
	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 10 02 Double-Ended Substation
		Date: 8/1/17
		Author: Office of Facilities
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Change History

Date	Description of Change	Pages / Sections Modified	Change Approver Initials
8/1/17	Updated section for System Design and Performance Requirements and Manufacturers	5>6 – C. 4.c..&d.; m; remove p. 8 – F.	SO
6/15/16	Updated division section from 16361_D to 26 10 02, removed references to other section numbers	-	mgl44
11/21/14	Amend text to refer to standard 16950 Electric Utility Meter; removed meter specific details and re-sequence subparagraphs.	12 - 16361-D; C.#4.m & m. 1. (System Design and Performance Requirements)	SO
11/21/14	Add paragraph # 8, re-sequence sub-paragraphs; Amend text in paragraph #10 all for clarity.	16 – 16361-D; H. #8 & #10	SO
10/17/14	Amend text in section C at various sub-paragraphs and add subparagraphs C.4.n. and C.4.o. to clarify existing conditions, intent and requirements.	9>14 - 16361-D; C. #2.b & 2.g, #3.d & 3.e, #4.c, 4d, 4.l , 4.m.2), 4.m.5), 4.m.6) 4.n. & 4.o. (System Design and Performance Requirements)	SO
10/17/14	Add text to paragraph #2 subset Shop Drawings Information, item c.to clarify nameplate data.	15 - 16361-D; D. #2.c (Submittals)	SO
10/17/14	Add comment to item #3.	16 - 16361-D; F .#3 (Manufacturers)	SO
10/17/14	Add new paragraphs #8, #9 & #10 under 'Unit substation transformer standard features' section. + Add text to paragraph #16 under 'Automatic throwover standard features' section.	17 - 16361-D; H. (Accessories or Special Features)	SO
10/17/14	Amend text in section H under 'Automatic throwover standard features;' to clarify existing conditions, intent and requirements.	17>18 - 16361-D; H (auto throwover section) #9, #12 & #16.	SO
10/17/14	Amend text to paragraph #1 + Add text in paragraph #3.	18 - 16361-D; K (Installation Guidelines)	SO
10/17/14	Add section after existing item#7 at end of first section to define operation with arc flash relays installed + Amend title of section to add (Includes Arc Flash System).	22>24 - 16361-D; Attachment 1 (ATO Operating Instructions Three-Breaker Automatic Throwover Summary of Normal Operation)	SO
10/17/14	Edit text to reduce desired operating times for protection scheme(s) to take place.	25 - 16361-D; Attachment 1 (II. Automatic Retransfer Between Sources (Closed Transition))	SO
10/17/14	Edit text to reduce desired operating times for protection scheme(s) to take place in Section B) (Manual Transfer (Closed Transition)).	25>26 - 16361-D; Attachment 1 (IV. Manual Operation via Breaker Control Switching)	SO

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A. Summary

This section contains design criteria for secondary unit substation which consisting of primary selector switches with fuses, cast coil copper wound substation transformers, and secondary switchgear and main protective devices.

B. References


The following industry standards, codes, and guidelines describe how the overall system should be designed:

1. ANSI C37.121, 1989 – Secondary Unit Substations
2. ANSI C37.13 – Low-voltage Power Circuit Breakers
3. ANSI C37.17 – Trip Devices
4. ANSI C37.20 – Switchgear Assemblies
5. ANSI C39.1 – Meters
6. ANSI C62.1 – Surge Arresters
7. NEMA ST 20, 1997 and IEEE C.57.12.01 – dry-type, cast coil, 2-winding, substation transformer for indoor application
8. UL 486A, UL 486B and UL 1558
9. NETA Acceptance Test Specifications (ATS)
10. Transformer efficiency shall comply with new D.O.E. Standards
11. ANSI c57.1201

C. System Design and Performance Requirements

Equipment service conditions shall meet temperature range of 0 to 40 degree C and humidity range of 5 to 95 percent, non-condensing.


1. System shall consist of two duplex load interrupter switches with two cast coil copper wounded transformers with a 480 V switchgear. The switchgear shall contain main-tie-main draw-out electrical operated circuit breaker with an automatic throw-over scheme.
2. Normal Primary/Incoming Section Equipment

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- a. The primary of the system shall be a two load interrupter switches to a common fuse that will allow the connection to the transformer to one of two incoming lines mounted inside dead-front metal enclosed compartment with a view window and with a close couple connection to the transformer section. Each primary switch that receives the radial feeders shall have 18 kV station class lightning/surge arresters.
- b. Each duplex interrupter switch shall have two sets of synchronized sources incoming lines. One switch shall be directly connected to the campus radial and the other switch shall be a jumper from the other set of duplex switches. These switches are provided for manual primary close transition throwover. Each switch section shall have a strip space heater.
- c. Terminals shall be compression-type for use with low smoke, zero halogen type and size 500 MCM cables.
- d. Maximum design voltage shall be 15 kV with Basic Impulse Level 95 kV and continuous current rating of 600A.
- e. One set of three power fuses shall be mounted in separate compartment within switch cabinet. Fuses shall be accessible through a hinged door, mechanically interlocked with interrupter switch such that entry may only be accomplished by de-energizing the switch.
- f. Interrupter enclosure shall be rated for the environment.
- g. Duplex switches shall have a mimic bus showing incoming and jumper section. Switches shall also have an engraved name plate indicating the fuse type and size.
- h. The interrupter switches shall have Kirk key interlock for locking out system for maintenance purpose
- i. Connections between incoming switches and transformer shall be Buss or with shielded 15 kV cable with a low smoke zero Halogen jacket.
- j. Switches shall be rear accessible.

3. Transformer Section Equipment


- a. Substation transformers shall be dry-type, cast coil, copper wound, 2-winding, air cooled with forced air Class AA/FA rating. Core and coil assembly shall be enclosed in a ventilated steel housing for indoor application.

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- b. Transformer connection shall be delta-wye with 15 kV primary, basic Impulse Level 95 kV and 480 Y/277 volts secondary.
- c. The cast coil transformer shall have 180 degree C or higher insulation including epoxy with 80 degree C rise over 40 degree C.
- d. Cast coil transformer shall include 120/240 VAC cooling fan to provide additional capacity with winding temperature monitor and alarm. This panel shall be fed from CPT in switch gear section. Transformer shall have a separate ground to the building ground bus with a # 4/0 AWG copper wire.
- e. All unit substation shall be grounded in three (3) locations (one on the transformer, one on the main interrupter switches and one on the 480 v switchgear), forming a total of six (6) separate ground paths from the unit substation to the building ground bus. All ground conductors shall not be smaller than size #4/0 Awg copper wire. Insure the ground resistance at the substation is no more than 5 ohms by adding more number of ground conductors, and/or ground rods for building grounding system.
- f. Provide isolation pads to isolate core and coil assembly from casing.
- g. Provide four 2-1/2 percent full capacity taps, two above and two below rated nominal voltage.
- h. Dry type transformer sound level shall not exceed the maximum specified by ANSI C57.1201 as shown below for applicable kVA.
 - 1) 301 – 500 kVA < 60 dB
 - 2) 501 – 700 kVA < 62 dB
 - 3) 701 – 1000 kVA < 64 dB
 - 4) 1500 – 2000 kVA < 65 dB

4. Secondary Low Voltage Switchgear Section Equipment

- a. The switchgear shall be directly connected to the adjacent transformer section and include main- tie-main circuit breaker with automatic/manual secondary close transition throwover with surge protection device. Surge protection shall be mounted directly to the bus in main protection devices section in accordance with the requirement of Transient Voltage Surge Suppression.

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- b. Provide line and load terminals accessible from the front only and they are suitable for conductors termination.
- c. Main and tie circuit breakers shall be electrically operated and true draw-out mounted, RMS sensing electronic trip with LSIG function, insulated case, 100% service rated, two-step stored energy type circuit breaker.
- d. All feeder breakers shall be draw-out type with LSI settings.
- e. For utility plant applications, substation shall be equipped with low voltage power circuit breaker for the entire substation.
- f. Bus connections shall be bolted, and accessible from front for easy maintenance.
- g. Bus or flexible bus link shall be copper and be sized in accordance with NEMA PB 2 Standard.
- h. Sections shall be aligned at front only.
- i. Provide fully equipped future space provisions with bussing and bus connections.
- j. M-T-M circuit breakers shall have a Kirk key lock to lock out system for maintenance.
- k. Substation design shall be suitable for the environment.
- l. If switchgear is separated, the use of conduit and wire shall not be used. Only bus duct or copper bus are approved for this type of installation. This is for the connection of the tie breaker and if switchgear is not directly connected to transformer.
- m. Each 480 V low voltage switchgear section shall be equipped with Schneider PowerLogic 5560 meter and shall be tied into the Yale data collection and storage system. See Yale University Design Standard 33 62 00 'Hydronic, Steam and Electrical Energy Metering' and separate Detail for the complete specification on the PowerLogic Meter and the electrical and communications components necessary to have a complete and functional system.
 - 1. The current transformers for PowerLogic meters, size and quantities are indicated on the drawings. The current transformers with current ratio shall be the class and model as follows:

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100/5 ratio PowerLogic meter shall be class 10 current transformer using an ITI model #21, #22, #115, #144, #297, #298 or #680.

200/5 and 400/5 ratio PowerLogic meter shall be class 20 current transformer using an ITI model #21, #22, #113, #114, #115, #144, #297, #298, #306, #307, #386 or #680.


500/5 and 600/5 ratio PowerLogic meter shall be a class 50 current transformer using an ITI model #115, #297, #298, #306, #307, #386, #388 or #680.

800/5, 1000/5, 1200/5 and 1600/5 ratio PowerLogic meter shall be a class 100 current transformer using an ITI model #115, #306, #386, #388 or #680.

2000/5 and higher ratio PowerLogic meter shall be a class 200 current transformer using an ITI model #115, #306, #386, #388 or #680.

When an Arc Flash system is to be installed, the CTs used for that system shall be as the class 100 series CTs. These CTs shall be a class 100 current transformer using an ITI model #115, #306, #386, #388 or #680.

2. All wiring for CTs shall be #10 AWG stranded SIS type wire.
 3. All PowerLogic meter CT wiring shall be to shorting blocks before being wired to the ABB test block. All wiring from the test block to the meter shall be tagged per the vendor supplied interconnection drawings. Test block shall be ABB style FT-1 and Cat # 129A514G01 with clear covers.
 4. PowerLogic meters shall have an engraved name plate indicating the CT ratio associated with that meter.
 5. All PowerLogic meters shall be tied into Yale's data storage system. Contractor shall run a raceway from the building secure data system to all substations.
- n. Switchgear shall have mimic bus showing breakers and other electrical items associated with the substation.
- o. Substation shall have the trip circuit from each of the two (2) main breakers wired to the section where the PLC is located. Contractor shall run six (6) wires from this location to the building fire alarm system main panel. The button at the fire alarm panel shall trip all the main breakers on the substation and also break the auto throw-over system in the switchgear. The button at

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the fire alarm panel shall contain two N.O. contacts and one N.C. contact for this operation.

D. Submittals

1. Designer Submittals
 - a. The protective devices short circuit and over current protection coordination study shall accompany unit substation submittals and the study shall certify all its components and the substation meets or exceeds the electrical system requirement. Study shall include all 480 v feeder breakers in switchgear.

2. Construction Documents
 Submit the following construction documents:

Product Data


- a. Submit manufacturer's catalog data for secondary unit substations and components including construction details and component and device specifications.

Shop Drawings Information

Submit project-specific shop drawings including the following:

- a. Front and side views of enclosures with overall dimension shown.
- b. Conduit entrance locations and requirements
- c. Nameplate legends, including fuse type & size and the CT ratio associated with each PowerLogic Meter.
- d. Size and number of bus bars per phase, neutral, and ground, including equipment withstand ratings.
- e. Primary selector device, transformer, secondary main-tie-main devices, instrument and metering details.
- f. Instruction for handling and installation of the unit substation.
- g. Electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of equipment and components.

Certified Test Reports

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- a. Provide factory transformer certified loss evaluation report.
- b. Provide field test reports and certify that the system is in compliance with test parameters.

Field Measurements

- a. Make necessary field measurements and provide equipment layout diagram to confirm that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

Operations and Maintenance Data

- a. Provide overcurrent protective device adjusting and testing instructions.
- b. O & M Manuals shall include bus tightening intervals and procedures, and overcurrent protective device maintenance procedures.

E. Product Standards

Products shall conform to the following standards:

1. ANSI C57.1201
2. NEMA PB-2, 1995
3. Latest Codes and Standards
4. Latest D.O.E. Efficiency on Transformers

F. Manufacturers


Subject to compliance with the design requirements, provide unit substation by one of the following manufacturers:

1. Square D
2. Cutler-Hammer/Eaton (Preferred)
3. ABB

G. Equipment


1. Power fuses shall be provided by Bussmann E-rated, GE Type EJ, or Shawmut Type CL-14.

H. Accessories or Special Features

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Unit substation transformer standard features:

1. Stainless steel diagrammatic nameplate mounted on transformer enclosure.
2. Provide provisions for lifting and jacking unit into place.
3. Base suitable for rolling and skidding parallel to centerline.
4. Equip 120 VAC space heaters with thermostat.
5. Include 3 kVA control transformer with a fused primary, 480 VAC to 120/240 VAC, single phase with a throw over capability.
6. Transformer high temperature monitor with local audible and visual alarm and contacts for remote alarm.
7. Each substation shall have a trolley lifting mechanism for the removal of circuit breakers.
8. Each substation shall have a two position selector switch for Maintenance Mode. This switch will toggle between the “ENABLED” and “DISABLED” positions. A white LED will accompany the “DISABLED” position and a blue LED will accompany the “ENABLED” position. The white LED will be lit when the switch is in either position. The blue LED will light when the switch is in “ENABLED” mode. This switch will be tied into the main breaker so that when in “ENABLED” mode the pick-up value of the main breaker will be reduced to a setting that is three settings lower than normal. This is to reduce arc flash hazard and protect personnel.
9. Each substation shall be supplied with a NEMA 1 remote control panel. This panel shall contain red and green LED lights indicating the breaker position of the M-T-M breakers in the switchgear. This panel shall also have a breaker control switch that will open and close each M-T-M circuit breaker. There shall be a terminal block in this panel to be used for the wiring from this panel to the switchgear. Vendor drawings shall show this wiring so the contractor knows where the wiring for this panel is terminated in the switchgear. The electrical contractor shall mount this panel away from the switchgear on a wall or column so that it is not within the arc flash zone, but is in view of the front of the switchgear.
10. Switchgear shall contain an ABB type REA arc flash fiber optic system. Switchgear shall be installed with relays and control wiring at the factory with the arc flash hardware. An ABB certified installer shall install the fiber optic wire at the job site after the major wire and cables have been installed. Each bus shall have as a minimum two (2) fiber loops. The fiber run shall start from and include the


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transformer up to the barrier at the tie breaker. This will be the same for each bus. The tie breaker shall have fiber runs only to include the tie and be independent of all other fiber runs. This system shall have a full functional test before the switchgear is put into service. Switchgear shall have two (2) REA 101 relays with two (2) REA 103 relays with associated hard wire and cables to have a fully functional and operating protection system. Switchgear shall be equipped so that the sections have a barrier that will provide that the flash is contained only within the “A” bus or the “B” bus side. The barrier shall be on both sides of the breaker.

11. Switchgear shall have two (2) sets of CTs, with one set on each incoming line side of the main circuit breaker. CTs shall be a minimum of Class 200 rating. Each CT shall be wired to shorting block and test block before being wired to REA 101 relay. System shall have test blocks so that all arc flash components can be removed without having to power down the substation. For approved PowerLogic Meter CTs see the section C.4.1.2. in this spec., All test blocks shall be ABB type FT with clear covers. All REA 101 relays shall be supplied with clear covers so that accidental contact with the switches is not possible.

Automatic throwover standard features:

1. Main-Tie-Main shall have automatic transfer to alternate source and automatic re-transfer to normal source with close transition.
2. Two sources shall be electrically interlocked.
3. Provide manual circuit breaker operation inhibited button.
4. No time delay on transfer and only re-transfer shall have 10 second delay with close transition.
5. Source stabilization before retransfer shall be set at 10 seconds.
6. Undervoltage sensing (Device 27) on both sources shall be set at 10% differential strap adjustable with local LED indication.
7. Phase loss (Device 47) set at 68% of nominal voltage with local LED indication.
8. Phase sequence (reverse phase) sensing (Device 47) on both sources set at 2 cycles with local LED indication.
9. Phase imbalance (Device 47) set at 2% strap adjustable with local LED indication. For Device 27 and Device 47, relay shall be ABB Cat #412N6175.
10. Provide Auto/Manual switch with removal key interlock and light indication.

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Note: Manual mode operation shall allow operator to parallel both synchronized sources for routine maintenance.

11. Control power shall have an automatic transfer switch between two incoming sources plus a TRIPP Model 4 uninterruptible power supply (UPS) with UPS bypass relay.
12. For AUTO throwover system, the PLC shall be powered by a UPS power supply system for a primary control power. The UPS shall be a TRIPP Model 4 or Eaton Cat# 9W9130L1000T-XL, no substitutes. PLC shall be Allen Bradley, no substitutes.
13. The drawout breakers shall have a full automatic mode in the test position.
14. Provide a test switch for simulating loss of voltage of either source.
15. Provide circuit breaker electrical trip lockout with amber LED light indication.
16. Provide sync check relay (Device 25) if it is required by the manufacturer. If required sync check relay shall be ABB Cat #424K2105
17. Refer to [Attachment 1 – ATO Operation](#) in the end for detailed operation instructions.

I. Extra Materials


1. One spare set of three 15 kV power fuses shall be required.

J. Special Requirements

1. Frame and cover printed operating instructions for unit substations, including key interlocking, control sequences, and emergency procedures, with clear acrylic plastic. Insert instructions in a fabricated frame of finished wood or metal and mount on front of unit substation.

K. Installation Guidelines


1. Install unit substations on 4 inches high concrete housekeeping pad that is both two (2) inches wider and longer than substation widest and longest section. The section with transformer shall have a VIB-X pad between the transformer and the concrete pad for insulation and vibration damping.
2. Tack weld or bolt substation support footings to channel-iron sills embedded in the concrete pad. Install sills level and grout flush with pad surface.

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3. Ground all metal parts of the unit substation to main electrical ground bus at six (6) locations.
4. Unit substation shall be accessible both front and rear.
5. Tighten all electrical connectors and terminals according to manufacturer's published torque values or as specified in UL 486A and UL 486B.
6. Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from substation units and components.

L. Field Quality Control

1. Field Quality Control Testing
 - a. Engage a factory-authorized service representative to supervise the field assembly of components, connections, preliminary testing, controls and safeties adjustment. Replace damaged and malfunctioning components and provide service result report in writing.
 - b. Owner will engage a qualified independent testing agency or an approved manufacturer's service organization to perform specific acceptance testing.
 - c. Perform visual and mechanical inspection and electrical tests stated in NETA ATS or submit equivalent manufacturer's startup procedures.
 - d. Perform load interrupter switchgear testing in accordance with NETA ATS, Section 7.5 Standards or approved equivalent manufacturer's startup procedures.
 - e. Perform air transformer testing in accordance with NETA ATS, Section 7.2 Standards or approved equivalent manufacturer's startup procedures.
 - f. Perform low voltage switchgear testing in accordance with NETA ATS, Section 7.2 Standards or approved equivalent manufacturer's startup procedures.
 - g. After the electrical testing is complete and the substation has been energized, demonstrate product and control capability in compliance with requirements.
 - h. Remove and replace malfunctioning components with new units and retest.
 - i. Provide certified reports that the system is in compliance with test parameters.
 - j. All equipment shall be vacuumed and cleaned prior to energization.
2. Commissioning

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- a. If this portion of the project includes commissioning, verify that insertions in the project specifications have been made that refer to the commissioning procedures in the commissioning specification section. Verify that the systems and equipment identified in this section of the standards, and listed in the project specifications, do not conflict with commissioning procedures for testing and training.

3. Monitoring


After Substantial Completion, when requested by owner, but no more than 6 months after Final Acceptance, commissioning agent will perform the following voltage monitoring and adjusting:

- a. During a period of normal load cycles as evaluated by owner, perform 7 days of 3-phase voltage recording at the low voltage switchgear outgoing section of the unit substation. Use voltmeters with calibration traceable to National Institute of Standards and Technology standards and with a chart speed of no less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period is unacceptable.
- b. If test results are unacceptable, take the following corrective actions, as appropriate:
 - Adjust transformer taps
 - Rebalance loads
 - Send a written request to the electrical utility for voltage adjustment
- c. Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
- d. Provide a written report describing voltage monitoring performance and corrective action taken

M. Cleaning and Adjusting

1. Clean and vacuum interior of separate enclosures to remove construction debris, dirt, and shipping material. Wipe all buses and terminals to remove dust with water or alcohol damped cloth.

N. Startup and Training

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Engage a factory-authorized service representative to train owner’s maintenance personnel as specified below:


1. Train owner’s maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals. Refer to Division1, Section 01730 Project Execution and Closeout.
3. Review data in the maintenance manuals. Refer to Division1, Section 01782 Operation and Maintenance Data.
4. Schedule training with owner, through Architect, with at least 7 days’ advance notice.

Attachment 1 – ATO Operation

When the “Control Power” light is on, the PLC is energized and it is functioning properly.

ATO OPERATING INSTRUCTIONS THREE-BREAKER AUTOMATIC THROWOVER SUMMARY OF NORMAL OPERATION (Includes Arc Flash System)

1. The selector switch is in AUTO mode, Source #1, (Main breaker), Source # 2 (Main breaker) and the Tie breaker are open. Source # 1 and Source # 2 are both energized only when their respective utility is available. When each source bus is energized the corresponding source main breaker will close after a 5 second time delay. However if both sources fail to energize no action will be taken by the PLC. Once one of the sources becomes available the dead bus side shall be transferred to the available energized bus by closing the tie breaker. Once the failed source is restored the PLC will monitor the source for 10 seconds for assured stability before issuing a retransfer via closed transition.
2. If both main breakers are closed and the tie breaker is open and if both sources fail, and then return simultaneously, no action is taken. The PLC will issue a transfer to the normal main if it is found to be open and its source is available.
3. No transfers will be allowed if one of the source mains trips due to an over-current or ground - fault situation. All such trips must be reset before normal operations can commence.
4. Once a transfer has occurred, if the tie breaker trips, it shall remain tripped / open until a manual reset is performed.
5. All interlocking of breakers are hardwired in the breaker close circuitry and programmed within the PLC to prevent the paralleling of unsynchronized sources. The PLC will

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perform the automatic commands within the boundaries set forth in the interlocking.

6. Manual operations are performed by placing the selector switch in MANUAL mode and via the use of the breaker control switches. The PLC will not be able to perform any automatic operations while the selector switch is in MANUAL mode. The auto mode light (blue) will turn off to alert the operator that the ATO is in MANUAL mode and no longer under PLC control.
7. If a breaker is commanded closed and does not close within 2 seconds, the breaker is then “locked out” via the PLC. The “Control Power” light will begin to blink to indicate a problem. To acknowledge and reset this alarm, switch the TRANSFER MODE SELECTOR to MANUAL. Switch back to AUTO for PLC controls operation. The system is equipped with a TEST switch to simulate loss of sources to test the ATO operation. The TEST switch can be placed in M1 FAIL mode to simulate a loss of Source # 1 or in M2 FAIL mode to simulate a loss of Source # 2. The simulation is all within the PLC program and thus no true power loss will occur. The inhibited source indication light will strobe and the system will operate as if a loss of power had occurred. True monitoring of the sources will remain uninhibited such that if one of the sources truly does fail while using the TEST switch the PLC will cancel the testing operation and begin addressing the true loss of power.


With ARC FLASH Relays Installed.

The throw over system shall operate the same as stated above if there are no presents of an ARC in the gear. When an ARC Flash is detected the following shall take place in the gear.

Under normal conditions the two main breakers are closed and the Tie breaker is open. When an ARC is detected the side that the sees the ARC (say The “A” side) that Main breaker will trip.

The Tie breaker shall be blocked so that the Tie breaker does not close. This trip shall be initiated by the ARC Flash relay directly and not through the PLC. The same event on the “B” side with the Main on that side will trip. Again the Tie breaker does not close. This trip shall be initiated by the ARC Flash relay directly and not through the PLC.

When the Unit substation is in the condition of, one main breaker closed and the Tie is closed the following shall be the system operation.

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When an ARC flash is detected depending on the location of the ARC the following will take place:

Condition 1: The “A” side main breaker is closed and the Tie Breaker is closed.

If the Arc is detected between the “A” side main and the Tie breaker, than the following will happen:

The “A” side main will open, the Tie will open and the “B” side Main will close. All of the trips shall be initiated by the ARC Flash relay directly and not through the PLC.

If the Arc is detected in the side after the Tie and on the “B” side section of the gear than the following will happen:

The Tie breaker will open and the “A” side main will remain closed. The “B” side Main beaker will be blocked so that this breaker cannot close. This trip shall be initiated by the ARC Flash relay directly and not through the PLC.

Condition 2: The “B” side main breaker is closed and the Tie Breaker is closed.

If the Arc is detected between the “B” side main and the Tie breaker than the following will happen:

The “B” side main will open, the Tie will open and the “A” side Main will close. All of the trips shall be initiated by the ARC Flash relay directly and not through the PLC.


If the Arc is detected in the side after the Tie and on the “A” side section of the gear than the following will happen:

The Tie breaker will open and the “B” side main will remain closed. The “A” side Main beaker will be blocked so that this breaker cannot close. This trip shall be initiated by the ARC Flash relay directly and not through the PLC.

I. AUTOMATIC SEQUENCE OF OPERATION (OPEN TRANSITION):

* Selector Switch is in AUTO mode.

A) LOSS OF POWER TO LOAD BUS # 1

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When power to LOAD BUS # 1 drops below the threshold settings of the load bus under-voltage relay, the PLC will open the source 1 breaker, 52-1 and initiate a transfer to Source # 2 IMMEDIATELY by closing the tie breaker 52-T. All loads will be serviced by Source # 2 until Source # 1 is restored and stable for 10 consecutive seconds.

B). LOSS OF POWER TO LOAD BUS # 2


When power to LOAD BUS # 2 drops below the threshold settings of the load bus under- voltage relay, the PLC will open the source 2 breaker, 52-2 and initiate a transfer to Source # 1 IMMEDIATELY by closing the tie breaker 52-T. All loads will be serviced by Source # 1 until Source # 2 is restored and stable for 10 consecutive seconds.

II. AUTOMATIC RETRANSFER BETWEEN SOURCES (CLOSED TRANSITION):

The ATO is still operating in AUTO mode and no faults have been detected. Upon return of the failed source, the PLC will monitor that source for 10 seconds to assure stability before retransfer. After 10 seconds and upon synchronization between the two sources for 0.5 second, as indicated by the synchronization light, the PLC will keep the tie breaker closed and also close the restored source main breaker to complete the retransfer of the load to its normal source. The PLC will open the tie breaker after a set time delay 0.5 second adjustable between 0.1-10 second once it has received confirmation that the normal source main has closed. If any main breaker trips due to an over-current or ground fault situation, before or after any transfers, then that main will not be able to close again until a manual reset is performed to clear all faults. If both sources fall simultaneously such that no source is available then the PLC will keep both source main breakers in their last state until one of the sources become available again. Automatic transfers will commence as previously described only when sources are available and no faults are present.

III. AUTOMATIC RETRANSFER BETWEEN SOURCES (OPEN TRANSITION):

The ATO is still operating in AUTO mode and no faults have been detected. Upon return of the failed source, the PLC will monitor that source for 10 seconds to assure stability before retransfer. After 10 seconds, the PLC will open the tie breaker and close the restored source main breaker to complete the retransfer of the load to its normal source. If any main breaker trips due to an over-current or ground fault situation, before or after any transfers, then that

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main will not be able to close again until a manual reset is performed to clear all faults. If both sources fall simultaneously such that no source is available then the PLC will keep both Source main breakers in their last state until one of the sources become available again. Automatic transfers will commence as previously described only when sources are available and no faults are present.

IV. MANUAL OPERATION VIA BREAKER CONTROL SWITCHING

Manual operations via the breaker control switches disable PLC automatic transfer operations. The transfer of sources is via open or closed transition and is enabled when switching from AUTO mode to MANUAL mode.


To manually transfer the load from its normal source to the alternate source when the normal Source is still available, do the following:

A) MANUAL TRANSFER (OPEN TRANSITION)

1. Turn the Selector switch to Manual mode. The auto mode light (blue) should turn off.
2. Verify that the alternate source is still available by noting whether the availability light is still on for that source.
3. After verification, open the normal source main breaker and close the tie breaker by using the tie breaker control switch to initiate a transfer of load service to the alternate source main breaker.

B) MANUAL TRANSFER (CLOSED TRANSITION)

1. Turn the selector switch to MANUAL mode. The auto mode light (blue) should turn off.
2. Verify that the synchronization of sources light (green) is on. **(NOTE):** The signal for this light is provided by the synchronization check relay (25). This some relay supplies the signal to enable Paralleling in the interlocking scheme for the mains and tie breakers.
3. After verification, close the tie breaker while the normal source main breaker and the alternate source main breaker is closed by using the tie breaker control switch to initiate a closed transition transfer of load service. **(NOTE):** Prolonged paralleling of

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sources can create a hazardous condition to the equipment and to the operator. Therefore, on adjustable 0.1-1.0 second external timer circuit (Factory set for 0.5 sec) is incorporated to limit the time of paralleling of the synchronized sources. If paralleling of sources exceeds the set time limit the tie breaker will open to remove the paralleling of sources.

4. After completing a manual transfer, turn the selector switch back to AUTO if automatic operation (PLC control) is desired. If the selector switch is left in MANUAL the auto mode light will remain off as a reminder that the switchboard is operating in MANUAL mode.

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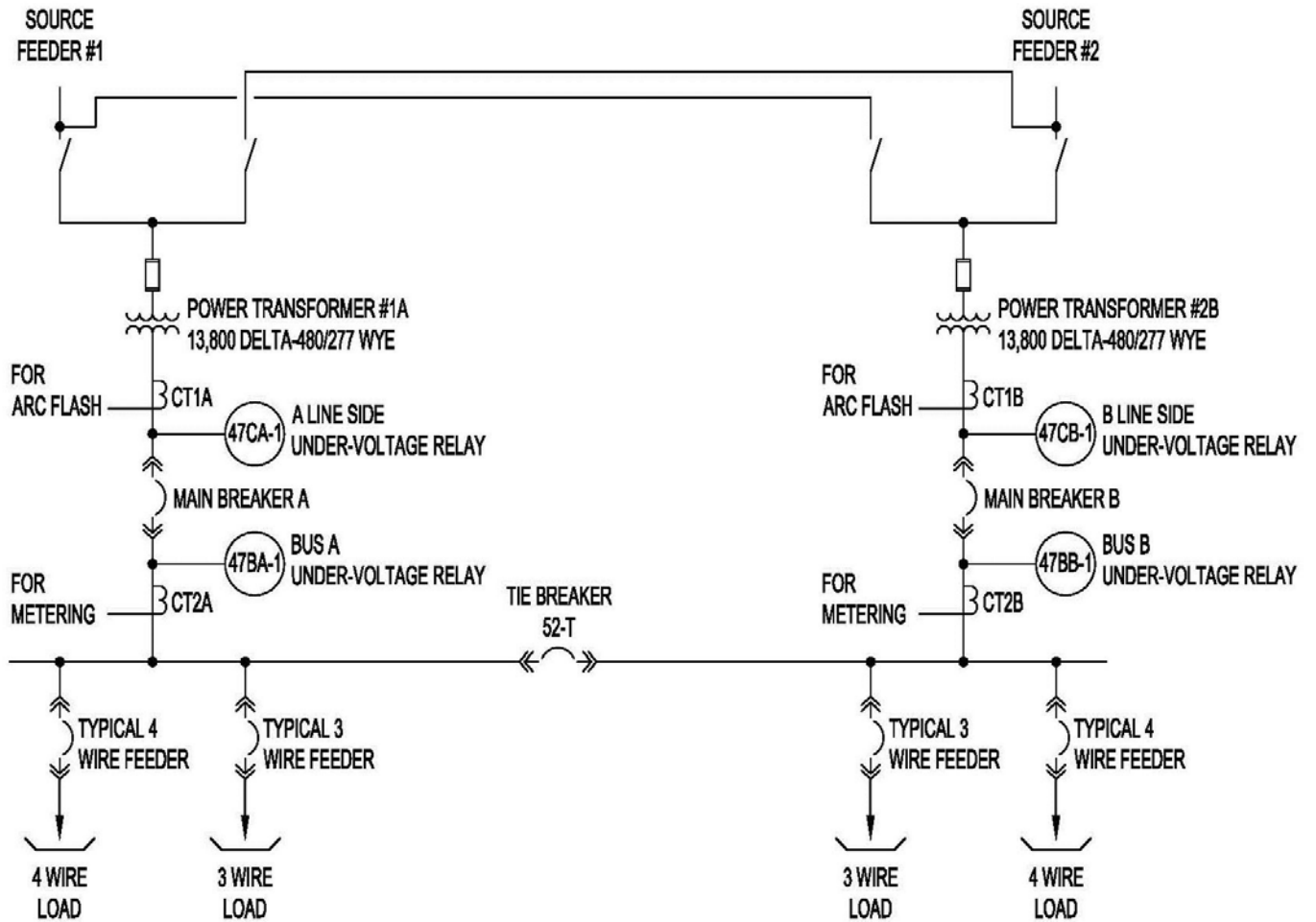



FIGURE 1-1

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OPERATION MODE
 CLOSED

TRIP PRESELECT
 52-1 52-T 52-2

TRANSFER MODE
 MANUAL

RETRANSFER MODE
 AUTO MANUAL

LOCAL BREAKER CONTROLS

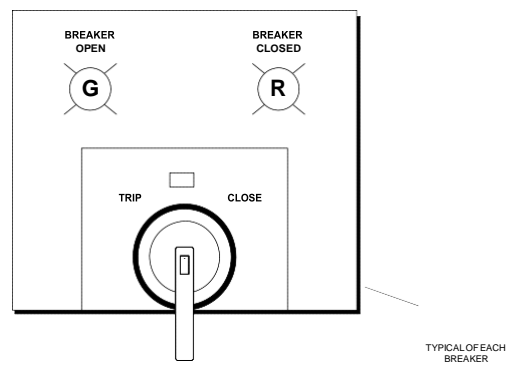

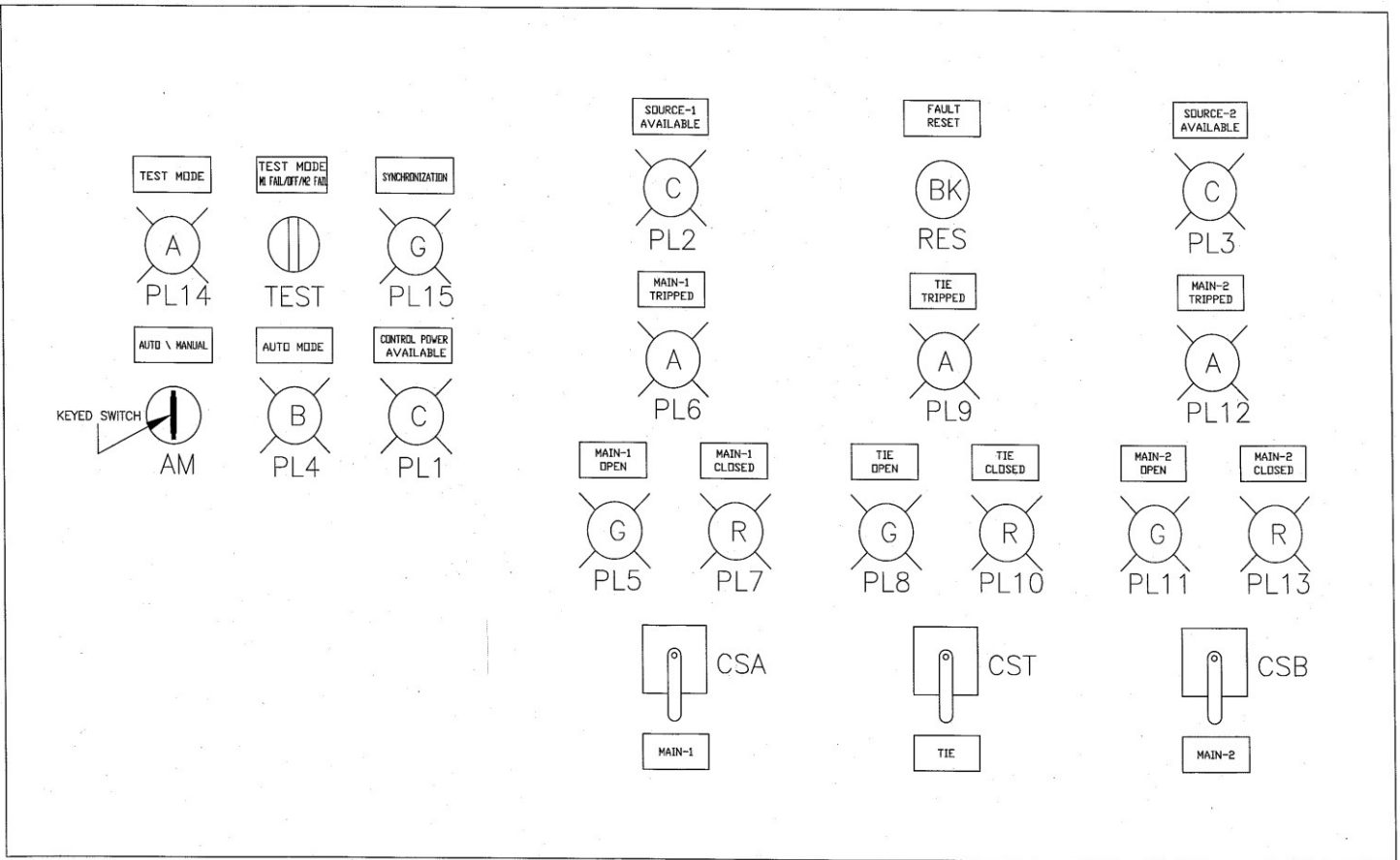



FIGURE 1-2

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ATO CONTROLS DETAIL 'A'
 4" X 3" ENGRAVED NAMEPLATE

FIGURE 1-3

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