effects (IR) are assumed to be negligible since the loop cabling is located in a mild environment (control building).

4.6 Not Used.

4.7 Per Reference 2.21 and 2.22, the potential transformers at the bus are G.E. type JVM-3. This type of potential transformer has an accuracy class of 0.3 at W and X burdens when operated at 58% of rated voltage. Based on the available burden information for the circuit components depicted on Ref. 2.16 and 2.18, the burden is assumed to be less than X and the accuracy of the potential transformers is assumed to be 0.3. (See file documentation for available circuit component burden data)

4.8 Assume Temperature Effects (TE) and Temperature Drift Effect (TD) for the time delay relays are negligible. The normal ambient temperature at the relays is within the vendor specified normal ambient temperature (Ref. 2.23).

4.9 Assume Power Supply Effects (PS) for the time delay relays are negligible. The supply voltage variation is expected to be encompassed by the voltage variation margin available (±10% of rated voltage, Ref. 2.23).

4.10 The vendor does not specify a Temperature Effect, Temperature Drift or Power Supply Effect for the undervoltage relay timing function. These effects will be assumed to be negligible.

5.0 DEVICE UNCERTAINTIES – A_X (Ref. 2.1)

$$A_X = \pm\sqrt{(RA_X)^2 + (TE_X)^2 + (HE_X)^2 + (SE_X)^2 + (RE_X)^2 + (PS_X)^2 + (SPE_X)^2 + (OVP_X)^2}$$

5.1 Undervoltage Relay Uncertainties – Voltage Trip: (Ref. Section 3.1.4)

Reference Accuracy – "RA"

$$RA_V = \pm\ 0.20\%\ of\ setting$$

$$RA_V = \pm\left(\frac{0.20}{100}(104.6)\right)V$$

$$RA_V = \pm\ 0.21\ V$$

Temperature Effects – "TE"

$$TE_V = \pm\ 0.20\%\ of\ setting$$

$$TE_V = \pm\left(\frac{0.20}{100}(104.6)\right)V$$

$$TE_V = \pm\ 0.21\ V$$

Humidity Effects – "HE"

Negligible – Reference Section 4.2

Radiation Effects – "RE"

Negligible – Reference Section 4.2

Power Supply Effects – "PS"

$$PS_V = \pm\ 0.20\%\ of\ setting$$

$$PS_V = \pm\left(\frac{0.20}{100}(104.6)\right)V$$

$$PS_V = \pm\ 0.21\ V$$

SSE Effects – "SE"

Negligible – Ref. Section 4.3

Static Pressure Effects – "SPE"

N/A for instrument type

Over Pressure Effects – "OVP"

N/A for instrument type

Total Undervoltage Relay Uncertainty (Voltage Trip) – A_V:

$$A_V = \pm\sqrt{(RA_V)^2 + (TE_V)^2 + (HE_V)^2 + (SE_V)^2 + (RE_V)^2 + (PS_V)^2 + (SPE_V)^2 + (OVP_V)^2}$$

$$A_V = \pm\sqrt{(0.21)^2 + (0.21)^2 + (0)^2 + (0)^2 + (0)^2 + (0.21)^2 + (0)^2 + (0)^2}$$

$$A_V = \pm 0.36\ V$$

5.2 Undervoltage Relay Uncertainties – Time Delay: (Ref. Section 3.1.5)

Reference Accuracy – "RA"

$$RA_T = \pm\ 10\%\ setting$$

$$RA_T = \pm \left(\frac{10}{100}(4)\right)\ \text{sec}$$

$$RA_T = \pm\ 0.40\ seconds$$

Temperature Effects – "TE"

Negligible – Reference Section 4.10

Humidity Effects – "HE"

Negligible – Reference Section 4.2

Radiation Effects – "RE"

Negligible – Reference Section 4.2

Power Supply Effects – "PS"

Negligible – Reference Section 4.10

SSE Effects – "SE"

Negligible – Reference Section 4.3

Static Pressure Effects – "SPE"

N/A for instrument type

Over Pressure Effects – "OVP"

N/A for instrument type

Total Undervoltage Relay Uncertainty (Time Delay) – A_T:

$$A_T = \pm\sqrt{(RA_T)^2 + (TE_T)^2 + (HE_T)^2 + (SE_T)^2 + (RE_T)^2 + (PS_T)^2 + (SPE_T)^2 + (OVP_T)^2}$$

$$A_T = \pm\sqrt{(RA_T)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2}$$

$$A_T = RA_T = \pm 0.40 \textit{ Seconds}$$

5.3 Time Delay Relay Uncertainties: (Ref. Section 3.2.4)

Reference Accuracy – "RA"

$$RA_{TD} = \pm\ 5\% \textit{ setting}$$

$$RA_{TD} = \pm \left(\frac{5}{100}(300)\right) \text{ sec}$$

$$RA_{TD} = \pm\ 15.00 \textit{ seconds}$$

Temperature Effects – "TE"

Negligible – Reference Section 4.8

Humidity Effects – "HE"

Negligible – Reference Section 4.2

Radiation Effects – "RE"

Negligible – Reference Section 4.2

Power Supply Effects – "PS"

Negligible – Reference Section 4.9

SSE Effects – "SE"

Negligible – Reference Section 4.3

Static Pressure Effects – "SPE"

N/A for instrument type

Over Pressure Effects – "OVP"

N/A for instrument type

Total Time Delay Relay Uncertainty – A_{TD}:

$$A_{TD} = \pm\sqrt{(RA_{TD})^2 + (TE_{TD})^2 + (HE_{TD})^2 + (SE_{TD})^2 + (RE_{TD})^2 + (PS_{TD})^2 + (SPE_{TD})^2 + (OVP_{TD})^2}$$

$$A_{TD} = \pm\sqrt{(RA_{TD})^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2}$$

$$A_{TD} = RA_{TD} = \pm 15.00\ Seconds$$

6.0 LOOP UNCERTAINTIES (Ref. 2.1)

6.1 SRSS of all individual device uncertainties – "A_L" (Ref. 2.1)

Loop Device Uncertainty (Voltage Trip):

$$A_{LV} = \pm\sqrt{(A_V)^2} = \pm A_V = \pm 0.36\ V$$

Loop Device Uncertainty (Time Delay – LOCA):

$$A_{LT1} = \pm\sqrt{(A_T)^2} = \pm A_T = \pm 0.40\ seconds$$

Loop Device Uncertainty (Time Delay – No LOCA):

$$A_{LT2} = \pm\sqrt{(A_T)^2 + (A_{TD})^2}$$

$$A_{LT2} = \pm\sqrt{(0.40)^2 + (15.00)^2} = \pm 15.01\ seconds$$

6.2 SRSS of all Measurement & Test Equipment Effects – "C_L" (Ref. 2.1)

Per Reference 2.8, a Fluke 45 Digital Voltmeter (or Fluke 8600A) is used to monitor the trip point of the undervoltage relays during calibration. The uncertainty data for a Fluke 45, taken from Ref. 2.10, will be used to estimate the M&TE effects. The reference accuracy of the Fluke 45 is:

$$RA_{F45} = \pm(0.2\%\ reading + 0.1\ V)$$

The reference accuracy above is for the 0-300V scale, medium resolution. This value is valid for ambient temperatures between 18°C and 28°C (64.4°F to 82.4°F). Since the expected temperature at calibration (104°F, i.e. 40°C) is outside the given range, a temperature correction factor from Ref. 2.10 must be applied. This correction factor is stated as: '<0.1 times the applicable accuracy specification per degree C for 0°C to 18°C and 28°C to 50°C (32° to 64.4° and 82.4° to 122°F). The temperature correction factor for this application is <0.1 (40-28) or 1.2.

The 'reading' will be assumed to be 104.6 V, the nominal trip setpoint.

$$RA_{F45} = \pm 1.2 * ((0.2*104.6/100) + 0.1)\ V = \pm 0.371\ V$$

The setting tolerance from reference 2.6 is ±1.50 V. As the setting tolerance is larger than the reference accuracy of the undervoltage relay (±0.21 V) and the test equipment error, ±1.50 V will be assumed for the M&TE error.

$$C_{LV} = \pm 1.50\ V$$

Per Reference 2.8, a Doble F2253 test set is used to measure the time delay for the undervoltage relays during calibration. Per Attachment 3, the timing accuracy of the F2253 is 0.0039% of reading. The 'reading' will be assumed to be 4 sec., the nominal setpoint.

$$RA_{TF2253} = \pm 0.0039*4/100 = \pm 0.000156\ V$$

The setting tolerance from reference 2.6 is ±0.2 seconds. As the reference accuracy of the undervoltage relay (±0.4 seconds) is larger than the setting tolerance and the test equipment error, ±0.4 seconds will be assumed for the M&TE error.

Therefore, the Loop Uncertainty for the time delay function with a LOCA signal present is:

$$C_{LT1} = \pm 0.4\ seconds$$

Per Reference 2.7, a Doble F2253 test set is used to measure the time delay for the time delay relays during calibration. Per Attachment 3, the timing accuracy of the F2253 is 0039% of reading. The 'reading' will be assumed to be 300 sec., the nominal setpoint.

$$RA_{TD_{F2253}} = \pm \frac{.0039}{100}(300) = \pm 0.0117\ seconds$$

The setting tolerance from reference 2.6 is ±15 seconds. As the setting tolerance and reference accuracy of the time delay relay (±15 seconds) is larger than the test equipment error, ±15 seconds will be assumed for the M&TE error.

Therefore, the Loop Uncertainty for the time delay function with no LOCA signal present is:

$$C_{LT2} = \pm SRSS\ (0.4,\ 15) \approx \pm 15.0\ seconds$$

6.3 SRSS of all individual device drifts – "D_L" (Ref. 2.1)

Undervoltage Relay Drift – DR_V

$DR_V = \pm$ 1.460 VAC for 30 months

Undervoltage Relay Temperature Drift – TD_V

Negligible – Reference Section 4.4

Undervoltage Relay Time Delay Drift – DR_T

$DR_T = \pm$ 0.327 sec for 30 months

Undervoltage Relay Time Delay Temperature Drift – TD_T

Negligible – Reference Section 4.10

Time Delay Relay Drift – DR_{TD}

$DR_{TD} = \pm$ 26.725 sec for 30 months

Time Delay Relay Temperature Drift – TD_{TD}

Negligible – Reference Section 4.8

Loop Drift (Voltage Trip):

$$D_{LV} = \pm\sqrt{(DR_V)^2 + (TD_V)^2}$$

$$D_{LV} = \pm\sqrt{(1.460)^2 + (0)^2}$$

$$D_{LV} = \pm 1.460\ V$$

Loop Drift (Time Delay – LOCA):

$$D_{LT1} = \pm\sqrt{(DR_T)^2 + (TD_T)^2}$$

$$D_{LT1} = \pm\sqrt{(0.327^2 + (0)^2}$$

$$D_{LT1} = \pm 0.327\ seconds$$

Loop Drift (Time Delay – No LOCA):

$$D_{LT2} = \pm\sqrt{(DR_T)^2 + (TD_T)^2 + (DR_{TD})^2 + (TD_{TD})^2}$$

$$D_{LT2} = \pm\sqrt{(0.327)^2 + (0)^2 + (26.725)^2 + (0)^2}$$

$$D_{LT2} = \pm 26.728 \text{ seconds}$$

6.4 Process Measurement Uncertainty – "PM"

No process measurement uncertainty is applicable to either the voltage or time delay setpoints.

6.5 Primary Element Uncertainty – "PE"

The primary elements for each loop are the potential transformers at the bus. Per Section 4.7, the accuracy class of the potential transformers is 0.3. Per Reference 2.12, the limits of transformer correction factor for a 0.3 accuracy class potential transformer are 1.003 to 0.997 (i.e. ±0.3%). Again assuming 104.6 V nominal output, the potential transformer uncertainty is:

$$PE = \pm\left(\frac{0.3}{100}(104.6)\right)V$$

$$PE = \pm\, 0.314\ V$$

No Primary Element Uncertainty is applicable to the time delay.

6.6 Insulation Resistance Effects – "IR"

Insulation Resistance Effect for the voltage trip function is assumed to be negligible (Reference Section 4.5). IR effects are not applicable to the time delay function.

6.7 Loop Uncertainty – Voltage Trip

$$LU_V = \pm\sqrt{(A_{LV})^2 + (C_{LV})^2 + (PM_V)^2 + (PE_V)^2 + (IR_V)^2}$$

$$LU_V = \pm\, SRSS\,(0.36,\ 1.5,\ 0,\ 0.314,\ 0)$$

$$LU_V = \pm\, 1.58\ V$$

6.8 Total Loop Uncertainty – Voltage Trip

$$TLU_V = LU_V + D_{LV}$$

$$TLU_V = \pm (1.58 + 1.460)\ V$$

$$TLU_V = \pm 3.04\ V$$

6.9 Loop Uncertainty – Time Delay (LOCA)

$$LU_{T1} = \pm\sqrt{(A_{LT1})^2 + (C_{LT1})^2 + (PM_T)^2 + (PE_T)^2 + (IR_T)^2}$$

$$LU_{T1} = \pm\ SRSS\ (0.40,\ 0.40,\ 0,\ 0,\ 0)$$

$$LU_{T1} = \pm\ 0.57\ seconds$$

6.10 Loop Uncertainty – Time Delay (No LOCA)

$$LU_{T2} = \pm\sqrt{(A_{LT2})^2 + (C_{LT2})^2 + (PM_T)^2 + (PE_T)^2 + (IR_T)^2}$$

$$LU_{T2} = \pm\ SRSS\ (15.01,\ 15.00,\ 0,\ 0,\ 0)$$

$$LU_{T2} = \pm 21.22\ seconds$$

6.11 Total Loop Uncertainty – Time Delay (LOCA)

$$TLU_{T1} = LU_{T1} + D_{LT1}$$

$$TLU_{T1} = (0.57 + 0.327)\ seconds$$

$$TLU_{T1} = \pm 0.90\ seconds$$

6.12 Total Loop Uncertainty – Time Delay (No LOCA)

$$TLU_{T2} = LU_{T2} + D_{LT2}$$

$$TLU_{T2} = (21.22 + 26.728)\ seconds$$

$$TLU_{T2} = \pm 47.95\ seconds$$

6.13 Allowable Values – Voltage Trip

Lower Allowable Value = Lower Analytic Limit + LU

Lower Allowable Value = 101.24 V + 1.58 V

Lower Allowable Value = 102.82 V

Upper Allowable Value = Upper Analytic Limit – LU

Upper Allowable Value = 109.89 V – 1.58 V

Upper Allowable Value = 108.31 V

6.14 Nominal Trip Setpoint – Voltage Trip

NTSP: ≥ (Lower Analytic Limit + TLU) & ≤ (Upper Analytic Limit – TLU)

NTSP: ≥ (101.24 V + 3.04 V) & ≤ (109.89 V – 3.04 V)

NTSP: ≥ 104.28 V & ≤ 106.85 V

6.15 Allowable Values – Time Delay (LOCA)

Lower Allowable Value = Lower Analytic Limit + LU

Lower Allowable Value = 3.28 seconds + 0.57 seconds

Lower Allowable Value = 3.85 seconds

Upper Allowable Value = Upper Analytic Limit – LU

Upper Allowable Value = 6.00 seconds – 0.57 seconds

Upper Allowable Value = 5.43 seconds

6.16 Allowable Values – Time Delay (No LOCA)

Lower Allowable Value = Lower Analytic Limit + LU

Lower Allowable Value = 240 seconds + 21.22 seconds

Lower Allowable Value = 261.22 seconds (4.36 min)

Upper Allowable Value = Upper Analytic Limit – LU

Upper Allowable Value = 360 seconds – 21.22 seconds

Upper Allowable Value = 338.78 seconds (5.64 min)

6.17 Nominal Trip Setpoint – Time Delay (LOCA)

NTSP: ≥ (Lower Analytic Limit + TLU) & ≤ (Upper Analytic Limit – TLU)

NTSP: ≥ (3.28 seconds + 0.90 seconds) & ≤ (6.00 seconds – 0.90 seconds)

NTSP: ≥ 4.18 seconds & ≤ 5.10 seconds

As shown above, the calculated Total Loop Uncertainty yields a setpoint range that will not support the existing plant setpoint (4 sec). Calculation margin will be removed by re-calculating the Total Loop Uncertainty using margin reduction techniques as described in Ref. 2.1.

The reduced margin Total Loop Uncertainty is given by:

$$TLU_{T1} = \pm\sqrt{(LU_{T1})^2 + (D_{L_{T1}})^2}$$

$$TLU_{T1} = \pm SRSS\ (0.57,\ 0.327)$$

$$TLU_{T1} = \pm 0.66\ seconds$$

The reduced margin Nominal Trip Setpoint range is therefore:

NTSP: ≥ (Lower Analytic Limit + TLU) & ≤ (Upper Analytic Limit – TLU)

NTSP: ≥ (3.28 seconds + 0.66 seconds) & ≤ (6.00 seconds – 0.66 seconds)

NTSP: ≥ 3.94 seconds & ≤ 5.34 seconds

6.18 Nominal Trip Setpoint – Time Delay (No LOCA)

NTSP: ≥ (Lower Analytic Limit + TLU) & ≤ (Upper Analytic Limit – TLU)

NTSP: ≥ (240 seconds + 47.95 seconds) & ≤ (360 seconds – 47.95 seconds)

NTSP: ≥ 287.95 seconds & ≤ 312.05 seconds

NTSP: ≥ 4.80 minutes & ≤ 5.20 minutes

6.19 LER Avoidance Analysis – Voltage Trip

LER Avoidance probability is based on a number "Z" calculated as shown below. If the value of Z is ≥ 1.28 then the probability of avoiding an LER is ≥ 90%, the acceptance criteria (Ref. 2.1). The LER Avoidance Analysis will be performed using the Lower Allowable Value.

$$Z = \frac{|AV - NTSP|}{\sigma_1}$$

Where:

AV = 103.0 volts (Recommended Value)
NTSP = 104.6 volts
σ_1 – Calculated as shown below

With:

n = # of standard deviations used in specifying the individual uncertainty components

$$\sigma_1 = \frac{1}{n}\sqrt{(A_{LV})^2 + (C_{LV})^2 + (D_{LV})^2}$$

$$\sigma_l = 0.5*(SRSS(0.36,\ 1.5,\ 1.460))$$

$$\sigma_l = 1.07\ V$$

Therefore:

$$Z = \frac{|103 - 104.6|}{1.07}$$

$$Z = 1.49$$

From common statistical tables (Ref. 2.14), this value of Z yields an LER avoidance probability greater than 90%.

6.20 LER Avoidance Analysis – Time Delay (LOCA)

The margin between the recommended lower allowable value and the nominal trip setpoint is less than the margin between the upper allowable value and nominal setpoint and will provide the least LER avoidance. Therefore the LER avoidance probability will be determined using the lower allowable value.

$$Z = \frac{|AV - NTSP|}{\sigma_1}$$

Where:

AV = 3.85 seconds (Recommended)
NTSP = 4.0 seconds
σ_l – Calculated as shown below

With:

n = # of standard deviations used in specifying the individual uncertainty components

$$\sigma_1 = \frac{1}{n}\sqrt{(A_{LT})^2 + (C_{LT})^2 + (D_{LT})^2}$$

$$\sigma_l = 0.5*(SRSS(0.40,\ 0.40,\ 0.327))$$

$$\sigma_l = 0.33\ seconds$$

Therefore:

$$Z = \frac{|3.85 - 4.0|}{0.33}$$

$$Z = 0.45$$

From common statistical tables (Ref. 2.14), this value of Z yields an LER avoidance probability less than 90%.

6.21 LER Avoidance Analysis – Time Delay (No LOCA)

Using the equations from section 6.20 and the values derived for the Time Delay No LOCA:

$$Z = \frac{|360 - 300|}{0.5*(SRSS(15.01, 15.0, 26.728, 0, 0))}$$

$$Z = 3.51$$

From common statistical tables (Ref. 2.14), this value of Z yields a LER avoidance probability greater than 95%.

6.22 Spurious Trip Avoidance Analysis – Voltage Trip

The most severe recoverable voltage transient postulated, is that of clearing a nearby transmission system or in-plant distribution system bolted fault. The bus voltage level during such an event could dip below the voltage trip setting and begin the relay timing. Therefore, no spurious trip avoidance analysis will be performed for the voltage trip setting. Spurious segregation from the off-site source is prevented by the time delay function.

6.23 Spurious Trip Avoidance Analysis – Time Delay LOCA

The probability of avoiding spurious trips is determined by calculating a value "Z" as shown below. If the value of Z is ≥ 1.645, the probability of avoiding a spurious trip is ≥ 95%. (Ref. 2.1)

$$Z = \frac{|NTSP - X_T|}{\sqrt{(\sigma_n)^2 + (\sigma_i)^2}}$$

Where:

NTSP – Nominal Trip Setpoint

X_T – Limiting Operating Transient Variation

$X_T = X_0 - T - T_c$, if the process variable decreases to the Analytic Limit

X_0 = maximum or minimum steady state operating value
T = magnitude of the limiting transient variation
T_c = modeling bias or uncertainty

σ_n – The standard deviation associated with the limiting operating transient, typically zero when the limiting operating transient is based on existing documented operating restrictions.

σ_i – The standard deviation associated with the loop uncertainty, calculated as shown below:

$$\sigma_i = \frac{1}{n}\sqrt{(A_{LT1})^2 + (C_{LT1})^2 + (D_{LT1})^2 + (PM_T)^2 + (PE_T)^2}$$

The most severe recoverable voltage transient postulated, is that of clearing a nearby transmission system or in-plant distribution system bolted fault. The maximum fault clearing time consideration for the applicable fault level circuit breakers would be 6 cycles. It is also prudent to assume an additional 10 cycles to allow for voltage recovery post-fault. This correlates to 0.267 seconds (16 cycles * 0.0167 seconds/cycle = 0.267 seconds).

$$Z = \frac{|4.0 - 0.267|}{0.5*(SRSS(0.40, 0.40, 0.327, 0, 0))}$$

$$Z = 11.42$$

From common statistical tables (Ref. 2.14), this value of Z yields a spurious trip avoidance probability greater than 95%.

6.24 Spurious Trip Avoidance Analysis – Time Delay (No LOCA)

Using the equations from section 6.23 and the values derived for the Time Delay No LOCA:

$$Z = \frac{|300 - 0.267|}{0.5*(SRSS(15.01, 15.0, 26.728, 0, 0))}$$

$$Z = 17.56$$

From common statistical tables (Ref. 2.14), this value of Z yields a spurious trip avoidance probability greater than 95%.

6.25 Reset Point Evaluation

The pickup (reset) point of the undervoltage relays should be such that under the worst case transient conditions the bus is not spuriously segregated from the off site source.

As stated previously, with 0.975 Per-Unit switchyard driving voltage, the lowest transient voltage on the Division III 4160V bus has been calculated to be 3359.2V (95.80V on a 120V basis) which occurs during the start of the HPCS pump, with voltage recovery to 3880.9 V (110.88V on a 120V basis). This condition provides an initial terminal voltage at the HPCS pump motor of 3329.25 V. Assuming a constant terminal voltage of 3329.25 V (i.e. no voltage recovery as the motor accelerates) the acceleration time of the HPCS pump motor has been determined to be no more than 3.28 seconds. Therefore, the actual recovery time to at least 3880.9 V would be no more than 3.28 seconds (the Lower Analytic Limit of the time delay setting).

The present pickup (reset) point for the under voltage relays is 105.65 V and the dropout (trip) point is established by the 99% tap setting at 104.60V. Assuming worst case performance of the relays, the trip could occur at the Upper Allowable Value of 107.53 V and the reset could occur at 108.60 V (i.e. 1.01 x 107.53).

Given the above, the bus voltage would recover above the reset point of the relay 108.60 V (3801 V) to at least 110.88 V (3880.9 V) before the time delay times out (even with the worst case performance from the time delay). Therefore, the reset value will prevent spurious segregation from the preferred off site source and is acceptable.

7.0 TSTF CALCULATIONS (Ref. 2.1)

7.1 As-Left Tolerance

ALT_V – Undervoltage Relay (Voltage Trip) TSTF-493 Calculation

$$ALT_V = RA_V = \pm 0.21 \text{ V}$$

ALT_T – Undervoltage Relay (Time Delay) TSTF-493 Calculation

$$ALT_T = RA_T = \pm 0.40 \text{ seconds}$$

ALT_{TD} – Time Delay Relay TSTF-493 Calculation

$$ALT_{TD} = RA_{TD} = \pm 15.0 \text{ seconds}$$

7.2 As-Found Tolerance (AFT)

The drift values used in this calculation were derived by statistical analysis, therefore per Reference 2.1:

$AFT = \pm DR$

AFT_V – Undervoltage Relay (Voltage Trip) TSTF-493 Calculation

$$\begin{aligned} DR_V &= \pm 1.460 \text{ V for 30 months} \\ AFT_V &= DR_V \\ &= \pm 1.460 \text{ V} \end{aligned}$$

AFT_T – Undervoltage Relay (Time Delay) TSTF-493 Calculation

$$\begin{aligned} DR_T &= \pm 0.327 \text{ seconds for 30 months} \\ AFT_T &= DR_T \\ &= \pm 0.327 \text{ seconds} \end{aligned}$$

AFT_{TD} – Time Delay Relay TSTF-493 Calculation

$$\begin{aligned} DR_{TD} &= \pm 26.725 \text{ seconds for 30 months} \\ AFT_{TD} &= DR_{TD} \\ &= \pm 26.725 \text{ seconds} \end{aligned}$$

7.3 Loop Tolerances

ALT_{LV} – As-Left Loop Tolerance Undervoltage Relay (Voltage Trip)

$$\begin{aligned} ALT_{LV} &= \pm \text{SRSS}(ALT_V) \\ &= \pm \text{SRSS}(0.21) \\ &= \pm 0.21 \text{ V} \end{aligned}$$

ALT_{LT} – As-Left Loop Tolerance Undervoltage Relay (Time Delay) - LOCA

$$\begin{aligned} ALT_{LT} &= \pm \text{SRSS}(ALT_T) \\ &= \pm \text{SRSS}(0.40) \\ &= \pm 0.40 \text{ seconds} \end{aligned}$$

ALT_{LTD} – As-Left Loop Tolerance Time Delay Relay – No LOCA

$$\begin{aligned} ALT_{LTD} &= \pm \text{SRSS}(ALT_T, ALT_{TD}) \\ &= \pm \text{SRSS}(0.40, 15.0) \\ &= \pm 15.0 \text{ seconds} \end{aligned}$$

AFT_{LV} – As-Found Loop Tolerance Undervoltage Relay (Voltage Trip)

$$\begin{aligned} AFT_{LV} &= \pm \text{SRSS}(AFT_V) \\ &= \pm \text{SRSS}(1.460) \\ &= \pm 1.460 \text{ V} \end{aligned}$$

AFT_{LT} – As-Found Loop Tolerance Undervoltage Relay (Time Delay) - LOCA

$$
\begin{aligned}
AFT_{LT} &= \pm \text{SRSS}(AFT_T) \\
&= \pm \text{SRSS}(0.327) \text{ seconds} \\
&= \pm 0.327 \text{ seconds}
\end{aligned}
$$

AFT_{LTD} – As-Found Loop Tolerance Time Delay Relay – No LOCA

$$
\begin{aligned}
AFT_{LTD} &= \pm \text{SRSS}(AFT_T, AFT_{TD}) \\
&= \pm \text{SRSS}(0.327, 26.725) \text{ seconds} \\
&= \pm 26.727 \text{ seconds}
\end{aligned}
$$

8.0 CONCLUSION

Voltage Trip:

The calculated setpoint range and the Upper Allowable Value are conservative with respect to the existing plant settings. The existing Lower Allowable Value (101.67 V) is non-conservative with respect to the calculated value.

Time Delay – LOCA

The initial calculated setpoint range would not support the existing LOCA Time Delay setpoint. Margin reduction techniques were used to remove some conservatism from the calculated values. With the reduced uncertainty, the existing plant setpoint was shown to be acceptable. The existing Allowable Value (3.6 seconds) is non-conservative with respect to the calculated Lower Allowable Value for the LOCA Time Delay. .

Time Delay – No LOCA

The calculated setpoint and allowable values are conservative with respect to the existing plant setpoints and allowable values. Therefore, the existing plant setpoint is acceptable.

The spurious trip and LER avoidance criterion is met for all values except the time delay lower allowable value. LER avoidance is not met using the recommended lower allowable value.

SUMMARY OF RESULTS – Voltage Trip	
SYSTEM	P81 – HPCS Diesel Generator (Electrical)
LOOP NUMBERS	127-1A/B, 127-2A/B
TOTAL LOOP UNCERTAINTY	± 3.04 V
LOOP UNCERTAINTY	±1.58 V
LOOP DRIFT	± 1.460 V
LOOP CALIBRATION UNCERTAINTY	± 1.50 V

	EXISTING	CALCULATED
Upper Analytic Limit	109.89 V	**************
Upper Allowable Value	≤ 107.53 V	≤ 108.31 V
Nominal Trip Setpoint	104.60 V	≥104.28 V and ≤106.85 V
Lower Allowable Value	≥ 103.00 V*	≥ 102.82 V
Lower Analytic Limit	101.24 V	**************

- Recommended Lower Allowable Value

SUMMARY OF RESULTS – Time Delay (LOCA)	
SYSTEM	P81 – HPCS Diesel Generator (Electrical)
LOOP NUMBERS	127-1A/B, 127-2A/B
TOTAL LOOP UNCERTAINTY	± 0.90 seconds (±0.66 sec. reduced margin)
LOOP UNCERTAINTY	± 0.57 seconds
LOOP DRIFT	± 0.327 seconds
LOOP CALIBRATION UNCERTAINTY	± 0.40 seconds

	EXISTING	CALCULATED
Upper Analytic Limit	6 sec	**************
Upper Allowable Value	≤4.4 sec	≤ 5.43 sec
Nominal Trip Setpoint	4.0 sec	≥3.94 sec and ≤5.34 sec
Lower Allowable Value	≥3.85 sec*	≥ 3.85 sec
Lower Analytic Limit	3.28 sec	**************

- Recommended Lower Allowable Value

SUMMARY OF RESULTS – Time Delay (No LOCA)	
SYSTEM	P81 – HPCS Diesel Generator (Electrical)
LOOP NUMBERS	127-1A/B, 127-2A/B, 162-1/2
TOTAL LOOP UNCERTAINTY	± 47.95 seconds
LOOP UNCERTAINTY	± 21.22 seconds
LOOP DRIFT	± 26.728 seconds
LOOP CALIBRATION UNCERTAINTY	± 15.0 seconds

	EXISTING	CALCULATED
Upper Analytic Limit	6.0 min	**************
Upper Allowable Value	≤5.5 min	≤ 5.64 min
Nominal Trip Setpoint	5.0 min	≥4.8 min and ≤5.2 min
Lower Allowable Value	≥4.5 min	≥ 4.36 min
Lower Analytic Limit	4.0 min	**************

Summary of Calibration Tolerances	
As-Left Undervoltage Relay (Voltage Trip) TSTF-493 (ALT_V)	±0.21 V
As-Left Undervoltage Relay (Time Delay) TSTF-493 (ALT_T)	±0.40 seconds
As-Left Time Delay Relay TSTF-493 (ALT_{TD})	±15.0 seconds
As-Found Undervoltage Relay (Voltage Trip) TSTF-493 (AFT_V)	±1.460 V
As-Found Undervoltage Relay (Time Delay) TSTF-493 (AFT_T)	±0.327 seconds
As-Found Time Delay Relay TSTF-493 (AFT_{TD})	±26.725 seconds
As-Left Loop Tolerance Undervoltage Relay (Voltage Trip) (ALT_{LV})	±0.21 V
As-Left Loop Tolerance Undervoltage Relay (Time Delay) – LOCA (ALT_{LT})	±0.40 seconds
As-Left Loop Tolerance Time Delay Relay – No LOCA (ALT_{LTD})	±15.0 seconds
As-Found Loop Tolerance Undervoltage Relay (Voltage Trip) (AFT_{LV})	±1.460 V
As-Found Loop Tolerance Undervoltage Relay (Time Delay) - LOCA (AFT_{LT})	±0.327 seconds
As-Found Loop Tolerance Time Delay Relay – No LOCA (AFT_{LTD})	±26.727 seconds

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ATTACHMENT 1	
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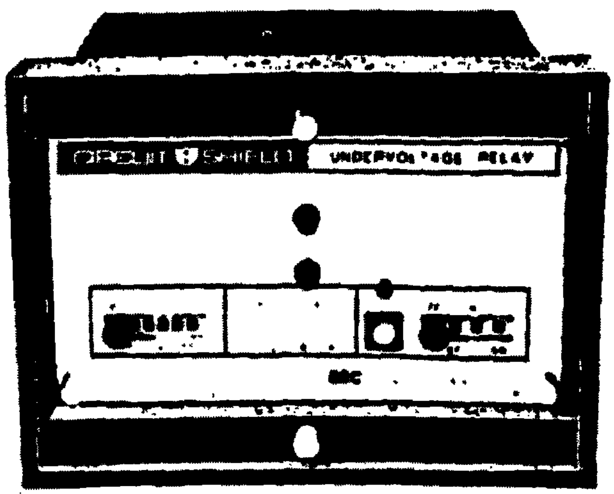
INSTRUCTIONS

Single Phase Voltage Relays

CATALOG SERIES 211

ITE-27N UNDERVOLTAGE RELAY
ITE-59N OVERVOLTAGE RELAY

Definite Time or High Speed



BBC Brown Boveri, Inc

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TO JC-Q1P81-90024
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INTRODUCTION

These instructions contain the information required to properly install, operate, and test I-T-E solid-state single phase voltage relays, ITE-27N and ITE-59N.

The I-T-E voltage relay is housed in a semi-flush drawout relay case suitable for conventional panel mounting.

All connections to the relay are made at terminals located on the rear of the case and clearly numbered.

Voltage and time dial settings are located on the front panel behind a removable clear cover. Provisions for a meter seal are included.

A target indicator is also mounted on the front panel. The target is reset by means of a pushbutton extending through the relay cover.

An LED indicator is provided for convenience in testing and calibrating the pickup and dropout settings.

PRECAUTIONS

The following precautions should be taken when applying these relays.

1. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized. Be sure control power is applied in the correct polarity before applying control power.

2. Apply only the rated control voltage marked on the front panel.

For relays with dual rated control voltage, withdraw the relay from the case and check that the movable link on the circuit board is in the correct position for the system control voltage.

3. Do not attempt to manually operate target vanes on these relays. Although the targets return their indication under shock, they can be damaged by manual operation with a pencil or pointed object.

4. Do not apply high voltage tests to solid-state relays. If a control wiring test is required, partially withdraw the circuit board from the case to break the connections before applying the test voltage.

5. The entire circuit assembly of the voltage relay is removable. This board should insert smoothly. Do not use force.

6. Note that removal of the tap block pin is equivalent to setting the lowest tap.

7. Follow test instructions to verify that the relay is in proper working order. If a relay is found to be defective we suggest that it be returned to the factory for repair. Immediate replacement of the removable element can be made from the factory; identify by catalog number. We suggest that a complete spare relay be ordered as a replacement, and the inoperative unit be repaired and retained as a spare. By specifying the relay catalog number, a schematic and circuit description may be obtained from your sales engineer should you desire to repair or recalibrate the relay. CAUTION: Since troubleshooting entails working with energized equipment, caution should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify the nearest Brown Boveri Electric Sales Office. Keep the relay clean and dry and use normal care in handling to avoid mechanical damage.

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2. INSTALLATION

Mounting

The outline dimensions and panel drilling and cutout information is given in Figure 1.

Connections

All I-T-E Protective Relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G". In all applications this terminal should be wired to ground.

Special care must be taken to connect control power in the proper polarity.

Internal and external connections are shown in the APPLICATION section, page 7.

For relays with dual rated control voltage, before energizing the relay, the relay element should be withdrawn from its case, and a visual check be made to insure that the movable control voltage selection link has been placed on the correct terminal for the system control voltage. The location of this link is shown in Figure 5.

3. SETTINGS

PICKUP

The pickup taps are identified by the actual value of voltage which will cause the output contacts to transfer.

DROPOUT

Dropout taps are identified as a percentage of the pickup voltage. Taps are provided for 70%, 80%, 90% and 99% of pickup, OR 30%, 40%, 50%, 60% of pickup.

TIME DIAL

The time dial taps are identified as 1,2,3,4,5, and 6. Refer to the time-voltage characteristic curves in the APPLICATION section of this manual. Time dial selection is not provided on relays with the high speed characteristic.

SPECIAL NOTE

Pickup and dropout voltages may be adjusted to values other than those provided by the fixed taps, by means of internal calibration potentiometers. See section on TESTING for procedures.

On units with a time dial, the operating time may also be adjusted to any specific value between those provided by the fixed taps.

APPLICATION DATA

I-T-E Single Phase Voltage Relays provide a wide range of protective functions, including undervoltage protection of motors 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 relays would be marginal.

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

The ITE-27N and ITE-59N are designed for those applications where exceptional accuracy, repeatability, and long term stability are required.

Harmonic distortion in the AC waveform can have a noticible effect on the relay operating point and on measuring instruments used to set the relay. See discussion in the TESTING section of this book. An internal harmonic filter module will be available at a later date for those applications where waveform distortion is a factor.

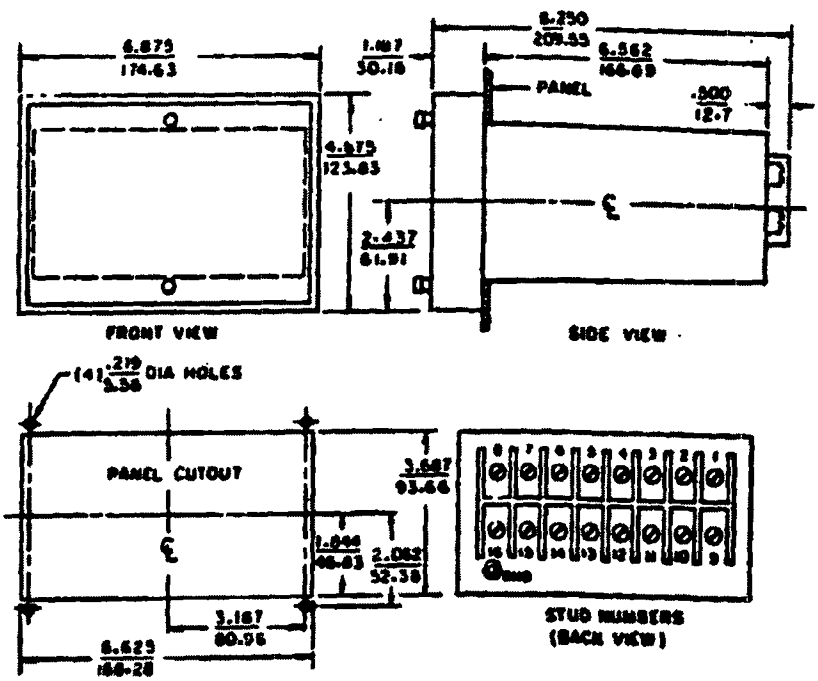

Figure 1
Relay Outline

Dimensions are
INCH
MM

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Characteristics of Common Units

Type	Pickup Range	Dropout Range	Time Delay Pickup	Time Delay Dropout	Control Voltage	Catalog Number
ITE-27N	60 - 110 V	70% - 99%	Inst	1-10 sec	48/125 Vdc	211T4175
	60 - 110 V	70% - 99%	Inst	0.1-1 sec	48/125 Vdc	211T6175
	60 - 110 V	70% - 99%	Inst	Inst	48/125 Vdc	211T0175
	~~70 - 120 V~~	~~70% - 99%~~	~~Inst~~	~~Inst~~	~~48/125 Vdc~~	~~211T0375~~
	60 - 110 V	30% - 60%	Inst	1-10 sec	48/125 Vdc	211T4275
	60 - 110 V	30% - 60%	Inst	0.1-1 sec	48/125 Vdc	211T6275
	60 - 110 V	30% - 60%	Inst	Inst	48/125 Vdc	211T0275
ITE-59N	100 - 150 V	70% - 99%	1-10 sec	Inst	48/125 Vdc	211U4175
	100 - 150 V	70% - 99%	0.1-1 sec	Inst	48/125 Vdc	211U6175
	100 - 150 V	70% - 99%	Inst	Inst	48/125 Vdc	211U0175

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RATINGS

Input Circuit Rating	:	ITE-27N 150 Vac Maximum Continuous
	:	ITE-59N 160 Vac Maximum Continuous
Burden	:	Less than 1 VA at 120 Vac
Frequency	:	50/60 Hz
Output Circuit	:	Each contact at 125 Vdc: 30A tripping duty 5A continuous 1A break, resistive 0.3A break, inductive
Control Power	:	Rated 48/125 Vdc at 0.05 ampere max. (must operate 34- 60 Vdc for 48V nominal) (must operate 70-142 Vdc for 125V nominal)
Temperature	:	ANSI range -20°C to +55°C Must operate -30°C to +70°C
Tolerances (Without harmonic filter module, 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 = +/- 0.2%. (See Note) Pickup and dropout settings, repeatability over dc control power range of 100-140 Volts (38-57V) = +/- 0.2%. (See Note) Pickup and dropout settings, repeatability over temperature range: -20 to +55°C +/- 0.4% 0 to +40°C +/- 0.2% (See Note)
Tolerances	:	Time Delay Instantaneous model ≤ 3 cycles operating time. Definite Time models (see appropriate curve), ±10% or ±20 milliseconds, whichever is greater.
Reset Time	:	Less than 2 cycles. (ITE-27N resets when input voltage goes above pickup setting.) (ITE-59N resets when input voltage goes below dropout setting.)
Dielectric	:	2000 Vac RMS, 1 Minute, all circuits to ground.

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

Harmonic Filter (Preliminary Data) OPTIONAL

The harmonic filter module attenuates all harmonics of the 50/60Hz input. Therefore, the relay then operates basically on the fundamental component of the input voltage signal. See figure on page 6 for typical filter response curve.

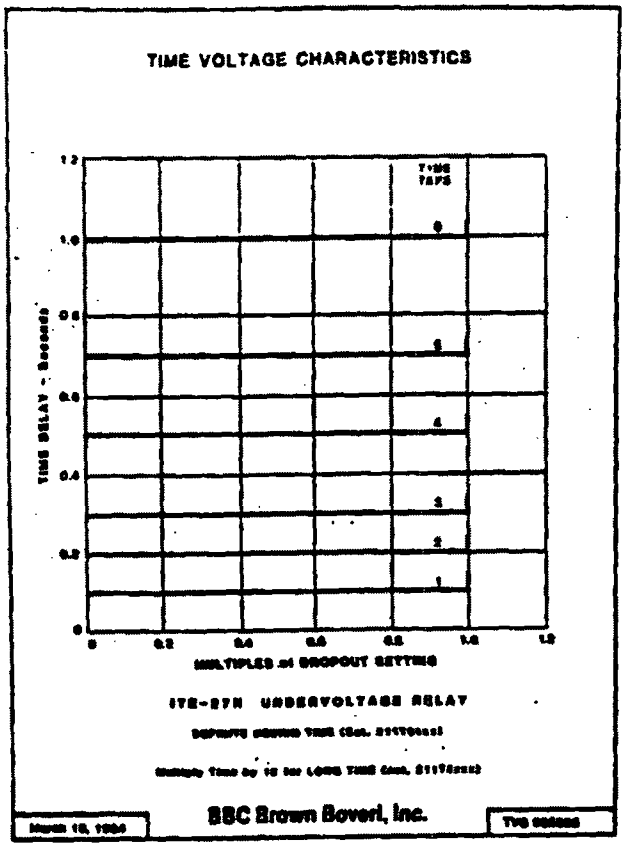
Ratings are the same as shown above except:

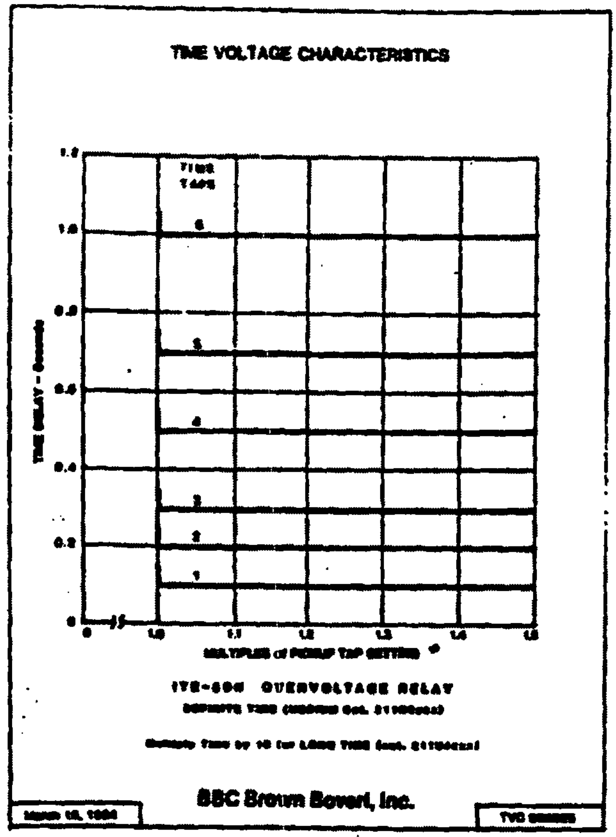
Pickup and dropout settings, repeatability over temperature range:

-20 to +55°C +/- 1.5%
0 to +40°C +/- 0.4%

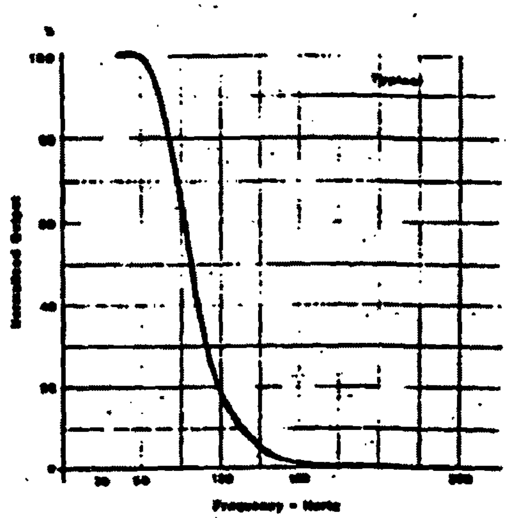
Time Delay
Instantaneous model < 4 cycles operating time

Reset Time
Less than 3 cycles





* NOT TO EXCEED INPUT RATING



FREQUENCY RESPONSE - OPTIONAL HARMONIC FILTER

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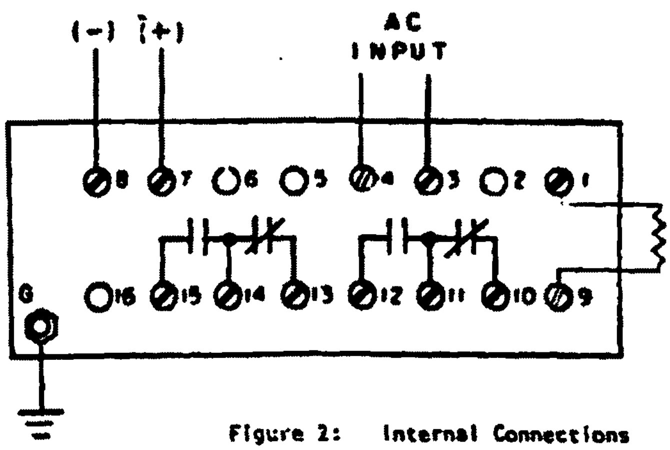
CONNECTION DIAGRAMS

OUTPUT CONTACT LOGIC

The following tables define the output contact states in various conditions of the measured input voltage and the control power supply. AS SHOWN means the contacts are in the state shown on the internal connection diagram for the relay being considered. TRANSFERRED means the contacts are in the opposite state to that shown on the internal connection diagram.

CONDITION	CONTACT LOGIC	
	ITE-27N	ITE-59N
Normal Control Power Input voltage below dropout setting	Transferred	As Shown
Normal Control Power Input voltage above pickup setting	As Shown	Transferred
No Control Power	As Shown	As Shown



Note: External resistor must be connected for relay to operate. Resistor is shipped mounted on the relay.

Figure 2: Internal Connections

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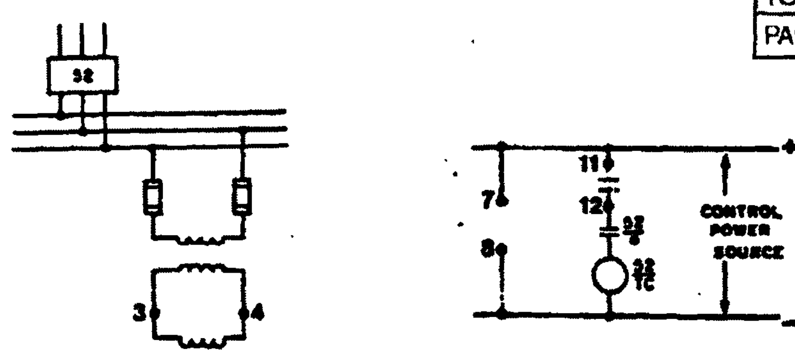
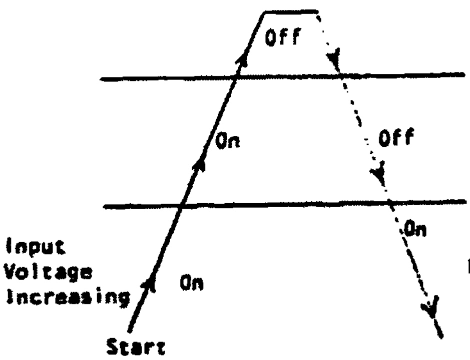


Figure 3: Typical External Connections



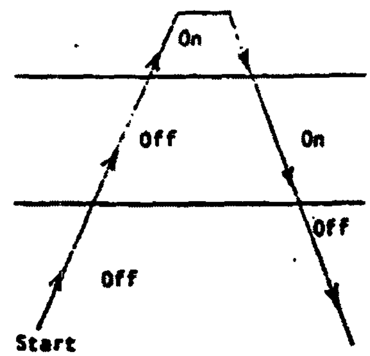


Figure 4a: ITE-27N Operation of Dropout Indicating Light

Figure 4b: ITE-59N Operation of Pickup Indicating Light

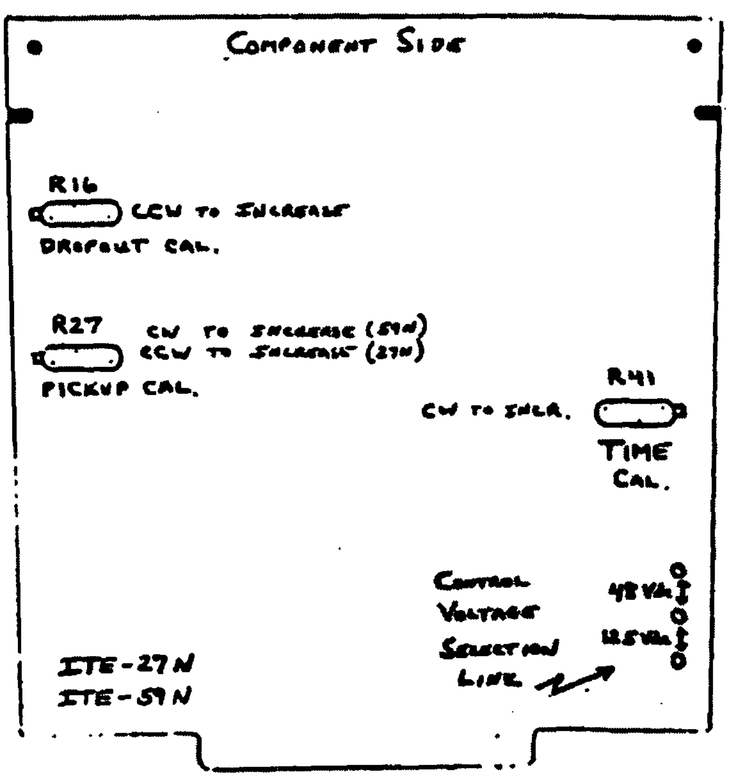


Figure 5: Circuit Board Locations of Key Components

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TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these relays. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative relay be returned to the factory for repair; however, a circuit description and/or a schematic diagram are available for those who wish to attempt repairs. Contact your local sales engineer or contact the factory. These relays have a control relay as the output stage. This output relay may be ordered from the factory. Replacement target head assembly may be ordered should the target be mechanically damaged. (See page 11)

Also available from the factory are circuit card extenders which are recommended for use when calibrating the relays. All these relays use the 18 point extender, catalog 200X0018.

DRAWOUT ELEMENT

Drawout circuit boards of the same catalog number are interchangeable. The board is removed by using the metal pull knobs on the front panel. The circuit board is identified by the catalog number on the front panel and a serial number stamped on the under side of the circuit board.

CAUTION

Since troubleshooting entails working with energized equipment, caution should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.

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2. HIGH POTENTIAL TESTS

Do not apply high potential tests to solid state relay circuits. If a control wiring insulation test is required, withdraw the circuit board from the case before applying the test voltage. Partial withdrawal to disconnect circuit board from connector in rear of case is adequate.

3. ACCEPTANCE TESTS

Follow calibration procedures under paragraph 4. Select Time Dial #3. For ITE-27N, Check timing by dropping voltage to 50% of pickup. For ITE-59N, by increasing voltage to 110 percent of pickup. Tolerances should be within those listed on page 5. Calibration may be trimmed or adjusted to the final settings required for the application at this time.

4. CALIBRATION TESTS

Connect the relay to the proper source of control voltage (to match the relay nameplate rating). For relays with dual rating, be sure the movable link on the circuit board is in the correct position. Connect the relay to the AC test source and to a timer. Typical test circuits are shown in figure 6. If very accurate settings are required for a particular application, say within ±3% of a given voltage, a stable, harmonic free test source is required. We recommend a "line corrector" type device be used in these cases. See figure 7 for the recommended AC test source circuit. The line corrector typically has less than 0.3% harmonic distortion.

A light emitting diode indicator is provided on the front panel for convenience in testing. Its action is instantaneous, thereby removing the uncertainty caused by the time delay before the output contacts transfer. The action of the indicator depends on the voltage level and the direction of voltage change and is best explained by referring to figure 4.

Pickup may be varied between the fixed taps by adjusting the pickup calibration potentiometer R27. Pickup should be set first, with the dropout tap set at 99%, and the pickup tap set at the nearest value to the desired setting. Decrease the voltage until dropout occurs, then recheck pickup by increasing the voltage. Readjust until pickup occurs at precisely the desired voltage.

Potentiometer R16 is provided to adjust dropout. Set the dropout tap to the next lower tap to the desired value. Increase the input voltage to above pickup and then lower until dropout occurs. Readjust R16 and repeat until the required setting has been made.

Similarly, the time delay may be adjusted higher or lower than the values shown on the time-voltage curves by means of the time delay calibration potentiometer R41. Time delay is initiated when the voltage falls from above pickup to below the dropout setting.

If the voltage does not return to above the pickup setting by the end of the time delay period, the output contacts will transfer.

The locations of the calibration potentiometers are shown in figure 5. The potentiometers are multi-turn types for excellent resolution and ease of setting.

BUILT-IN TEST FUNCTION

A built-in test function is provided for convenience in functionally testing the relay and associated devices. CAUTION: tests should be made with the main circuit de-energized. If tests are to be made on an energized circuit, take all necessary precautions. The test button is labelled TRIP. For the ITE-27N, when the button is depressed, an undervoltage condition is simulated, and the relay will operate. For the ITE-59N, an overvoltage condition is simulated. For relays with time delay function, you must hold the button in for as long as the set time delay to get an operation.

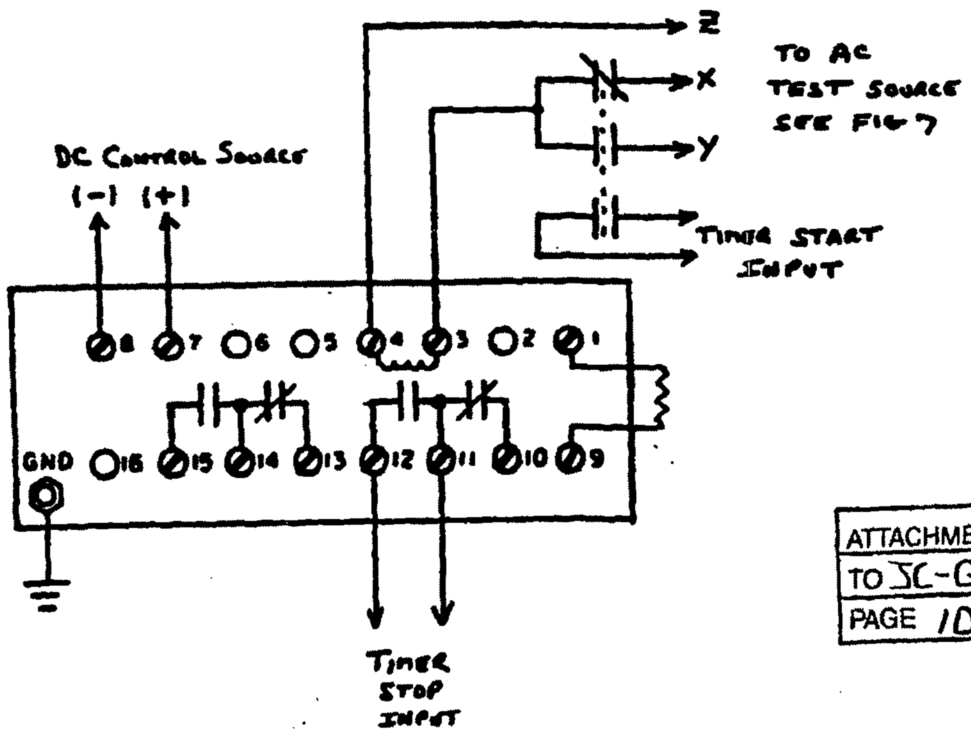

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Figure 6: Typical Test Circuit Connections

The following AC test source arrangement is suggested when pickup or dropout settings must be made and verified to accuracies better than ±3 percent of the set point. The line corrector stabilizes the line voltage and has low harmonic content. Ferroresonant regulators are not acceptable due to high harmonic content of the output waveform. Two variable transformers provide coarse and fine voltage adjustments. The voltmeter accuracy must be sufficient for the setting being made: ±1/4 percent is recommended. The relay should be energized for 10 to 15 minutes before settings are made, to allow the circuits to stabilize.

T1, T2	Variable Autotransformers	(1.5 amp rating)
T3	Filiment Transformer	(1 amp secondary)
V	AC Voltmeter	

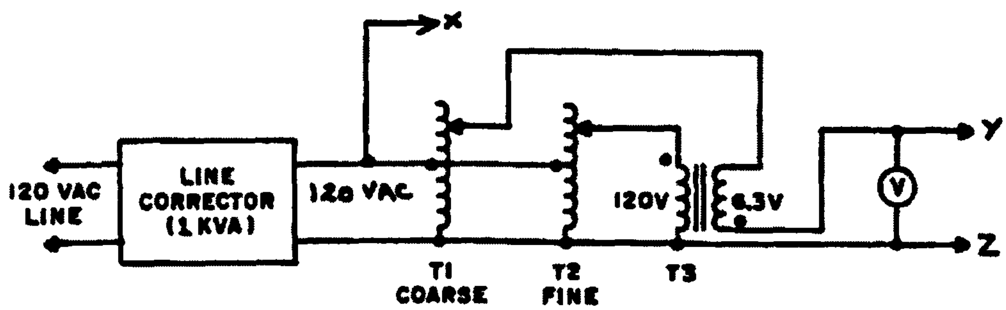


Figure 7. Suggested AC Test Source Arrangement

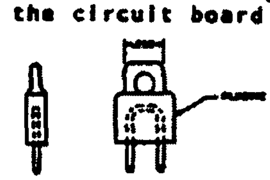
If desired, calibration potentiometers can be resealed with a drop of nail polish at completion of calibration procedures.

In Case of Difficulty

1. Check wiring to the relay.
2. Be sure control power is applied and in correct polarity.
3. Check that the control power selection link on the circuit board is in the correct position for the system control voltage.

4. Check AC input voltage to relay and relay settings.

Control power selection for dual rated units is accomplished by changing a wire on a 2 position terminal block on the circuit board or by moving a link. The link is red and looks like:



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Replacement of Target Head Assembly

The relay target is an electrically operated, magnetically held device.

Should the orange/black target disk be damaged, it can easily be replaced. Order target head assembly part 609283-102 from the factory.

Replacement procedure:

1. From the front of the relay, pull the existing plastic holder straight off using needle nose pliers.
2. Carefully place the new target assembly on the pole pieces with disk end closest to you.
3. With control power and normal AC voltage applied, press the target reset button. If the target shows orange, remove the assembly, rotate 180 degrees, and reinstall. Actuate target reset. Target should turn to black.

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BBC Brown Boveri, Inc.
35 North Snowdrift Road
Allentown, PA 18106
Phone: (215) 395-7333

Issue C
(3/84)

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to JC-Q1P81-90024
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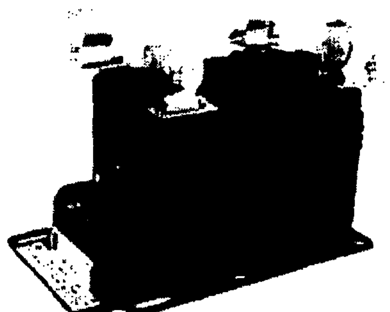
2,400 V to 4,800 V BIL 60 kV
Indoor Voltage

JVM-3

50/60 Hz

®



JVM-3 voltage transformer (two-fuse design)

Application

Designed for indoor service; suitable for operating meters, instruments, relays, and control devices.

Regulatory Agency Approvals

UL Recognized .... File E178265

Thermal Rating (Volt-Amperes)

55°C Rise above 30°C Ambient 750
30°C Rise above 55°C Ambient 500

Weight - Shipping/Net

(approximate, in pounds)
Unfused 35/30
With Fuses 38/33

Reference Drawings

Accuracy Curve 9689241268
Excitation Curve 5454043
Outline Drawings:
Unfused 8949739
One/Two Fuse; –040 and –042 9926292
One Fuse; –033, –31, –32 8949740
Two Fuse; –024, –18, –19 8949741
Wiring Diagram .... refer to page 42, figure 5

Accessories .... Catalog Number

Fuses:
2400 Volt Class, 1 Ampere 9F60AAB001
4800 Volt Class, 1 Ampere 9F60BBD001
4800 Volt Class, 0.5 Ampere 9F60BBD905
Secondary Terminal Conduit Box 9925183001

JVM-3 DATA TABLE

Line-To-Line Circuit Voltage For Permissible Primary Connection Δ	Y	Y Only	Transformer Rating ① Primary Voltage	Ratio	ANSI Accuracy Classification, 60 Hz: Burden Per ANSI, Operated at Rated Voltage	Burden Per ANSI, Operated at 58% of Rated Voltage	Burden Impedance as at Rate Voltage but Operated at 58% Rated Voltage ②	Catalog Number	Primary Fuse Rating Amps	Volts
Unfused										
2400	2400	4160	2400	20:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021001	–	–
4200	4200	–	4200	35:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021002	–	–
4800	4800	–	4800	40:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021003	–	–
With One Primary Fuse										
–	–	2400	2400	20:1	–	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021042	1 A	2400
–	–	4160	2400	20:1	0.3 W, X, M, Y; 1.2 Z	–	–	763X021033	1 A	4800
–	–	4200	4200	35:1	–	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021031	0.5 A	4800
–	–	4800	4800	40:1	–	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021032	0.5 A	4800
With Two Primary Fuses										
2400	–	2400 ③	2400	20:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021040	1 A	2400
–	–	4160	2400	20:1	0.3 W, X, M, Y; 1.2 Z	–	–	763X021024	1 A	4800
4200	–	4200 ③	4200	35:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021018	0.5 A	4800
4800	–	4800 ③	4800	40:1	0.3 W, X, M, Y; 1.2 Z	0.3 W,X; 1.2 M, Y	0.3 W', X', M', Y'; 1.2 Z	763X021019	0.5 A	4800

Notes:

① For continuous operation, the transformer-rated primary voltage should not be exceeded by more than 10%. Under emergency conditions, over-voltage must be limited to 1.25 times the transformer primary-voltage rating.

② Operated at 58% of Rated Voltage; the prime symbol (') is used to signify that these burdens do not correspond to standard ANSI definitions.

③ For Y connections, it is preferred practice to connect one lead from each voltage transformer directly to the grounded neutral, using a fuse only in the line side of the primary. By this connection a transformer can never be "alive" from the line side by reason of a blown fuse on the grounded side.

Data subject to change without notice.

 GE Meter 130 Main St., Somersworth, NH 03878 USA & Canada: (800) 626-2004 Fax: (518) 869-2828; GE Worldwide: (518) 869-5555

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to JC-Q1P81-90024
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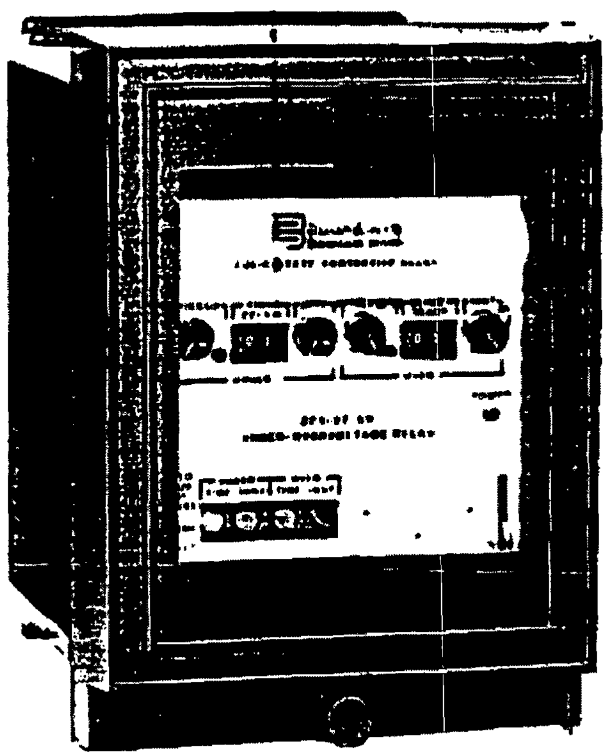
INSTRUCTION MANUAL

FOR

UNDERVOLTAGE, OVERVOLTAGE, AND

UNDER/OVERVOLTAGE RELAYS

MODEL NUMBERS: BE1-27, BE1-59, AND BE1-27/59



CONTROL...
THIS ...
CAT. II

Basler Electric
Highland, Illinois

Publication: 9 1706 00 990
Revision: B

SECTION 1

GENERAL INFORMATION

PURPOSE

The BE1-27 Undervoltage, BE1-59 Overvoltage and the BE1-27/59 Under/Overvoltage Relays are solid-state devices which provide reliable protection for generators, motors and transformers against adverse system voltage conditions.

Application

Electric power systems are designed for constant voltage operation. Loads utilizing commercial electric power are designed to operate at a constant input voltage level with some tolerance. Radical voltage variations on a power system are indicative of a system malfunction. Protective relays which monitor system voltage and provide an output signal when the voltage goes outside predetermined limits, find a variety of applications. Some of these applications include motor, and transformer protection, interface protection for cogeneration systems, and supervision of automatic transfer switching schemes.

Motor Protection

When selecting the type of protection for motor applications, the motor type, voltage rating, horsepower, thermal capability during start-up, and exposure to automatic transfer restarting following a voltage interruption need to be considered. During motor start-up, a low terminal voltage condition will inhibit the motor from reaching rated speed. The BE1-27 undervoltage relay will detect this low voltage condition and trip. Critical applications requiring continuous motor operation and applications where overloads during start-up may be maintained for a given time period, usually have a definite time or inverse time delay characteristic incorporated to avoid unnecessary tripping during low voltage dips. If the undervoltage condition persists for the established time delay, the relay output contacts are connected to the station alarm annunciator panel, allowing the station operator to take corrective action. The BE1-59 Overvoltage relay is applied to insure the voltage does not exceed the limits established by the machine manufacturer for proper operation. Overvoltage conditions stress the insulation level of the equipment and may cause a dielectric breakdown resulting in a flashover to ground.

Automatic Transfer Switching

Distribution substations are sometimes designed with duplicate supply circuits and transformers to eliminate service interruptions due to faults located on the primary feeder. In order to restore service within a given acceptable time period, automatic transfer switching can be applied to initiate the throwover from primary power to the alternate power source. The BE1-27 Undervoltage Relay can initiate switching after a given time delay to void transfer switching during temporary low voltage conditions. To return the substation to normal service upon the restoration of primary voltage, the BE1-59 overvoltage relay supervises the transition to its normal operating condition.

Cogeneration

Utilities employ the use of a voltage check scheme to supervise reclosing at the substation when cogenerators are connected to a radial distribution feeder and the cogenerator is capable of supplying the entire load when the utility circuit breaker is open. During a faulted condition, the utility requires the cogenerator to be disconnected from the system before reclosing the utility breaker. If the cogenerator is connected to the system, the utility will reclose to an energized line.

This could result in reconnecting two systems out of synchronism with each other. A BE1-27 undervoltage relay monitoring the line voltage will inhibit reclosing of the utility circuit breaker if the line is energized by the cogenerator.

At the interface between the utility and the cogenerator, overvoltage and undervoltage relays are installed as minimum protection to provide an operating-voltage window for the cogenerator. During faulted conditions, when the cogenerator may become overloaded, the BE1-27 Undervoltage Relay will detect the decline in voltage and remove the cogenerator from the system. The BE1-59 Overvoltage Relay will protect the system from overvoltage conditions that occur when power factor correction capacitors are located on the feeder.

Transformer Protection

Voltage relays can be applied to protect large transformers from damage as a result of overexcitation. The concern for transformer overvoltage may be minimized in many power system applications where proper voltage control of the generating unit is provided. However, where a tap changing regulating transformer is located between the generating source and the load, some form of voltage protection may be required to supplement the tap changing control and to prevent equipment damage due to over, as well as undervoltages resulting from a failure of the tap changing control. The BE1-27/59 Under/Overvoltage Relay is well suited for these applications.

Ground Fault Detection

In a three-phase, three-wire system, a single conductor may break or the insulation may deteriorate resulting in a high resistance ground fault which may not be detected by the overcurrent relays. This condition, however, may be sensed by an overvoltage relay connected to a grounded wye, broken delta set of potential transformers (PT's) as illustrated in Figure 1-1. With this connection, and a sensitive relay setting, an unbalanced voltage condition, such as described above, can be quickly detected and isolated.

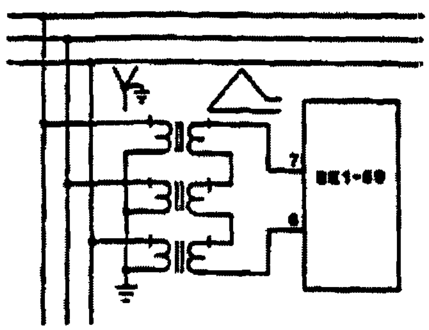


Figure 1-1. Ground Fault Detection

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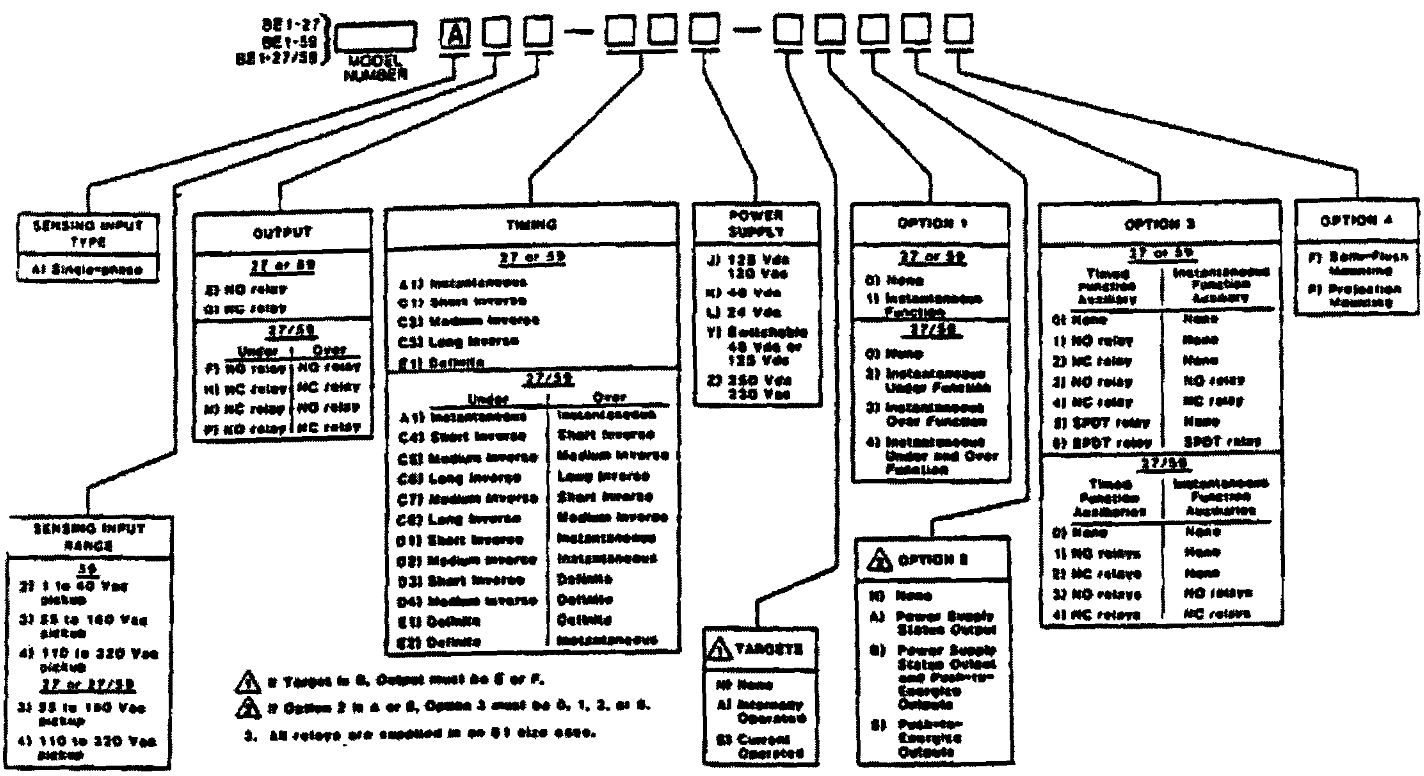
MODEL AND STYLE NUMBER

The electrical characteristics and operational features included in a specific relay are defined by a combination of letters and numbers which constitutes the device's style number. The style number together with the model number describe the features and options in a particular device and appear on the front panel, drawout cradle, and inside the case assembly. The model number BE1-27/59 designates the relay as a Basler Electric Class 100 Under/Overvoltage Relay.

STYLE NUMBER IDENTIFICATION CHART



SAMPLE STYLE NUMBER

The style number identification chart above illustrates the manner in which a relay's style number is determined. For example, if the model number is BE1-27/59 and the style number is A3F E1J A0S1F the device has the following features:

A) Single-phase voltage sensing
3) Sensing input compatible with a pickup adjustment range of 55 to 160 Vac
F) Two normally open output relays (one per function)
E1) Definite timing for each function
J) Operating power derived from a 125 Vdc or 100/120 Vac source
A) Two internally operated target indicators (one per function)
0) No instantaneous functions
S) Push-to-energize outputs (pushbuttons)
1) Two normally open auxiliary output relays (one per function)
F) Semi-flush mounting

SPECIFICATIONS

Voltage Sensing

Nominally rated at 50/60 Hz, (120/240V or 100/200V) with a maximum continuous voltage rating of 360V (120V nominal) or 480V (240V nominal) at a burden less than 1 VA per phase. Frequency range is from 40 to 70 Hz.

Power Supply

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
K	48 Vdc	24 to 60 Vdc	6.5 W
J	125 Vdc 120 Vac	62 to 150 Vdc 90 to 132 Vac	7.5 W 19.0 VA
L†	24 Vdc	12 to 32 Vdc	7.0 W
Y*	48 Vdc 125 Vdc	24 to 60 Vdc 62 to 150 Vdc	6.5 W 7.5 W
Z	250 Vdc 230 Vac	140 to 280 Vdc 190 to 270 Vac	9.5 W 25.0 VA

* The Type Y power supply is field selectable for 48 or 125 Vdc. Selection must be implemented at the time of installation. This power supply option is factory set for 125 Vdc.

† Type L power supply may require 14 Vdc to begin operating. Once operating, the voltage may be reduced to 12 Vdc.

Target Indicators

Magnetically latching, manually reset target indicators are optionally available to indicate that a trip output contact has energized. Either internally operated or current operated targets may be selected. Current operated targets require a minimum of 0.2 Adc flowing through the output trip circuit, and are rated at 30 A for 1 second, 7 A for 2 minutes, and 3 A continuously. Internally operated targets should be selected if the breaker control circuit is ac powered, or if the relay has normally closed output contacts.

Output Contacts

Output contacts are rated as follows:

Resistive
120 Vac - make, break, and carry 7 A continuously.
250 Vdc - make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.1 A.
500 Vdc - make and carry 15 A for 0.2 seconds, carry 7 A continuously, break 0.1 A.

Inductive
120 Vac, 125 Vdc, 250 Vdc - break 0.1 A (L/R = 0.04).

Undervoltage and Overvoltage Pickup Range	Continuously adjustable over the range of 1 to 40, 55 to 160, or 110 to 320 Vac as defined by the Style Chart. See Section 3, System Voltages for explanation of pickup ranges.
Undervoltage and Overvoltage Pickup Accuracy	±2% or ±0.5 volts of the pickup setting, whichever is greater.
Dropout Accuracy	±2% of pickup.
Instantaneous Time Accuracy	Less than 50 ms for a voltage level that exceeds the pickup setting by 5% or 1 volt, whichever is greater.
Definite Time Range	Adjustable over the range of 0.1 to 9.9 seconds in increments of 0.1 seconds. A setting of 00 designates instantaneous timing.
Definite Time Accuracy	Within ± one half of the least significant digit time plus 50 ms.
Inverse Time	Inverse curve types are defined by the Style Chart and are represented by the curves shown on pages 3-4, 3-5, and 3-6. Inverse time is adjustable from 01 to 99 in increments of 01. Incrementing the time dial varies the inverse curve along the Y axis. A setting of 00 designates instantaneous timing.
Inverse Time Accuracy	Within ±5% or 50 ms (whichever is greater) of the indicated time for any combination of the time dial setting and pickup setting and is repeatable within ±2% or 50 ms (whichever is greater) for any combination of time dial and tap setting.
Shock	15g in each of three mutually perpendicular axes.
Vibration	2g in each of three mutually perpendicular axes swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep.
Isolation	2500 Vac at 60 Hz for 1 minute (1500 Vac for one minute across open contacts) in accordance with IEC 255-5 and ANSI/IEEE C37.90-1978 (Dielectric Test).

Surge Withstand Capability	Qualified to ANSI/IEEE C37.90-1978, C37.90a-1974, and IEC 255.
Fast Transient	Qualified to ANSI/IEEE C37.90.1-198X.
Impulse Test	Qualified to IEC 255-5.
Temperature Operating	-40°C (-40°F) to +70°C (+158°F)
Storage	-65°C (-85°F) to +100°C (+212°F)
Weight	14 pounds maximum.
Case Size	All units supplied in an S1 size case.

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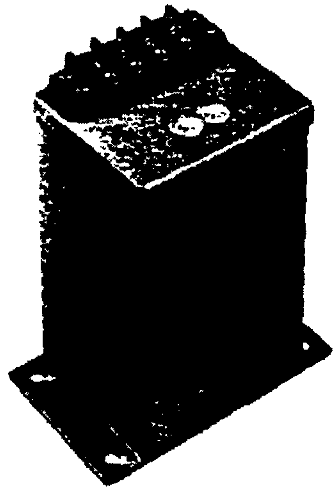
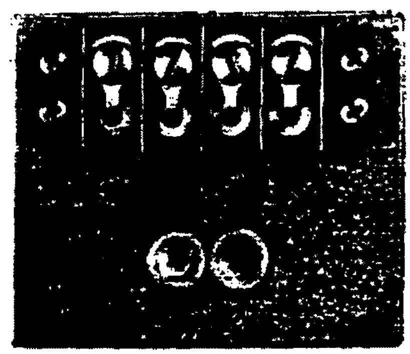
GENERAL ELECTRIC'S NEW TYPE 4725 FREQUENCY TRANSDUCERS



- New Compact Size.
- ±0.5% Accuracy
- ±0.02% Voltage Rejection
- 1 ma output (0-10K ohms Load Range)
- ±0.02% linearity
- ±0.02% Load Resistance effect
- Readily Interchanged Electrically & Mechanically with Type 4701



FUNCTION

Type 4725 transducers convert frequency of 50, 60, and 400 Hz at 120 volts into dc millamps (0.5 ma to +0.5 ma). The load may be 0-10K ohms.

DESCRIPTION

The new, compact Type 4725 Frequency Tranaducer employs the latest technology to give a constant current output into a variable load impedance. Outstanding operating characteristics, such as less than ±0.2% temperature influence on accuracy over −20°C to +65°C operating temperature range, result from the solid-state design. The semi-conductors and integrated circuits are mounted on epoxy fiberglass circuit boards. The electronic circuits and supporting components of these units are mounted on an integral steel cradle, which is housed in a welded steel enclosure. Since there is no potting, removal of two screws provides easy access to the entire assembly.

GENERAL APPLICATION

• panelboards & switchboards • control equipment • telemetering equipment • engine-generator sets • motor-generator sets • missile ground-support equip. • nuclear control systems • power monitors • turbine control.

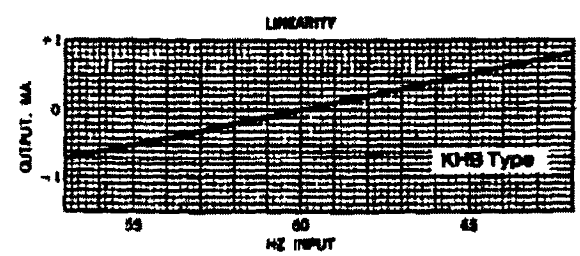
The Type 4725 Frequency Transducer is capable of driving any indicating instrument or direct-acting and potentiometric recorder. Devices most commonly used are Types DB-16, 18, 30, and 40 switchboard instruments; Type 180 Edgewise; Type 195 or Type 196 meter relays; BIG LOOK ® and HORIZON LINE ® panel meters; and CH & CF recorders. Frequency transducers are used by OEM's utilities, contractors, and industrial manufacturers.

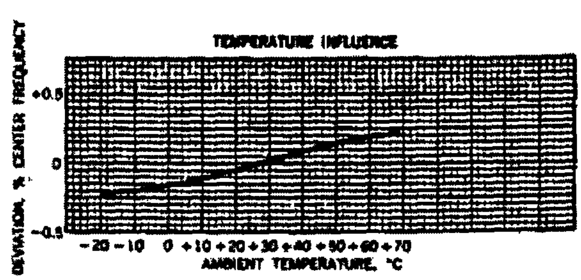
OPERATION

Frequency to dc translation is accomplished through the use of a diode-pumped integrator circuit. High-quality components such as field-effect switching transistors and metalized polycarbonate capacitors are used to ensure excellent performance.

A precision dc reference supply provides a zero drift bias level to the input switching stage. Zero crossing of the input waveform causes the input switching stage to change state and transfer a charge through a precision reactive element to an integrating stage. The dc level in the integrating stage is then amplified to a constant current output signal in the high-gain operational amplifier output stage. Surge protectors and electrostatic shields are employed to provide input and output surge protection. Stability, high resolution and broad field adjustability are provided through the use of 20-turn precision potentiometers for zero and span.

TYPICAL PERFORMANCE CURVES





GENERAL SPECIFICATIONS
TYPE 4725 FREQUENCY TRANSDUCERS

Full Scale Calibration: see Table I

Potential Input:
a. Nominal, 85-135 volts
b. Overload withstand, continuous, 150 volts
c. Overload withstand, 1 minute, 200 volts
d. Burden at 120 volts, <2 va, including amplifier power

Frequency Span: see Table I; for other spans consult factory

Operating Temperature Range: −20°C to +65° C

Max. Temperature Effect on Accuracy:
<±0.2% of center frequency

Full-Scale Output: 1 ma

Output Load Range: 0-10K ohms

Linearity: ±0.02% of center frequency

Line Voltage Rejection: ±0.02% of center frequency

Adjustments:
a. zero, ±10% of center frequency, minimum adjustment
b. calibrate, ±20% of nominal full scale values in Table I, minimum adjustability

Ac Component On Output Signal: <1%

Response Time: 400 milliseconds

Dielectric Test: 1500 v RMS

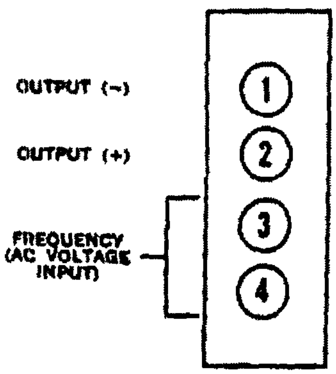
Weight 1.2 lbs

TABLE I, FREQUENCY TRANSDUCERS
Typical Standard Model Calibration

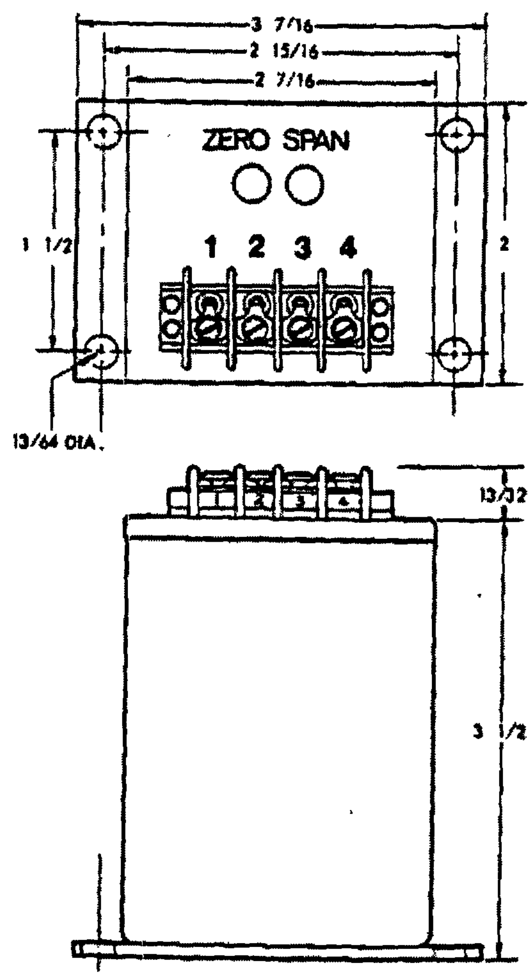
Frequency Span Hz			Catalog No.	Output Range DC			RL Load
Low	Center	High		Low	Center	High	
45	50	55	50-472500JBHB	−0.5 ma	0.0 ma	+0.5 ma	0-10K
55	60	65	50-472500JKHB	−0.5 ma	0.0 ma	+0.5 ma	0-10K
380	400	420	50-472500JVHB	−0.5 ma	0.0 ma	+0.5 ma	0-10K

Note: All models are self-powered from 85-135 volt signal input.

INPUT/OUTPUT & WIRING DATA



DIMENSIONS



INSTRUMENT PRODUCTS DEPARTMENT
40 FEDERAL STREET, LYNN, MASS. 01910
GENERAL ELECTRIC

INSTRUCTIONS

GEI-19008E

SUPERSEDES GEI-19008D

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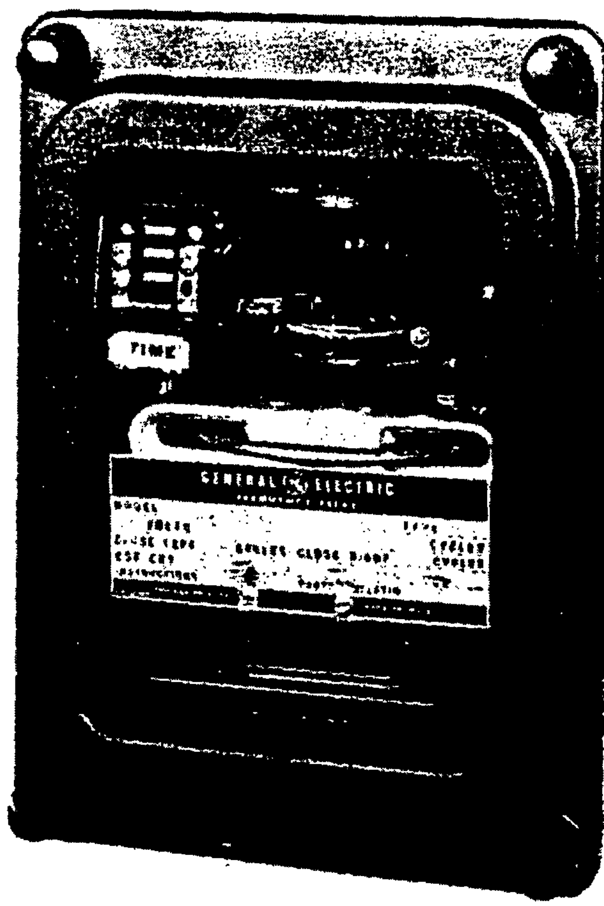
FREQUENCY RELAYS

TYPES

IJF51A, IJF51B,
and IJF52A



GENERAL ELECTRIC

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(8042893) Cover

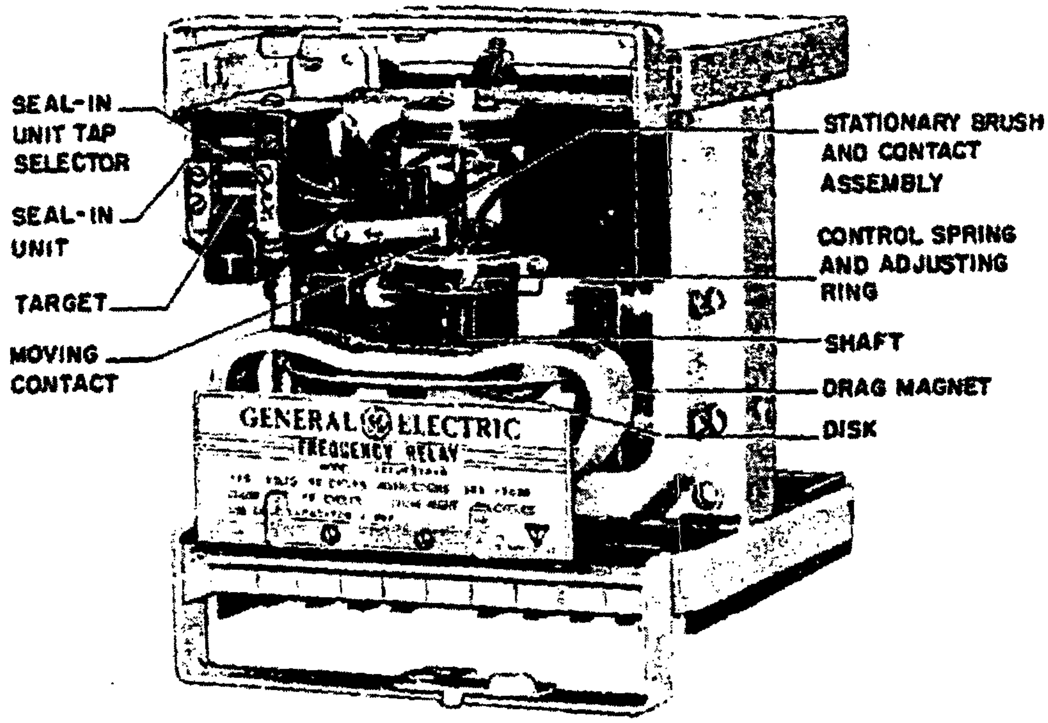

Fig. 1 Type IJF Relay Removed From Case (Front View)

Fig. 1 (8009059)

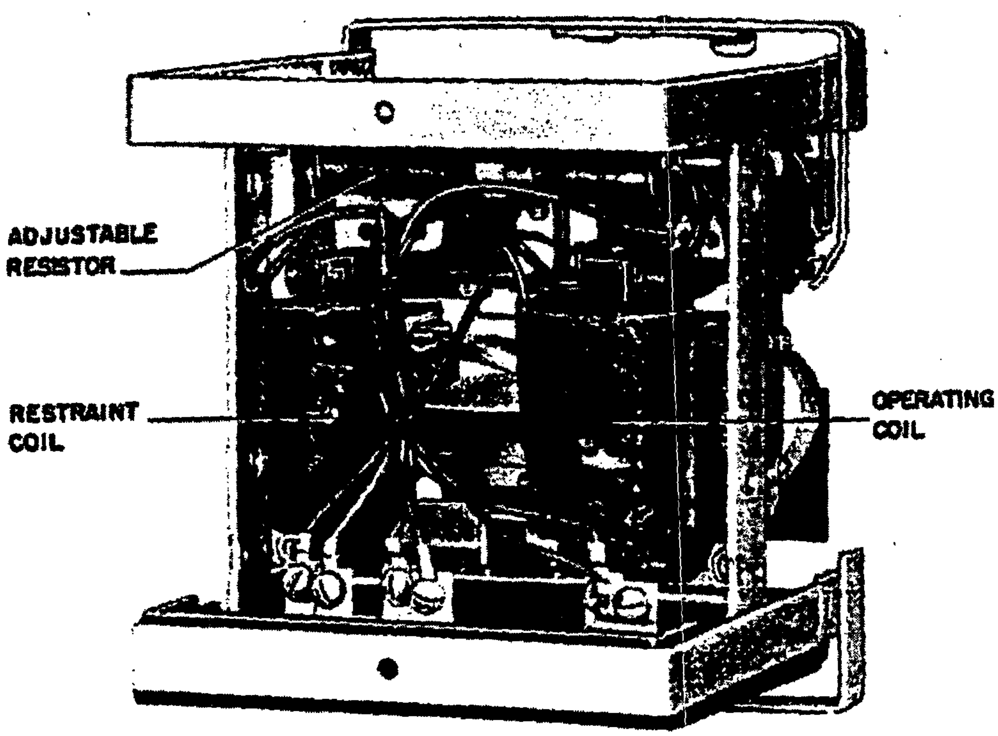

Fig. 2 Type IJF Relay Removed From Case (Rear View)

Fig. 2 (8009060)

FREQUENCY RELAYS
TYPE IJF

INTRODUCTION

These are relays of the induction disk type intended for the protection of apparatus against the effects of overfrequency or underfrequency.

The Type IJF is an induction disk type relay mounted in a single unit drawout case. It has two shaded-pole U-magnet type driving elements acting on opposite sides of the disk. One of these, the operating element, is designed to drive the disk in the direction to close the left contacts, and the other, the restraining element to drive the disk in the contact-opening direction on relays having single-throw contacts and to close the right contacts on relays having double-throw contacts. The disk shaft is restrained by a spiral spring, the principal purpose of which is to hold the contacts open when the relay is de-energized. The motion of the disk is retarded by permanent magnets to give the correct time delay for closing the contacts.

There is a seal-in unit mounted to the left of the shaft on the Type IJF51A and IJF51B relays. The Type IJF52A relay has a seal-in unit mounted on both sides of the shaft. This element has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close, the seal-in element picks up and seals in. When the seal-in element picks up it raises a target into view which latches up and remains exposed until released by pressing a button beneath the lower left corner of the cover.

The case is suitable for either surface or semiflush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case and also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at both ends or at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug which completes the circuits. The outer blocks, attached to the case, have the studs for the external connections, and the inner blocks have the terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also lock the latch in place. The cover, which is fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit the cover is first removed, and the plug drawn out. Shorting bars are provided in the case to short the current transformer circuits. The latches are then released, and the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel either from its own source of current and voltage, or from other sources. Or, the relay unit can be drawn out and replaced by another which has been tested in the laboratory.

APPLICATION

The Type IJF frequency relays are recommended for protection of synchronous apparatus against overspeed or underspeed conditions caused by loss of load in the case of generators, or loss of supply power in the case of motor and condensers. The relays can be used to operate protective devices, or to sound an alarm whenever the frequency of the circuit varies by a predetermined amount above or below normal.

RATINGS

These relays are available in frequency ratings from 25 to 60 cycles and voltage ratings of 115 and 230 volts.

The current closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying ratings are affected by the selection of the tap on the seal-in coil as indicated in Table I.

TABLE I

Function	Amperes, AC or DC	
	2-Amp Tap	0.2 Amp Tap
Tripping Duty	30	5
Carry Continuously	3	0.3

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

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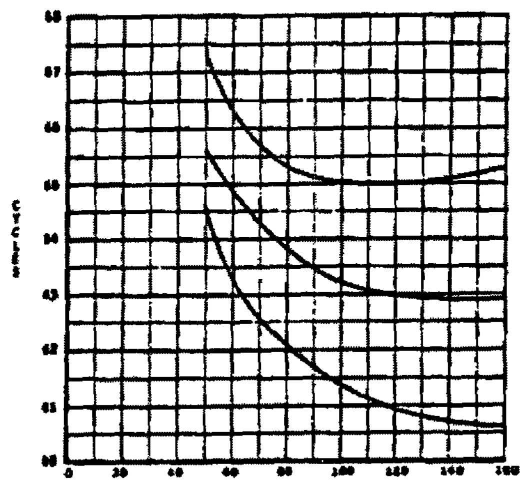


Fig. 3 Type IJF51A Relay, Voltage-Frequency Characteristics

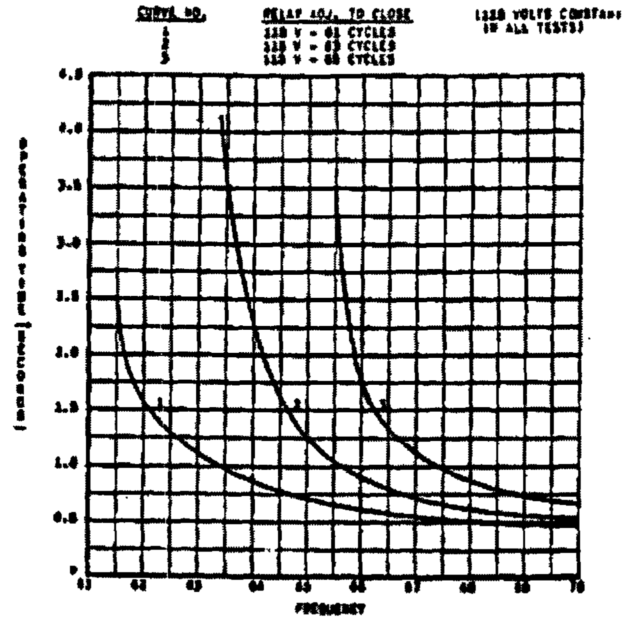


Fig. 4 Type IJF51A Relay, Time-Frequency Characteristics

Fig. 3 (K-6400147)

Fig. 4 (K-6400146)

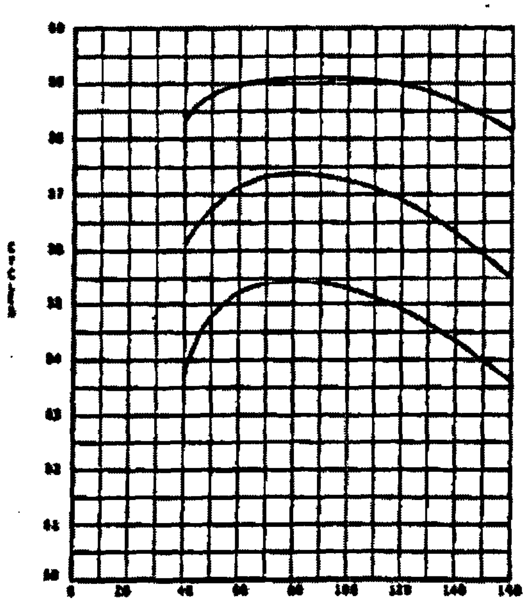


Fig. 5 Type IJF51B Relay, Voltage-Frequency Characteristics

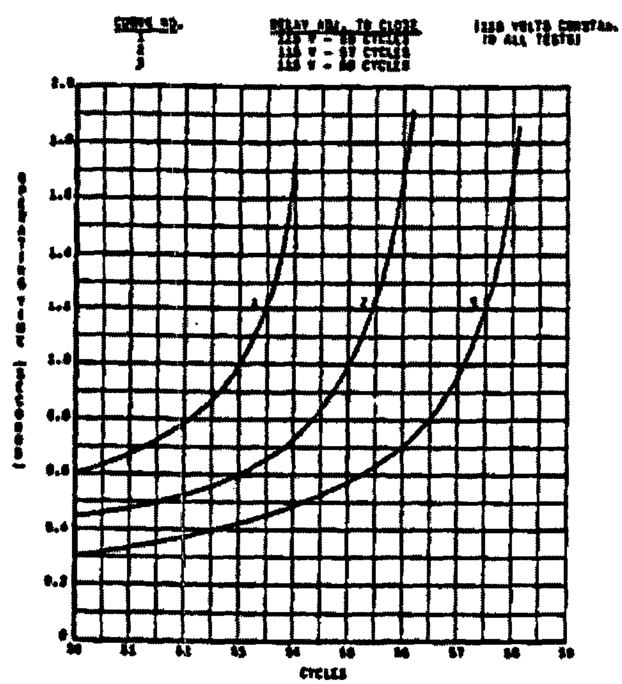


Fig. 6 Type IJF51B Relay, Time-Frequency Characteristics

Fig. 5 (K-6400146)

Fig. 6 (K-6400149)

The 2-ampere tap has a d-c resistance of 0.13 ohms and a 60 cycle impedance of 0.53 ohms while the 0.2-ampere tap has a 7 ohm d-c resistance and a 52 ohm 60 cycle impedance. The tap setting used on the seal-in element is determined by the current drawn by the trip coil.

The 0.2-ampere tap is for use with trip coils that operate on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage. If this tap is used with trip coils requiring more than 2 amperes, there is a possibility that the 7-ohm resistance will reduce the current to so low a value that the breaker will not be tripped.

The 2-ampere tap should be used with trip coils that take 2 amperes or more at 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 connections being such that the tripping current does not pass through the contacts or the target and seal-in coils of the protective relay.

BURDENS

Burden data for the 55-60 cycle underfrequency relay and 60-65 cycles overfrequency relays are given in Table I at 115 volts 60 cycles.

Burdens listed are total burden of relay.

TABLE II

Relay	Volt Amps	Power Factor	Watts
IJF51A	8.7	.99	8.6
IJF51B	5.8	.98	5.7

Total burdens for the Type IJF52A relay at 115 volts are as follows:

TABLE III

Freq.	Volt Amps	Power Factor	Watts
25	6.3	.95	6
60	10.7	.89	9.5

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 the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident, a claim should be filed at once with the transportation company and the nearest Sales Office of the General Electric Company notified promptly.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust, and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel diagram is shown in Fig. 12.

CONNECTIONS

Internal connection diagrams for the various relay types are shown in Fig. 7 to 9 inclusive. Typical wiring diagrams are given in Fig. 10 and 11.

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.

AUXILIARIES

When external capacitors, and in some cases resistors, are furnished with relays they are identified by means of serial numbers. These numbers are of the form KX-1023 or OA-2155 The purpose of these numbers is to insure that each relay, when installed, will be provided with the same auxiliaries with which it was calibrated at the factory.

The reason for this precaution is to eliminate the variation in calibrations of the relays which would otherwise result from the variation in electrical properties of the auxiliaries.

ADJUSTMENTS

TARGET AND SEAL-IN ELEMENT

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2-ampere tap.

BURDENS IMPOSED ON POTENTIAL TRANSFORMERS

(Data are for one element and based on 120 volts at rated frequency; where no specific frequency rating is assigned, data are for 60 cycles.)

G-E Type*	Rating: Volts	Rating: Cycles	Impedance (Ohms)	Effective Resistance (Ohms)	Inductance (Henrys)	Volt-amperes	Watts	Vars†	Power Factor
VOLTMETERS									
AB-10-12-13-15-16-18	150	60	3020	2960	1.52	4.8	4.7	0.9	0.98
AB-15-16-18 Expanded Scale	120	60	2400	1870	4.0	6.0	4.67	3.76	0.78
AB-30	150	60	3190	3120	1.8	4.52	4.43	0.94	0.98
AD-6-7-10	150	25–60	2700	2700	0.50	5.3	5.3	0.2	1.00
AD8	175	25–60	2680	2680	0.35	5.3	5.3	0.1	1.00
AH 11	150	25–60	2000	2000	0	7.2	7.2	0	1.00
AH-11	175	25–60	2340	2340	0	6.1	6.1	0	1.00
AH-12	150	25–60	1790	1790	0	8.0	8.0	0	1.00
AH-12	175	25–60	1870	1870	0	7.7	7.7	0	1.00
AO-21, -22, -58, -72	150	25–60	15000	15000	0.50	1.0	1.0	0	1.00
AP-9	150	Up to 125	21300	21300	1.04	0.68	0.68	0	1.00
AR	175	Up to 125	1590	1590	0	9.0	9.0	0	1.00
AR-2	150	25–60	2220	2220	0.61	6.5	6.5	0.7	1.00
AR-2	175	25–60	2600	2600	0.61	5.6	5.6	0.4	1.00
C, C-4, C-6-7, CP	90–130	Up to 125	152 #	152	0	95.0	95.0	0	1.00
CP-4-5	150	Up to 125	760 #	760	0	19.0	19.0	0	1.00
CD-3-4-7-8, CDP-3-4, CD-13-14, CD-27-28, C-20-21	150	25–60	650 #	650	0 §	22.1	22.1	0 §	1.00 §
CR, CR-2, CRP	90–130	25	548 #	540	0.57	26.4	26.0	4.2	0.99
CR, CR-2, CRP, CRP-4-5-6	90–130	60	378 #	366	0.49	24.8	23.5	7.8	0.95
CR-16-17-18-19-20-21 24-25-26, CRP-4-5-6	90–130	25	569 #	560	0.66	25.3	24.8	4.4	0.98
CR-16-17-18-19-20-21 24-25-26, CRP-4-5-6	90–130	60	617 #	579	0.56	23.3	21.9	7.9	0.94
H, H-2	175	Up to 125	1870	1870	0	7.7	7.7	0	1.00
H-5	175	Up to 125	1870	1870	0	7.7	7.7	0	1.00
HW	175	Up to 125	757	757	0	19.1	19.1	0	1.00
O, OS	175	Up to 125	3730	3730	0	3.8	3.8	0	1.00
P	150	60	1700	1700	0.04	8.5	8.5	0.1	1.00
P	75–150	Up to 125	1520	1520	0	9.5	9.5	0	1.00
P-3	150	Up to 125	2030	2030	0.07	7.1	7.1	0.1	1.00
P-4	150	Up to 125	3030	3030	0	4.8	4.8	0	1.00
PL-2	150	Up to 125	1200	1200	0.03	12.0	12.0	0.1	1.00
R, R-3-4-6-7	175	Up to 125	1540	1540	0	9.4	9.4	0	1.00
RP	175	Up to 125	3200	3200	0	4.5	4.5	0	1.00
WATTMETERS OR VARMETERS (N)									
AB-10-12-13 Single Phase	115	25–125	6000	6000	0	2.4	2.4	0	1.00
AB-10-12-13 Polyphase	115	25–125	7000	7000	0	2.1	2.1	0	1.00
AB-15-16-18 Single Ph. Varmeter	120	60	4730	1510	12.0	3.0	0.95	2.85	0.32
AB-15-16-18 (Single Phase)	120	60	6790	6790	0	2.1	2.1	0	1.00
AB-30 (Single Phase)	120	60	8800	8800	0	1.64	1.64	0	1.00
AB-15-16-18 (Polyphase)	120	60	7340	7340	0	2.0	2.0	0	1.00
AB-30 (Polyphase)	120	60	9300	9300	0	1.55	1.55	0	1.00
AD-6-7 (Single Phase)	115	25–60	3700	3700	0.02	3.9	3.9	0	1.00
AD-6-7 (Polyphase)	115	25–60	3200	3200	0.01	4.5	4.5	0	1.00
AD8 (Single Phase)	115	25–60	3600	3600	0.02	4.0	4.0	0	1.00
AH-12 (Single Phase & Polyphase)	115	25–60	2200	2200	0	6.5	6.5	0	1.00
AP-9 (Single Phase)	120	25–125	8220	8220	0.009	1.75	1.75	0	1.00
AR (Single Phase & Polyphase)	110	Up to 125	2690	3690	0	3.3	3.3	0	1.00
AR-2 (Single Phase)	115	25–60 500 W	2600	2600	0	5.6	5.6	0	1.00
CD-3-4 (Single Phase)	115	25–60	1100 #	1100	0.19	13.1	13.1	0.9	1.00
CR-2 to 7 incl	115	25	1570 #	256	9.67	9.1	1.4	9.0	0.16
12 to 25 incl	115	60	1090 #	120	2.87	13.3	1.4	13.2	0.11
C-4-6-7, CP (Single Phase)	110	60	108 #	105	0.06	133.0	130.0	27.8	0.98
C-4-6-7, CP (Polyphase)	110	60	114 #	113	0.02	126.0	126.0	8.4	1.00
C-20-21, CP-4-5 (Polyphase) CD-3-4-7-8, CDP-3-4, CD-27-28	110	Up to 125	1100 #	1110	0.12	13.1	13.1	0.5	1.00
C-12 to 17 incl, each element	110	25	1570 #	256	9.87	9.1	1.4	9.0	0.16
C-12 to 17 incl, each element	110	60	1090 #	120	2.87	13.3	1.4	13.2	0.11
H, H-5 (Single Phase & Polyphase)	110	Up to 125	2210	2210	0.01	6.5	6.5	0	1.00
H-2 (Single Phase & Polyphase)	110	Up to 125	2320	2320	0.01	6.2	6.2	0	1.00
P (Single Phase)	110	Up to 125	2800	2800	0.01	5.1	5.1	0	1.00
P-3-4-7 (Single Phase)	110	Up to 125	5500	5500	0.01	2.6	2.6	0	1.00
P-3-4-7 (Polyphase)	110	Up to 125	3300	3300	0.01	4.4	4.4	0	1.00
P-6 (Single Phase)	110	Up to 125	2250	2250	0.01	6.4	6.4	0	1.00
PL-2 (Single Phase)	100	Up to 125	840	840	0	17.1	17.1	0	1.00
S (Form WSP)	150	60	94	92	0.05	132.0	130.0	20.7	0.98

For explanation of Reference Marks, see page 3.

Attachment 2
to JC-Q1P81-90024
SHEET 17 OF 17

angle e ·or is normally so small that it can be neglected in all bu the most exacting measurements.

In general terms, a Ratio Correction Factor (RCF) greater than 1—for instance, 1.002—will cau e the meters and instruments in the secondary circuit to read low (0.2 percent low for an RCF of 1.002).

A negative (lagging) phase-angle error will cause a wattmeter in the secondary circuit of a potential transformer to read high (for the normal situation of lagging line power factors). This results from the fact tha· a lagging potential phase-angle error decreases the power factor angle of the secondary circuit, over what it was in the primary circuit, by decreasing the angle by which the current lags the voltage as shown in Fig. 9. Since the watt reading results from the product of the voltage, current, and power factor (cosine of power-factor angle), a decreased angle gives an apparent higher power factor which makes the wattmeter read high.

STANDARD ACCURACY CLASSIFICATION

The USASI Standards for Instrument Transformers, USAS C57.13, has standardized on a method of classifying potential transformers as to accuracy. As the accuracy is dependent on the burden, standard burdens have been designated, and these are the burdens at which the accuracy is to be classified.

The standard burdens have been chosen to cover the range normally encountered in service and are listed by the letters W, X, Y, Z, and ZZ, as follows:

USASI STANDARD BURDENS FOR POTENTIAL TRANSFORMERS

Burden	Volt-amperes at 120 volts	Burden Power Factor
W	12.5	0.10
X	25.0	0.70
Y	75.0	0.85
Z	200.0	0.85
ZZ	400.0	0.85

NOTE—USASI Standards state that standard burdens for potential transformers shall have the same volt-ampere and power-factor values for all frequencies.

It should be pointed out that the burden of any specific meter or instrument may approximate, but seldom is the same as, any one of the standard burdens. The standa. burden serves merely as a standardized reference point at which the accuracy of the transformer may be stated.

The accuracy classification as given by USASI is as follows:

USASI ACCURACY CLASSES FOR POTENTIAL TRANSFORMERS

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

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

The *Ratio Correction Factor* (RCF) has been defined as the factor by which the marked ratio must be multiplied in order to obtain the true ratio.

The *Transformer Correction Factor* (TCF) represents a method of setting down in one number, the combined effect of the ratio error and the phase-angle error on wattmeter or similar measurements where the change in power factor from primary to secondary circuits enters the measurement. TCF is defined as the factor by which a wattmeter reading must be multiplied to correct for the combined effect of the instrument transformer ratio correction factor and phase angle. The limits of TCF, as indicated in the table above, have been set up by USASI for the range of load power factor set forth in the table. If the power factor of the primary circuit is outside this range, the TCF of the transformer also may be outside the limits specified, even though the transformer is correctly listed as one which will meet a certain accuracy class.

Since published data on potential-transformer characteristics, as well as the data given on transformer calibration certificates, are usually given in the form of ratio correction factor and phase-angle error, it is necessary to have a means of interpreting these data in terms of the accuracy classification given in the table. This is done as follows:

For any known ratio correction factor of a given potential transformer, the positive and negative limiting values of the phase-angle error (γ) in minutes may be adequately expressed as follows:

$$\gamma = 2600\ (\mathrm{TCF} - \mathrm{RCF})\dagger.$$

†The formula—$\gamma = 2600\,(\mathrm{TCF}\text{-}\mathrm{RCF})$—and the parallelograms of Fig. 10 derived from it are approximate only. The correct formula is: $\mathrm{Cos}\,(53.13^\circ + \gamma) = 0.6\,\frac{\mathrm{RCF}}{\mathrm{TCF}}$. However, the approximate formula introduces very little error into the calculation and is entirely adequate for normal purposes.

F2250

Attachment 3
to JC-1Q1P81-90024
SHEET 1 OF 4

doble

TECHNICAL SPECIFICATIONS

F2253 is the only product offered by Doble in F2250 series.

F2251 and F2252 are no longer a part of Doble product line.

TOGETHER WE POWER THE WORLD

F2250 POWER SYSTEM SIMULATORS

General Specifications

Source Operation:
Accuracy specifications include all errors contributed by variations in power line voltage, load regulation, stability, and temperature, up to full output power. Stable source operation in four quadrants: load power factor from 1 to 0, leading or lagging. The F2250 Family is supplied with a Certificate of Calibration traceable to the National Institute of Standards and Technology.

Source Power:
May be lower than the maximum rating at frequencies other than 50/60 Hz or DC.

Electrostatic Discharge Immunity:
IEC 801-2: I.E.C. performance level 1 @ 10 KV: normal performance within specifications. I.E.C. performance level 2 @ 20 KV: no permanent damage.

Surge Withstand Capability:
ANSI/IEEE C37.90. The F2250 functions as a source during surge withstand capability tests, when the specified isolating circuit is interposed between the F2250 and the test relay.

AC Amplitude Accuracy:
From 20° to 30° C, ±0.4% of reading maximum at 50/60 Hz From 0° to 50° C, ±0.5% of reading absolute maximum Typically 0.2% of reading.

Distortion:
Low distortion sine waves; total harmonic distortion: 0.2% typical; 2% maximum at 50/60 Hz.

Noise:
-80 dB of range

Phase Angle:

Range:	0 to + 359.9° (Lead) / 0 to -359.9° (Lag)
Accuracy:	±0.25° at 50/60 Hz
Resolution:	±0.1° at 50/60 Hz

Frequency:

Range:	dc; ac from 0.1 Hz to 10 kHz
Accuracy:	From 0° to 50° C, ±0.0005% or ±5 PPM; at 60 Hz frequency accuracy is ±0.0003 Hz
Manual Ranges:	dc; ac: base frequency of 50/60 Hz, up to 20th and the 100th harmonic

F2010 Minicontroller/Automation Ranges and Resolutions:

Range: 0.1 to 9999.9 Hz

Range is dependent on the frequency selection on the simulator. When the frequency selection on the simulator is 60 (50) Hz, range is 0.1 Hz to 99.999 Hz with 0.001 Hz resolution. When a higher level of harmonic is selected on the simulator, then the range is the base range (0.1 - 99.999 Hz) multiplied by the selected level of harmonic, and the resolution is equal to the order of the harmonic times (0.001 Hz).

Example 1: If the base frequency selection is 120 (or 100) Hz, which is the second harmonic, then the range is 0.2 Hz to 199.99 Hz with a resolution of 0.002 Hz.

Example 2: If the base frequency selection is 300 (or 250) Hz, which is the fifth harmonic, then the range is 0.5 to 499.99 Hz with a resolution of 0.005 Hz.

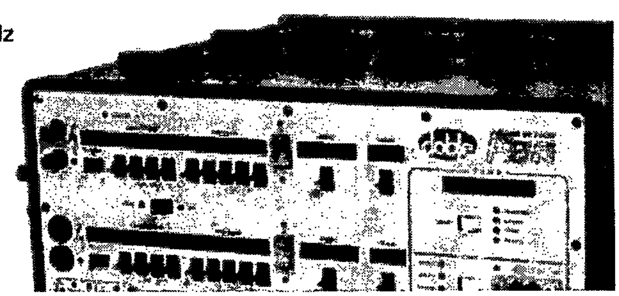
RAMP/SET:
RAMP: Continuously increments/decrements voltage, current, and phase angle at different ramp rates. Insures smooth, linear changes in value carried to next significant digit, by changing the least significant digit.

Ramp Rates: • Least Significant Digits per Second (L.S.D./s).

Amplitude: 1,5,10, 100 and 1000 L.S.D./s

Phase Angle: 1,2,5, 360 L.S.D./s.

SET: Individually sets each digit, with next significant digit carry over.



Attachment 3
to JC-1Q1P81-90024
SHEET 2 OF 4

General Specifications — continued

Logic Outputs:
Two sets of galvanically isolated Logic Outputs, each set has a normally open (Form A) terminal, shared common terminal, and a normally closed (Form B) terminal.

Switching Power: 10 watts maximum

Input Voltage: 300 V-dc and (or) ac peak maximum

Switching Current: 0.2 A make or break maximum

Carry Current: 0.3 A maximum

Operate Time: 1 millisecond maximum

Logic/Signal Inputs:
Two sets of galvanically isolated Logic/Signal Inputs, each set has a voltage sensing terminal for ac or dc voltage, a shared common terminal, and a dry contact sensing terminal.

Contact Sense Mode, for dry contacts:

Open Circuit Test Voltage: 30 volts nominal
Short Circuit Test Current: 90 mA nominal
Threshold: 460 ohms nominal

Voltage Sense Mode, for ac and dc voltages:

Input Voltage: 420 volts dc and (or) peak ac maximum

Input Impedance: 100 K ohms nominal

Threshold: 1.5 volts nominal

Multi-Mode Digital Timer:
Accuracy: ±0.0005% of reading, ± one least significant digit, ±50 microSeconds.

Resolution: 10 microSeconds. (1 least significant digit).

Ranges: 0 - 9999.99 milliseconds; 0 - 9999.99 seconds; 0 - 9999.99 cycles;

GPS time of day may be displayed when using the F2895 GPS Option

Line Power Supply:
105 - 132 V or 210 - 264 V (field selectable) at 47-63 Hz

Operating Temperature: 0° to 50° C

Storage Temperature: -25° to +70° C

Humidity: Up to 95% relative humidity, non-condensing.

Displays: 0.3" High Intensity filtered LED

Interfaces:
RS232 remote control to PC

IEEE 488 instrument inter-communications network

D232 for F2010 Minicontroller

External Signal inputs for voltage and current conditioning amplifier

Battery Simulator (optional):
Range: 48 V, 125 V, 250 V-dc

Power: 60 w

Enclosure:
High impact, molded, flame retardant ABS
- Meets National SafeTransit Association testing specification

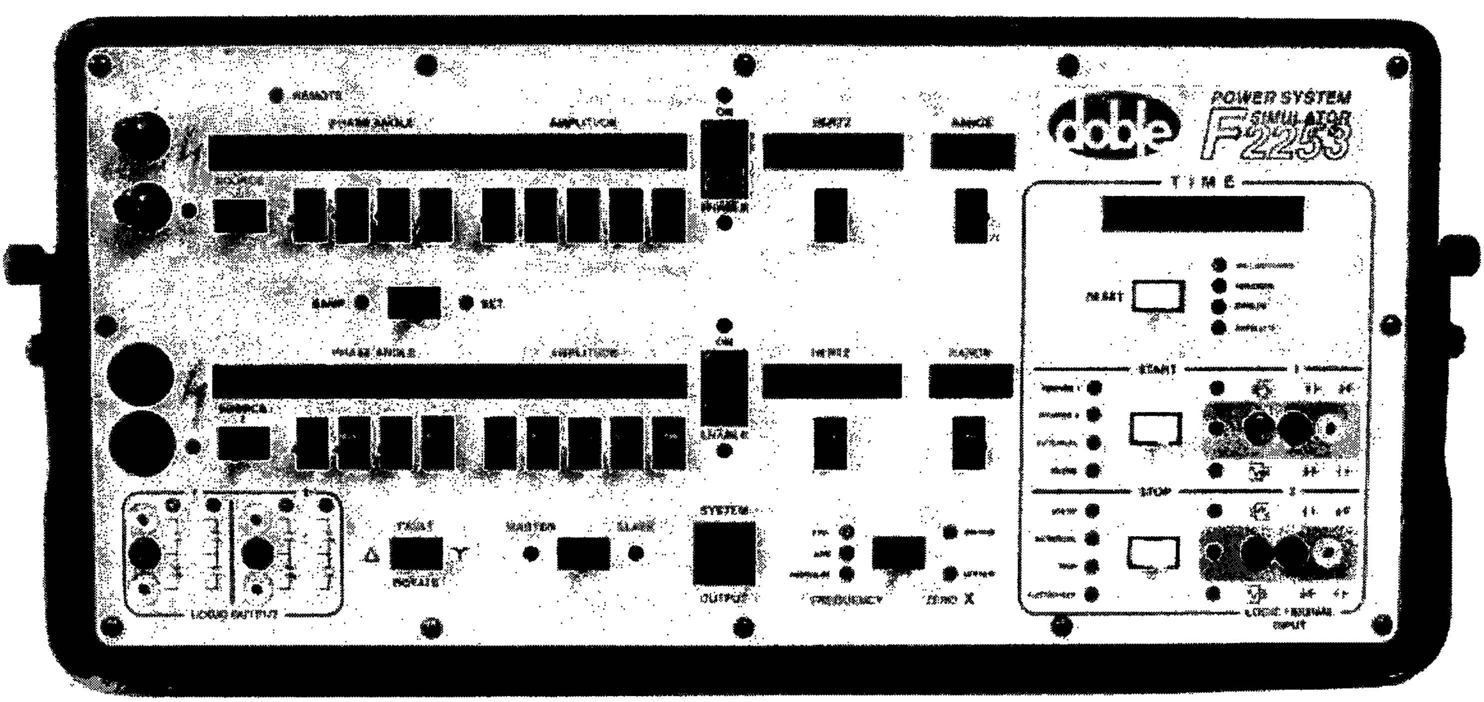
No. 1A for immunity to severe shock and vibration

Dimensions:
9.5 x 19.75 x 22 inches or 24 x 50 x 55.8 cm

Weight:
50 lbs./22.7 kg

Audible Noise:
Measured at 2 meters: ANSI Type 2

Typically: Front: 52.5 dBA Rear: 55 dBA
L.H.: 54 dBA R.H.: 52.5 dBA



F2253 VOLTAGE AND CURRENT SOURCES

Attachment 3
to JC-1Q1P81-90024
SHEET 3 OF 4

MODE 1: Source 1 Voltage
Source 2 Current

	Power 50/60/Hz & DC	Ranges (Resolution)
Source 1 AC Voltage		
Continuous Power	150 VA-rms	75, 150, 300 V-rms (0.01V)
Source 1 DC Voltage		
Continuous Power	150 watts	106, 212, 424 V-dc (0.01V)
Source 2 AC Current		
1.5 second Transient	675 VA-rms	15, 30, 45, 60, 90 (0.01A), 180 A-rms (0.1A)
Continuous Power	450 VA-rms	7.5, 15, 22.5, 30, 45 (0.001A), 90 A-rms (0.01A)
Source 2 DC Current		
1.5 second Transient	675 watts	15, 30, 45, 60, 90 (0.01A), 180 A-dc (0.1A)
Continuous Power	450 watts	5, 10, 15, 20, 30 (0.001A), 60 A-dc (0.01A)

MODE 2: *Source 1 Current*
Source 2 Current

	Power 50/60/Hz & DC	Ranges (Resolution)
Source 1 AC Current		
1.5 second Transient	225 VA-rms	15, 30, 60 A-rms (0.01A)
Continuous Power	150 VA-rms	7.5, 15, 30 A-rms (0.001A)
Source 1 DC Current		
1.5 second Transient	225 watts	15, 30, 60 A-dc (0.01A)
Continuous Power	150 watts	5, 10, 20 A-dc (0.001A)
Source 2 AC		
Current 1.5 second Transient	450 VA-rms	15, 30, 60 (0.01A), 120 A-rms (0.1A)
Continuous Power	300 VA-rms	7.5, 15, 30, 60 A-rms (0.001A)
Source 2 DC		
Current 1.5 second Transient	450 watts	15, 30, 60 (0.01A), 120 A-dc (0.1A)
Continuous Power	300 watts	5, 10, 20, 40 A-dc (0.001A)

F2252 VOLTAGE AND CURRENT SOURCES

MODE 1: Source 1 Voltage
Source 2 Current

	Power 50/60/Hz & DC	Ranges (Resolution)
Source 1 AC Voltage		
Continuous Power	150 VA-rms	75, 150, 300 V-rms (0.01V)
Source 1 DC Voltage		
Continuous Power	150 watts	106, 212, 424 V-dc (0.01V)
Source 2 AC Current		
1.5 second Transient	450 VA-rms	15, 30, 60 (0.01A), 120 A-rms (0.1A)
Continuous Power	300 VA-rms	7.5, 15, 30, 60 A-rms (0.001A)
Source 2 DC Current		
1.5 second Transient	450 watts	15, 30, 60 (0.01A), 120 A-dc (0.1A)
Continuous Power	300 watts	5, 10, 20, 40 A-dc (0.001A)

Attachment 3
to JC-1Q1P81-90024
SHEET 4 OF 4

MODE 2: Source 1 Current
Source 2 Current

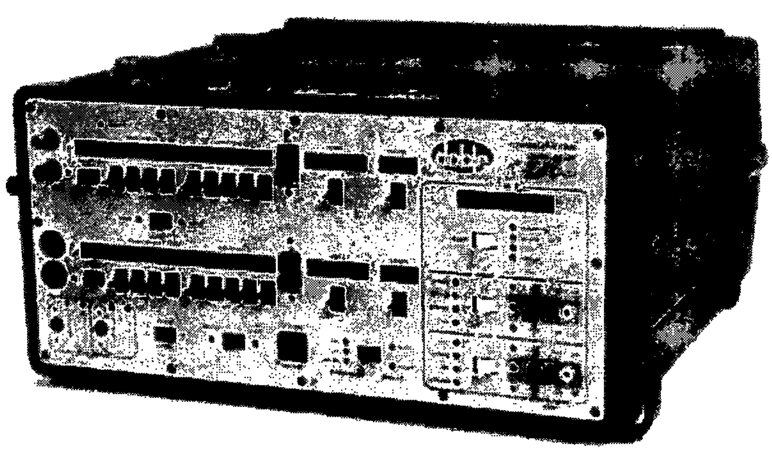
	Power 50/60/Hz & DC	**Ranges (Resolution)**
Source 1 AC Current		
1.5 Second Transient	225 VA-rms	15, 30, 60 A-rms (0.01A)
Continuous Power	150 VA-rms	7.5, 15, 30 A-rms (0.001A)
Source 1 DC Current		
1.5 Second Transient	225 watts	15, 30, 60 A-dc (0.01A)
Continuous Power	150 watts	5, 10, 20 A-dc (0.001A)
Source 2 AC Current		
1.5 second Transient	225 VA-rms	15, 30, 60 A-rms (0.01A)
Continuous Power	150 VA-rms	7.5, 15, 30 A-rms (0.001A)
Source 2 DC Current		
1.5 second Transient	225 watts	15, 30, 60 A-dc (0.01A)
Continuous Power	150 watts	5, 10, 20 A-dc (0.001A)

F2251 VOLTAGE AND CURRENT SOURCES

	Power 50/60/Hz & DC	**Ranges (Resolution)**
Source 1 AC Voltage		
Continuous Power	150 VA-rms.	75, 150, 300 V-rms (0.01V)
Source 1 DC Voltage		
Continuous Power	150 watts	106, 212, 424 V-dc (0.01V)
Source 2 AC Current		
1.5 second Transient	225 VA-rms	15, 30, 60 A- rms (0.01A)
Continuous Power	150 VA-rms	7.5, 15, 30 A-rms (0.001A)
Source 2 DC Current		
1.5 second Transient	225 watts	15, 30, 60 A-dc (0.01A)
Continuous Power	150 watts	5, 10, 20 A-dc (0.001A)

Specifications are subject to change without notice.

For more information, contact fserieshelp@doble.com



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Doble is certified ISO 9001:2000
Doble is an ESCO Technologies Company

MKT-SL-F2250TS-09/08

DESIGN VERIFICATION COVER PAGE

☐ ANO-1 ☐ ANO-2 ☐ IP-2 ☐ IP-3 ☐ JAF ☐ PLP
☐ PNPS ☐ VY ☒ GGNS ☐ RBS ☐ W3 ☐ NP

Document No. JC-Q1P81-90024	Revision No. 3	Page 1 of 4
Title: Division III Degraded Bus Voltage Setpoint Validation (T/S 3.3.8.1)		

☒ Quality Related ☐ Augmented Quality Related

DV Method: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
☐	Electrical	
☐	Mechanical	
☒	Instrument and Control	Robin Smith [signature] 11/8/13
☐	Civil/Structural	
☐	Nuclear	
☐		
☐		

Originator: Mary Coffaro / M. Coffaro 11/8/13
Print/Sign/Date After Comments Have Been Resolved

DESIGN VERIFICATION CHECKLIST

Sheet 1 of 3

IDENTIFICATION:				DISCIPLINE:
Document Title: Division III Degraded Bus Voltage Setpoint Validation (T/S 3.3.8.1)				☐ Civil/Structural ☐ Electrical ☒ I & C ☐ Mechanical ☐ Nuclear ☐ Other
Doc. No.:	JC-Q1P81-90024	Rev. 3	QA Cat. 1	
Verifier:	Robin Smith Print	[signature] Sign	4/8/13 Date	
Manager authorization for supervisor performing Verification. ☒ N/A	Print	Sign	Date	

METHOD OF VERIFICATION:		
Design Review ☒	Alternate Calculations ☐	Qualification Test ☐

The following basic questions are addressed as applicable, during the performance of any design verification. [ANSI N45.2.11 – 1974] [NP QAPD, Part II, Section 3][NP NQA-1-1994, Part I, BR 3, Supplement 3S-1].

NOTE The reviewer can use the "Comments/Continuation sheet" at the end for entering any comment/resolution along with the appropriate question number. Additional items with new question numbers can also be entered.

1. Design Inputs – Were the inputs correctly selected and incorporated into the design?
   (Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable.
   All inputs need to be retrievable or excerpts of documents used should be attached.
   See site specific design input procedures for guidance in identifying inputs.)

   Yes ☒ No ☐ N/A ☐

2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed? *Are the latest applicable revisions of design documents utilized?*
   Yes ☒ No ☐ N/A ☐

3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?
   Yes ☒ No ☐ N/A ☐

4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?
Yes ☒ No ☐ N/A ☐

5. Construction and Operating Experience – Have applicable construction and operating experience been considered?
Yes ☒ No ☐ N/A ☐

6. Interfaces – Have the design interface requirements been satisfied and documented?
Yes ☒ No ☐ N/A ☐

7. Methods – Was an appropriate design or analytical (for calculations) method used?
Yes ☒ No ☐ N/A ☐

8. Design Outputs – Is the output reasonable compared to the inputs?
Yes ☒ No ☐ N/A ☐

9. Parts, Equipment and Processes – Are the specified parts, equipment, and processes suitable for the required application?
Yes ☐ No ☐ N/A ☒

10. Materials Compatibility – Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
Yes ☐ No ☐ N/A ☒

11. Maintenance requirements – Have adequate maintenance features and requirements been specified?
Yes ☒ No ☐ N/A ☐

12. Accessibility for Maintenance – Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
Yes ☐ No ☐ N/A ☒

13. Accessibility for In-service Inspection – Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
Yes ☐ No ☐ N/A ☒

14. Radiation Exposure – Has the design properly considered radiation exposure to the public and plant personnel?
Yes ☐ No ☐ N/A ☒

15. Acceptance Criteria – Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
Yes ☐ No ☐ N/A ☒

16. Test Requirements – Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
Yes ☒ No ☐ N/A ☐

17. Handling, Storage, Cleaning and Shipping – Are adequate handling, storage, cleaning and shipping requirements specified?
Yes ☐ No ☐ N/A ☒

18. Identification Requirements – Are adequate identification requirements specified?
Yes ☐ No ☐ N/A ☒

19. Records and Documentation – Are requirements for record preparation, review, approval, retention, etc., adequately specified? Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?
Yes ☒ No ☐ N/A ☐

20. Software Quality Assurance- ENN sites: For a calculation that utilized software applications (e.g., GOTHIC, SYMCORD), was it properly verified and validated in accordance with EN- IT-104 or previous site SQA Program?
ENS sites: This is an EN-IT-104 task. However, per ENS-DC-126, for exempt software, was it verified in the calculation?
Yes ☐ No ☐ N/A ☒

21. Has adverse impact on peripheral components and systems, outside the boundary of the document being verified, been considered?
Yes ☒ No ☐ N/A ☐

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date	
1	Comments provided by markup	Comments resolved Comments incorporated	RS/ 9-15-12	Comm