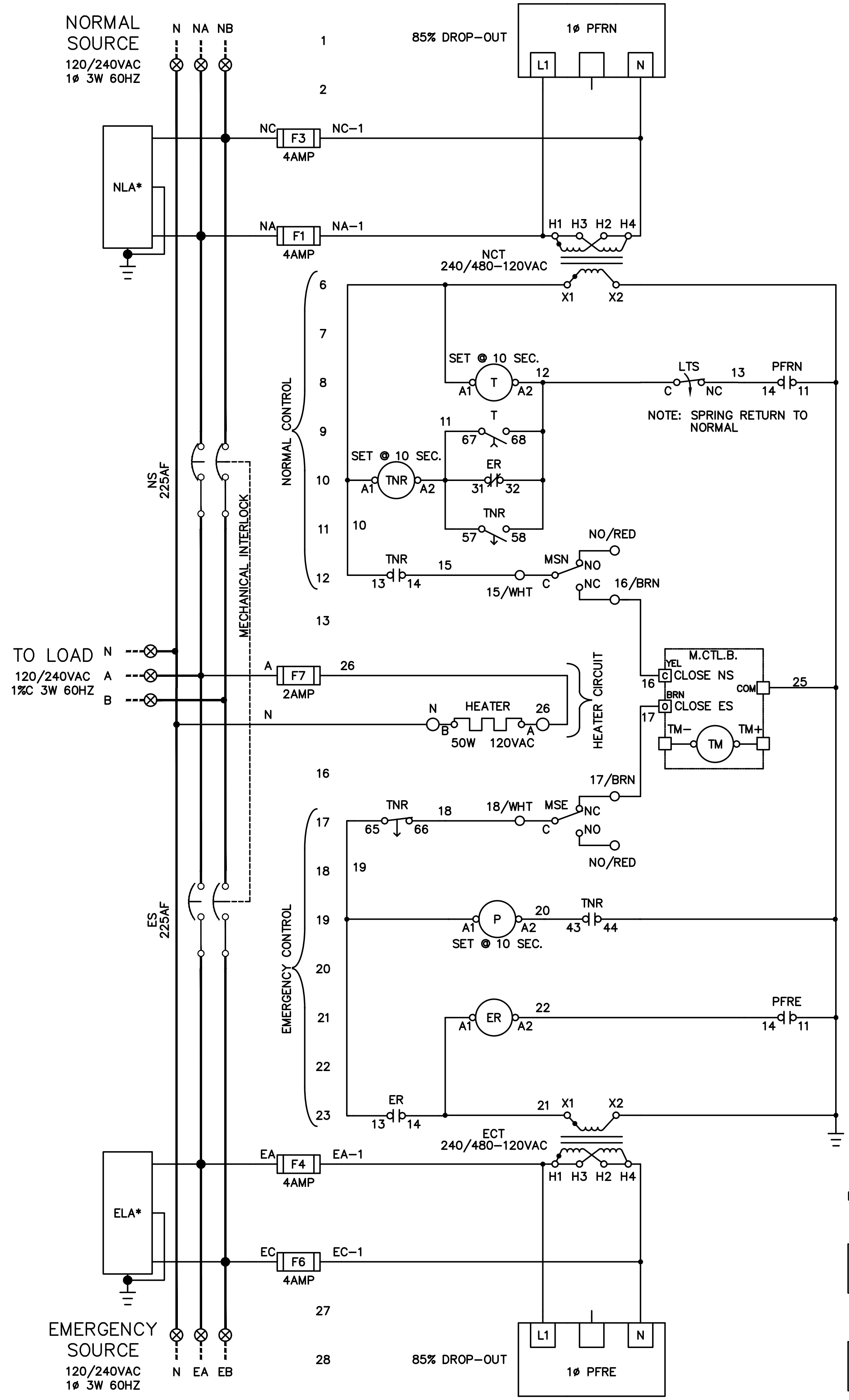
INSTALLING, OPERATING AND MAINTAINING

AUTOMATIC TRANSFER SWITCHES

AS MANUFACTURED FOR FLORIDA POWER & LIGHT

WITH ELECTROMECHANICAL CONTROLS

Lake Shore Electric Corporation
205 Willis Street
Bedford, OH 44146
Toll Free: 800-225-0141
Phone: 440-232-0200
Fax: 440-232-5644



PFRN PHASE FAILURE RELAY (NORMAL) 8

NLA NORMAL SURGE SUPPRESSOR

F1–3 FUSE (4AMP)

NCT NORMAL CONTROL TRANSFORMER

T TIME DELAY TO PICKUP RELAY (ON DELAY) (.1–30 SEC) 9

LTS LOAD TEST SWITCH

TNR NORMAL CONTROL RELAY TIMED & INST. (OFF DELAY) 11,12,17,19

MSN MICRO SWITCH (NORMAL)

NS NORMAL SWITCH

M.CTL.B. MOTOR CONTROL BOARD

F7 FUSE (2AMP) (FOR HEATER CKT)

TM TRANSFER MOTOR

ES EMERGENCY SWITCH

MSE MICRO SWITCH (EMERGENCY)

P TIME DELAY TO DROPOUT RELAY (OFF DELAY) (.1–30 SEC) 25,27

ER EMERGENCY CONTROL RELAY 10,23

ECT EMERGENCY CONTROL TRANSFORMER

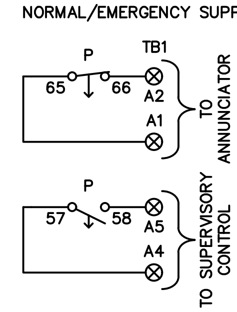
F4–6 FUSE (4AMP)

ELA EMERGENCY SURGE SUPPRESSOR

PFRE PHASE FAILURE RELAY (EMERGENCY) 21

25

NORMAL/EMERGENCY SUPPLY UNDERVOLTAGE ALARM



NOTES

1) ALL RELAYS, TIMERS, SWITCHES & CIRCUIT BREAKERS ARE SHOWN IN THE NORMAL POSITION & DE-ENERGIZED STATE
⊗ 2) CUSTOMER CONNECTION TERMINAL BLOCK (TB1)
○ 3) LAKE SHORE CONNECTION TERMINAL BLOCK (TB2/3)
4) CUSTOMER WIRING
5) CUSTOMER CABLING
* 6) OPTIONAL EQUIPMENT
7) USE 14GA SIS WIRE
8) INCLUDE DESICCANT BAGS AND 2 SETS OF DRAWINGS IN ENCLOSURE PRIOR TO SHIPMENT.
9) TERMINATE CONTROL WIRES WITH RING LUGS WHERE POSSIBLE

REV	DESCRIPTION	BY	APV	DATE
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

LAKE SHORE ELECTRIC Corp
BEDFORD, OHIO U.S.A.

STYLE 2 225A 2P 3Ø 4W 277/480V
-

SCALE: - | DRN: - - | CHK: - - | APV: - -

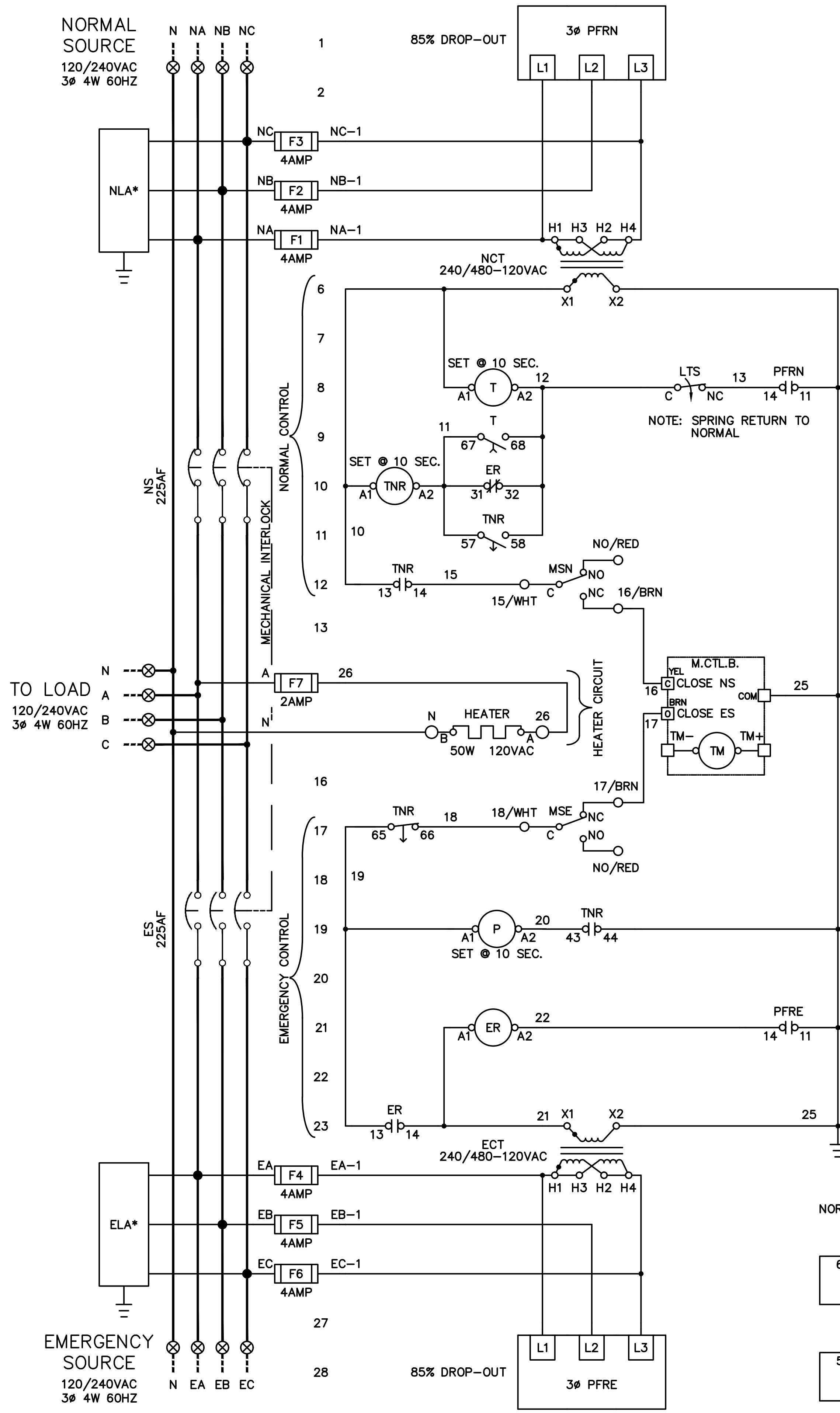
PROJ: -
-

CUSTOMER: FLORIDA POWER AND LIGHT COMPANY
-

DWG NUMBER FPL220225C_-04 -

QUOTE/JOB#: -

PG 1 OF 1



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F1-3 FUSE (4AMP)

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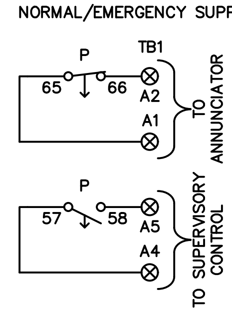

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-	-	-	-	-
-	-	-	-	-

LAKE SHORE ELECTRIC Corp
BEDFORD, OHIO U.S.A.

STYLE 2 225A 3P 3Ø 4W 120/240V
-

SCALE: - | DRN: - - | CHK: - - | APV: - -

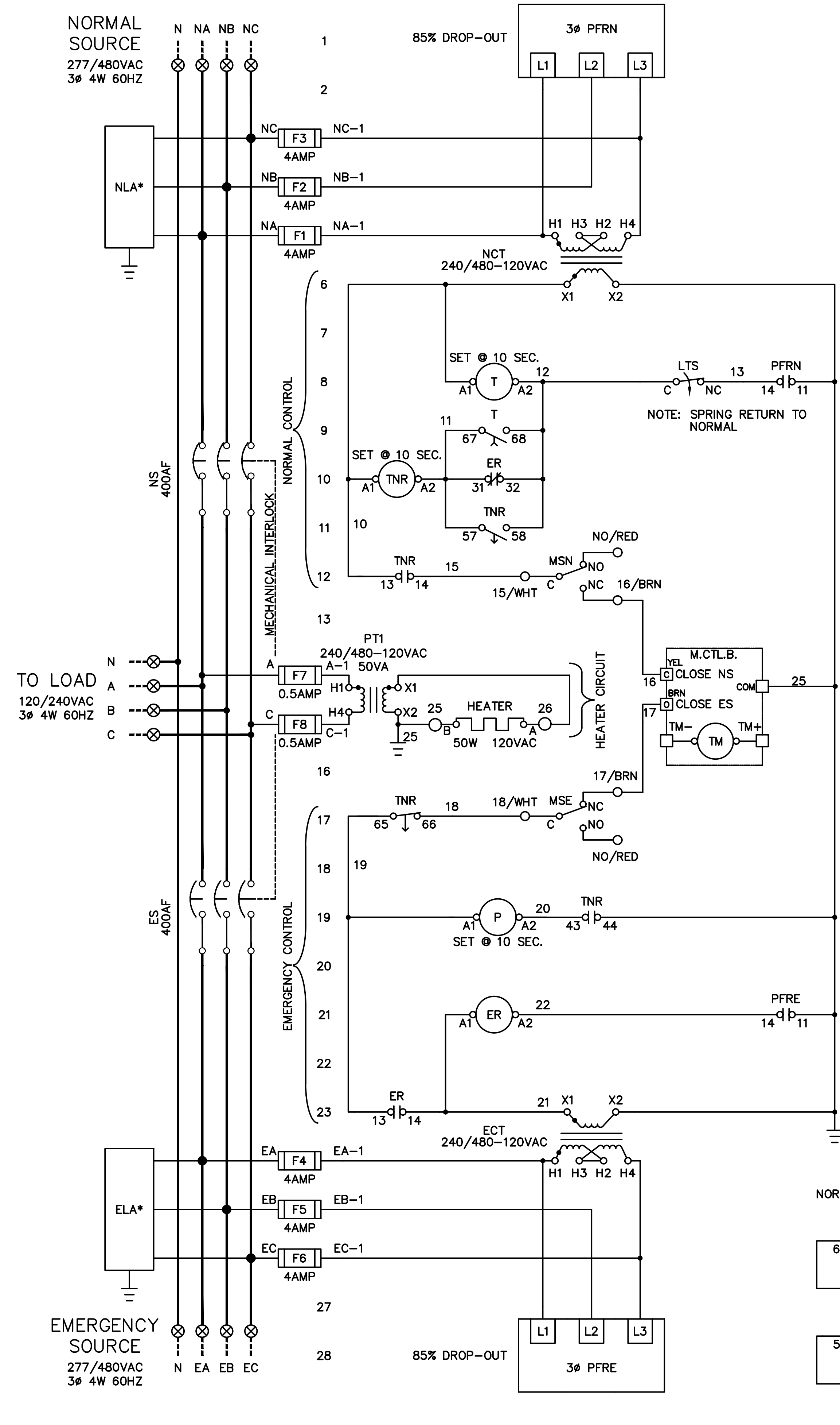
PROJ: -
-

CUSTOMER: FLORIDA POWER AND LIGHT COMPANY
-

DWG NUMBER FPL230225G_-03 -

QUOTE/JOB#: -

PG 1 OF 1



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F1-3	FUSE (4AMP)
NCT	NORMAL CONTROL TRANSFORMER
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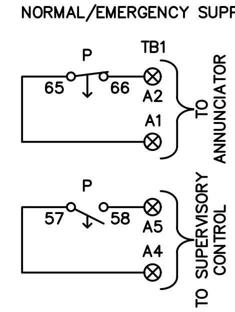

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-	-	-	-	-
-	-	-	-	-

LAKE SHORE ELECTRIC Corp
BEDFORD, OHIO U.S.A.

FPL230400CI ATS
277/480VAC 3P 3Ø 4W 400A

SCALE: - | DRN: --- --/--/-- | CHK: --- --/--/-- | APV: --- --/--/--

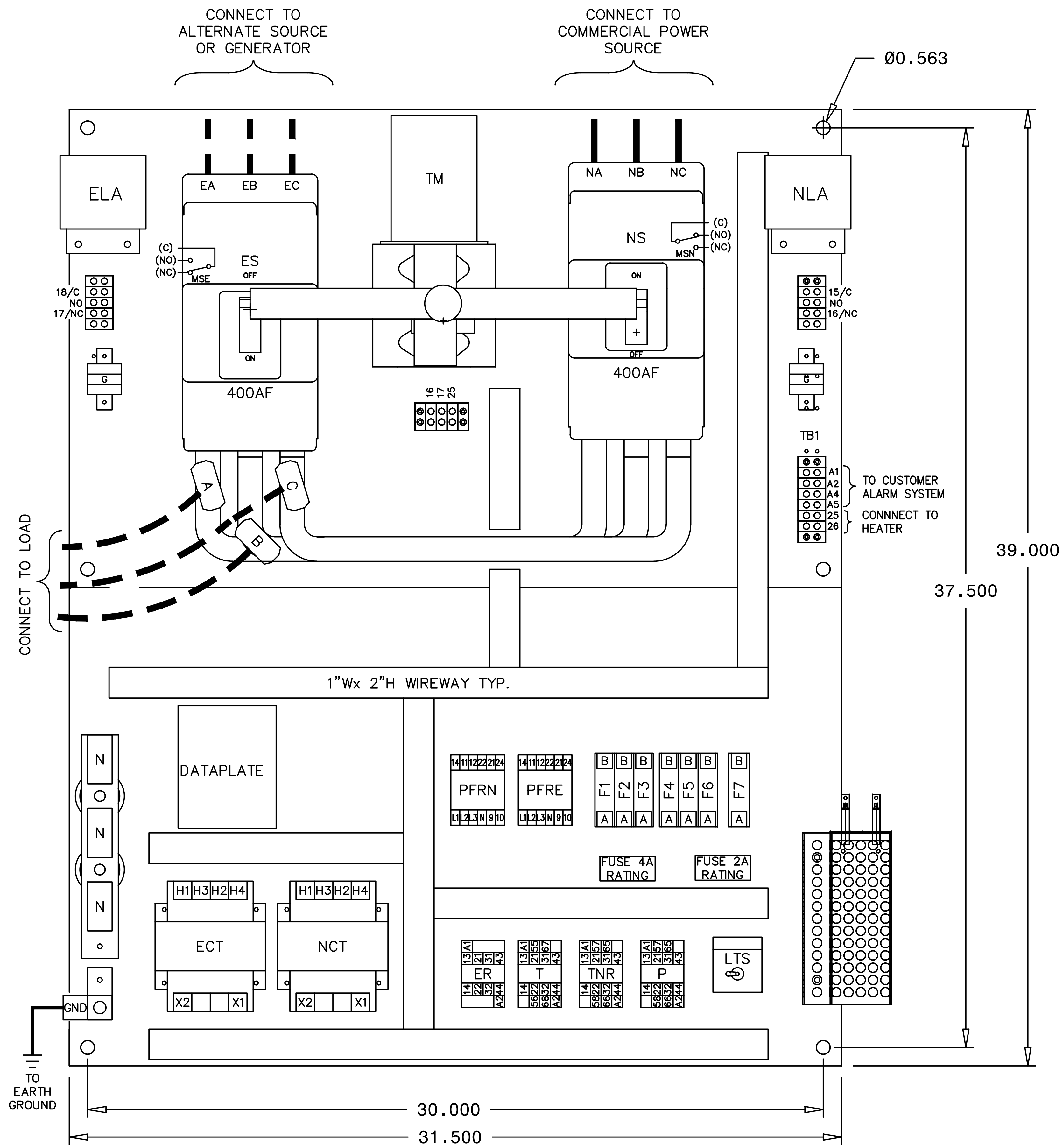
PROJ: M&S NUMBER 0-283-408-090
-

CUSTOMER: FLORIDA POWER AND LIGHT COMPANY
-

DWG NUMBER 1X1-0XXX-03 -

QUOTE/JOB#: -

PG 1 OF 1



LUG/CONNECTION DATA:

CURRENT RATING	STANDARD LUG	OPTIONAL LUG
A) 400A:	(1) 2/0-500MCM OR (2) 2/0-250MCM	(1) 500-600MCM
B) GROUND	(1) #14-1/0	

REV	DESCRIPTION	BY	APV	DATE
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

LAKE SHORE ELECTRIC Corp
BEDFORD, OHIO U.S.A.

STYLE 2 400A 3P 3Ø 4W 277/480
-

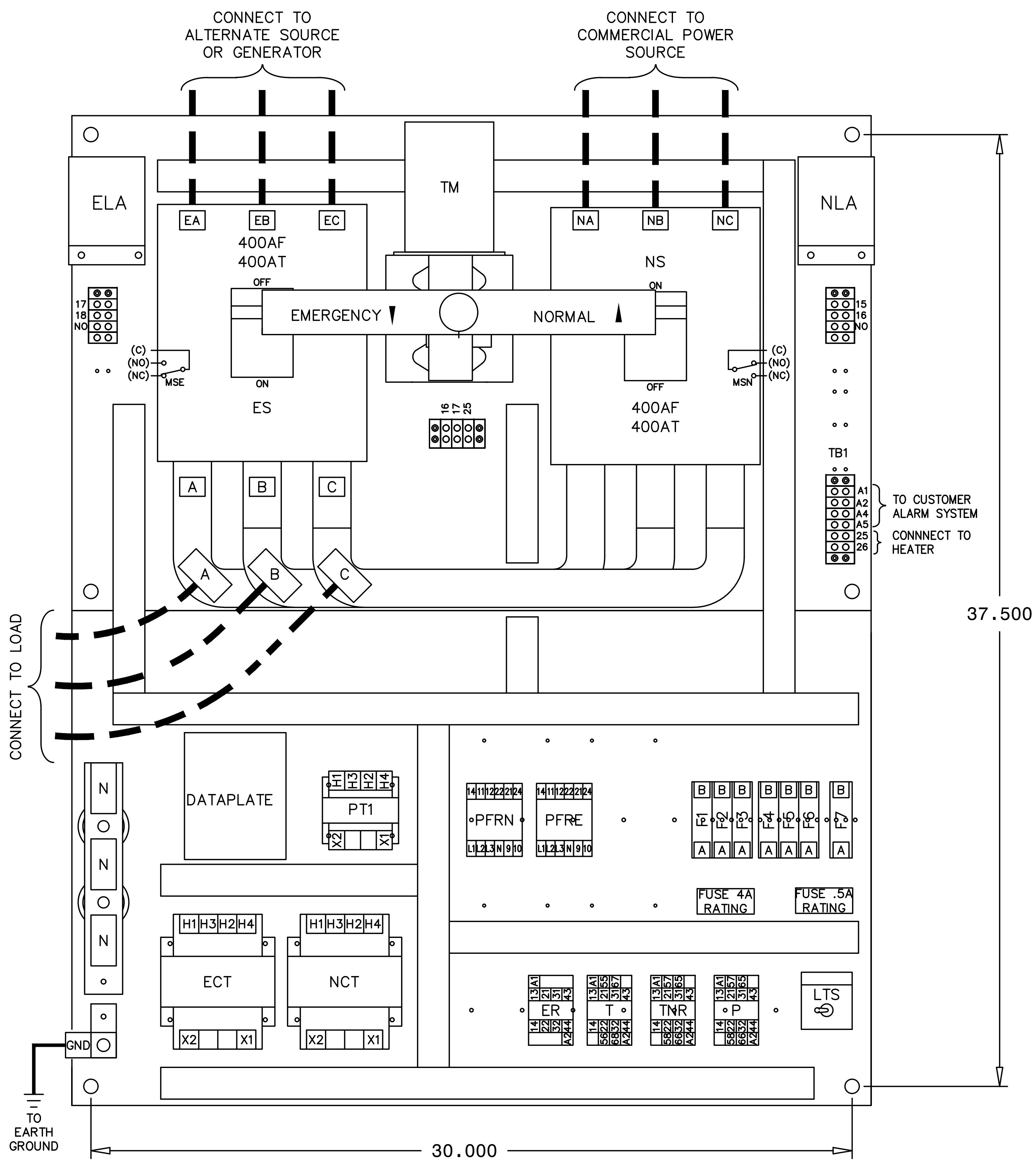
SCALE: 1=5 | DRN: --- --/--/-- | CHK: - - | APV: - -

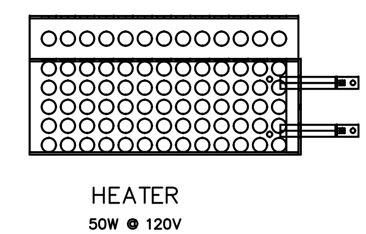
PROJ: -
-

CUSTOMER: FLORIDA POWER AND LIGHT COMPANY
-

DWG NUMBER: FPL230400G_-04 CH | -

QUOTE/JOB#: - | PG 1 OF 1





NOTE –
HEATER TO BE LOCATED
ON ENCLOSURE FLOOR.
IF OPEN–TYPE, HEATER
TO BE SHIPPED LOOSE AND
MOUNTED BY CUSTOMER.

REV	DESCRIPTION	BY	APV	DATE
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

LAKE SHORE ELECTRIC Corp
BEDFORD, OHIO U.S.A.

FPL230400CI ATS
277/480VAC 3P 3Ø 4W 400A

SCALE: 1=5 | DRN: --- --/--/-- | CHK: --- --/--/-- | APV: --- --/--/--

PROJ: M&S NUMBER 0-283-408-090
-

CUSTOMER: FLORIDA POWER AND LIGHT COMPANY
-

DWG NUMBER: 1X1-0XXX-04 | -

QUOTE/JOB#: - | PG 1 OF 1

WARNING!

WHEN WORKING ON EQUIPMENT OF THIS TYPE, EXTREME DANGER OF ELECTROCUTION EXISTS THAT MAY RESULT IN INJURY OR DEATH. DO NOT ATTEMPT ANY REPAIRS OR ADJUSTMENTS TO THIS EQUIPMENT WITHOUT FIRST TAKING THE APPROPRIATE PRECAUTIONS TO PREVENT PERSONAL INJURY AND EQUIPMENT DAMAGE.

DURING INSTALLATION AND USE OF THIS PRODUCT, COMPLY WITH THE NATIONAL ELECTRICAL CODE (NEC), FEDERAL, STATE AND LOCAL CODES, AND ALL OTHER APPLICABLE SAFETY CODES.

MAIN UTILITY / EMERGENCY POWER MUST BE OFF DURING INSTALLATION, WHEN PERFORMING EQUIPMENT MAINTENANCE OUTSIDE THE EQUIPMENTS NORMAL MAINTENANCE SCOPE AND WHEN PERFORMING REQUIRED MAINTENANCE ON ANY POWER CABLE(S) CONNECTED TO THE EQUIPMENT. TAKE ANY OTHER PRECAUTIONS DETERMINED TO PREVENT PERSONAL INJURY AND EQUIPMENT DAMAGE.

WARRANTY

Lake Shore Electric Automatic Transfer Switches are guaranteed against defective materials and workmanship for a period of one year from date of shipment. If, within one year after shipment, it is proved to Lake Shore's satisfaction that the equipment requires valid warranty work and Lake Shore is promptly notified of same, Lake Shore will make necessary corrections, free of charge. F.O.B. works where manufactured.

Such necessary corrections constitute the full extent of Lake Shore's warranty. There are no warranties, which extend beyond those described herein. This warranty is exclusive and is in lieu of all other warranties, whether written, oral, implied or statutory. No warranty of merchantability or of fitness for purpose shall apply.

Lake Shore is not responsible for damage to its equipment through improper installation or use, unauthorized repair or modifications, or attempts to operate it above its rated capacities or in abnormal environments. In no event, whether as a failure to meet conditions of the warranty or otherwise, shall Lake Shore be liable for any special, incidental, or consequential damages, including, but not limited to, loss of profit or revenues, loss of good will, damages to associated equipment, cost of capital, cost of substitute products, facilities, service or replacement power, costs of downtime or claims of third parties for such damages.

> **Notice:** The owner of this automatic transfer switch must perform certain required maintenance functions as described in **APPENDIX A**, **APPENDIX B**, and **APPENDIX C** of this manual in order to maintain Lake Shore's one year exclusive warranty. Failure to perform this maintenance shall void the warranty.

Table of Contents

NOTE

Engineering changes may have been made after publication date. Any departure from this manual should be checked with Lake Shore Electric Corporation.

Lake Shore Electric Corporation reserves the right to change specifications without prior notice.

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1. CONSTRUCTION

All of the molded case switches and/or circuit breakers are electrically interlocked through control relays and auxiliary switches, and mechanically interlocked through a walking beam mechanism which is located on the rear of the baseplate. This mechanism is a fulcrum and lever device which positively prevents both molded case switches or circuit breakers from being on the ON position simultaneously. It provides a "Fail-Safe" design.

The gear motors can operate on either AC or DC, and the gear reduction unit is permanently lubricated so that no maintenance is required.

All transfer switches are provided with an insulated operating handle to enable personnel to manually operate the transfer switch should this become necessary. The handle is permanently mounted and readily accessible in an emergency.

All relays are of the industrial type to ensure long life and minimum maintenance. All relays are rated for continuous duty to eliminate overheating of coils. The only relays that are continuously energized are the Phase Failure Relay Normal (PFRN), Time Delay to Pickup (T) and the Normal Control Timer (TNR).

All timed control relays are of the pneumatic type.

Standard wiring harnesses are manufactured from 16-gauge insulated machine tool wire. All control circuits are protected with fuses.

2. DESCRIPTION OF OPERATION

Normally, the transfer switch operates on the preferred power source with the Normal molded case switch in the closed position and the Emergency molded case switch in the open position. (Refer to Wiring Diagrams, Pages 7, 9 and 11.

> **Note:** These wiring diagrams are for reference only and should not be used in place of wiring diagrams are for reference only and should not be used in place of wiring diagrams for a specific switch.)

All Phases of the preferred power source are continuously monitored by a voltage sensitive relay which is adjustable from 70% to 90% of nominal. In the event of a drop in any phase of the preferred voltage below the drop-out set point the voltage relay, the TNR Timer begins timing.

Upon completion of this ten second delay, the transfer switch motor is energized through the emergency relay and TNR contact opening the Normal switch and closing the Emergency switch, thus affecting the power source transfer. With the switch now operating on the emergency source, the voltage relay continues to monitor the preferred source.

When all phases of the preferred source return to the pickup level of the voltage relay, the "T" Timer begins timing, upon completion of this 10 second delay, the transfer switch motor is energized through the "TNR" contact, opening the Emergency Switch and closing the normal switch, thus affecting the power source transfer.

3. INSTALLATION

3.1. MOUNTING AND CONNECTING

The standard Lake Shore transfer switch is designed for operation in a clean, dry, dust-free location where a minimum of vibration is present.

Enclosed type transfer switches are general designed for wall mounting; however, it is possible to adapt other configurations. Open transfer switches are generally mounted in a switchboard; consequently, there are certain steps which should be followed.

1. Allow adequate space for movement of movement of the manual operating handle.
2. Mount to a rigid framework to prevent vibration.
3. Review all Electrical clearances with the enclosure door or panels closed.
4. On rear connected switches, insure there is no strain on the studs due on improper alignment.
5. Lug sizes and arrangements may vary depending on molded case switch manufacturer.
6. Optional lug arrangements are available but must be specified at the time the transfer switch is ordered. Consult Lake Shore Electric for details.

Before bringing the power cables within the enclosure, be certain that the lugs will be of adequate size. If not, larger lug sizes may be ordered from Lake Shore Electric.

The preferred (normal)source power cable is connected to the Normal molded case switch at the terminals marked NL1, NL2, and NL3 (refer to Wiring Diagrams, Pages 7, 9 and 11.)

The alternate (emergency) source power cable is connected in a like manner to the Emergency molded case switch terminals marked EL1, EL2 and EL3. (Note: Be careful to pass the cable through any current transformers or other devices which may be part of a generator control.) The load connections are made to the common bus at the terminals marked L1, L2, and L3. On three-phase, four-wise transfer switches or single-phase, three-wire transfer switches, a neutral bus is provided. NOTE: Verify that phase sequence rotation of normal and emergency sources are identical. Failure to do this will result in damage to the transfer switch and other equipment and will void the warranty extended by Lake Shore Electric Corporation.

A ground lug is provided on all transfer switches. This lug **must** be connected to the earth ground. When installing the power cables, be careful not to disturb or damage the control wires that go to the various terminals.

CAUTION: Be sure to check that all power cable lugs are torqued to the applicable requirement for the switch (see APPENDIX B).

Connect the contacts of the “P” Timer to the annunciator and supervisory controls. This contact closes to the annunciator and opens to the supervisory control 10 seconds after either normal or emergency or both sources fail.

3.2. PLACING THE TRANSFER SWITCH IN OPERATION

Before energizing the switch electrically, be certain all external connections have been properly made according to the wiring diagram provided with the switch. Inspect all wires, cables, and bus bar for abraded insulation, foreign matter, and electrical clearance.

Manually set the transfer switch to the Normal source (Normal breaker CLOSED & Emergency breaker OPEN) and energize the normal source. The “T” Timer will time out in 10 seconds and energize the TNR Timer which will allow the transfer switch to stay on the preferred normal source.

If the T Timer or TNR Timer do not pick up, place a voltmeter on the normal source to be sure that the voltage is adequate and within the range of the Phase Failure Relay (PFR). The switch will not operate on a voltage other than that stamped on the nameplate of the transfer switch.

Do not attempt to energize the alternate (emergency) source until the switch is operating satisfactorily on normal. With the normal source operating, the emergency source may now be **manually** energized for testing. The emergency source including all safety interlocks should be checked over before an attempt is made at a complete automatic systems test. When the emergency source has been tested satisfactorily and de-energized, a test of the automatic system can now be tried.

All Lake Shore Electric Automatic Transfer Switches are furnished with a Load Test Switch. This switch may be installed in the PFR or mounted separately on the panel. A test of the automatic circuitry can be initiated by moving this load test switch to the test position. This will cause the normal control circuits to de-energize and give a signal to transfer to the emergency position.

To test the full automatic operation of the transfer switch, make sure the transfer switch is operating on the normal source. Place the load test switch in the test position. The transfer switch will transfer to the emergency source after a 10 second time delay.

After the emergency operation has been tested, return the load test switch to the normal position. This will cause the transfer switch to return to the preferred (normal) source after the 10 seconds time delay of the T Timer.

The above test are sufficient to place the transfer switch in operation. The following paves contain specific information on the various components and troubleshooting information.

4. OPERATING MECHANISM

4.1. GENERAL INFORMATION

The operating mechanism, pictured in Figure 1 (page 15). The motor (4) is a universal type, reversible motor and is shipped as a complete component including the gearbox. The gearbox is a sealed unit, which should never require maintenance or attention. Because of the wide range of molded case switches used on Lake Shore Electric Transfer Switches, if motor replacement is necessary, please specify the serial number and model number of the transfer switch.

4.2. OPERATION

When a signal to transfer is received through the normally-closed contacts of the auxiliary switch, the motor is energized and the gear box turns the drive drum (8) which sets up a friction pull between itself and the drive shoe lining (13). This friction pull is sufficient to pull the drive arms (2) over to the new position, actuating the switch handle. As soon as the dive arms have reached their new position, the auxiliary switch changes position cuttings off the motor while at the same time setting up the circuit for the next transfer in the opposite direction. Because of the built-in features of the friction drive, it is possible to manually operate the switch by moving the manual handle (1) without engaging any clutches or devices.

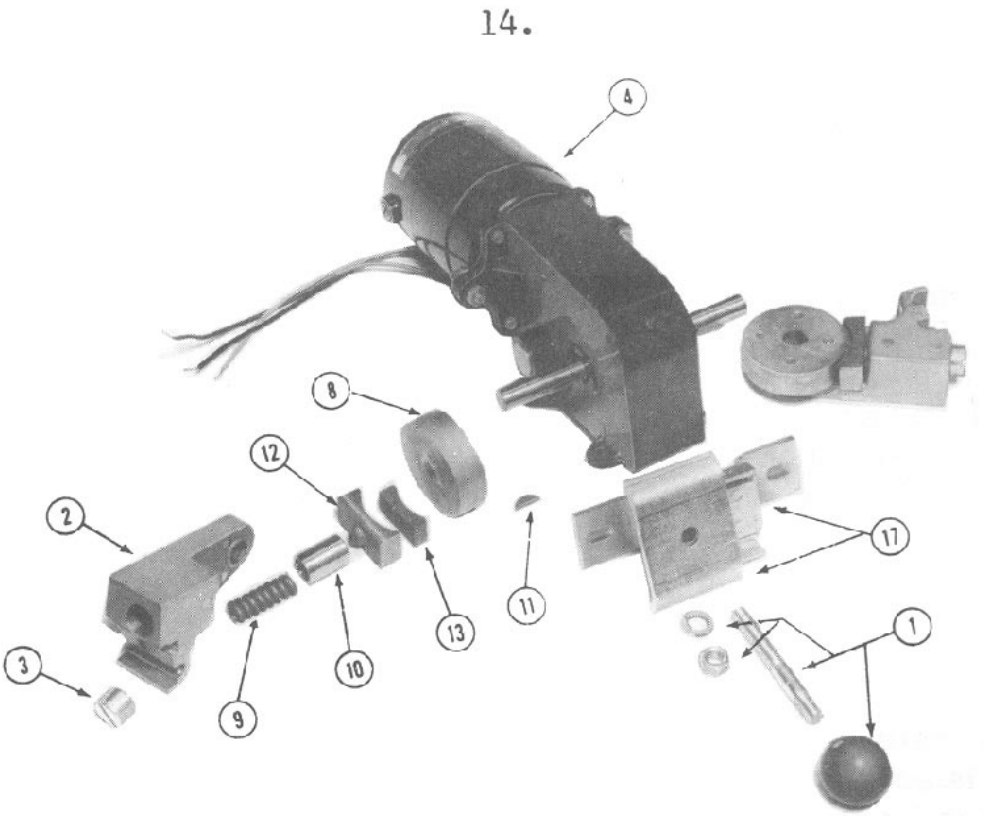
4.3. REQUIRED MAINTENANCE

Please refer to the APPENDIX A for required maintenance on the operating mechanism necessary to maintain your exclusive one-year Lake Shore Electric Corporation warranty.

4.4. MOTOR ASSEMBLY

To assemble the operating mechanism, first place the drive drum keys (11) on each side of the shaft, which extends from the gearbox. Next, slide the two drive drums (8) on the shafts. Insert one drive shoe pivot (10) into one drive arm (2) from the bottom, followed by the drive shoe (12) and the drive shoe lining (13). Be sure that the lining fits snugly into the drive shoe and that the concave cup end of the drive shoe pivot (10) engages the nipple on the drive shoe. Hold the entire assembly together and slip it onto one shaft, pushing it all the way to the drive drum. Now the spring (9) and adjustment screw (3) may be assembled into the drive arm (2) from the top. Repeat this procedure for the other drive arm assembly, if present.

Place the lever arm support (17) in such a way that it straddles the gearbox and engages the drive arm assemblies on both sides of the gearbox. Tighten the mounting screws and assemble the lever arm across the two molded case switches by fastening the lever arm to the lever arm support with the manual handle assembly (1). Observe the molded case switch-actuating lever, as it is manually opens and closes the molded case switch, checking that it completely transfers the molded case switches. The disassembly procedure of the mechanism is the reverse of the above.



LEGEND

1. Manual Handle
2. Drive Arms
3. Adjustment Screw
4. Motor

8. Drive Drums
9. Spring
10. Drive Shoe Pivot
11. Drive Drum Keys
12. Drive Shoe
13. Drive Shore Lining

17. Lever Arm
    Mounting Bracket

Figure 1

5. MOLDED CASE SWITCHES

5.1. GENERAL INFORMATION

The molded case switches used in transfer switches are the standard devices supplied by molded case switch manufactures. Figure 2 (page 16).

Thermal magnetic or magnetic trip units may be installed (Accessory 23) for thermal overload and short circuit protection. When these trips are provided, a bell alarm contact is included inside the breaker to indicate to the transfer switch circuit that the breaker has tripped due to an overload. This breaks the motor circuit and prevents the transfer switch from cycling between the Normal and Emergency positions.

If either breaker trips due to overload, it can be reset by manually operating the transfer switch to a position so that the breaker resets. After resetting, return the transfer switch to the proper position. A shunt trip may also be provided. This allows the breaker to be electrically tripped from a remote location and can also be reset manually.

5.2. INSPECTION AND MAINTENANCE

Terminal lugs and trip units must be tight to prevent overheating. Due to the inherent wiping action built into the moving contacts of all molded case switches, operating the switch several times under load will remove any high resistance film that may have formed. Under normal conditions, additional cleaning of contacts is not required. However, should operating and/or atmospheric conditions make it desirable to clean the contacts further, the following procedure is recommended. (Refer to Figure 2).

Remove cover, arc chutes, and cable terminal assemblies. Wipe contact surfaces with a clean, lint free cloth. If surfaces are excessively oxidized or corroded, scrape lightly with a fine file before wiping.

The auxiliary micro switches are mounted internally to the molded case switch.

Figure 2

6. TIMING RELAYS

The following Timing Relays are used on Lake Shore Automatic Transfer Switches.

Timing Relay	Factory Setting	Time of Delay	Function
T	10 Seconds	On Delay	Time Delay to Transfer to Normal
TNR	10 Seconds	Off Delay	Time Delay to Transfer to Emergency
P	10 Seconds	Off Delay	Time Delay to Alarm Circuit

TNR, P Relay

These relays are pneumatic. They are true OFF delay relay as no power is required for timing. When power is applied to the relay coil the N.O. and N.C. contacts transfer. When power is removed from the relay coil the timing cycle starts. After the timer has timed out the contacts will transfer to their original state.

7. VOLTAGE RELAYS

7.1. VOLTAGE SENSING – CLOSE DIFFERENTIAL

This relay continuously monitors the voltage of a three phase or a single-phase power source. When the voltage in each phase attains a value equal to or greater than the "pick-up" setting, the output contacts change state and the L.E.D. energizes. When the voltage of any phase falls below the "drop-out" setting, the output contacts revert to their de-energized state and the "LED" turns off.

Pick-up and dropout values are adjustable from 70 to 100% of nominal voltage via two potentiometers that are externally accessible.

FACTORY SETTING

Unless a customer or specifications require specific settings, the voltage Sensing Relay will be factory set to dropout at 80% and pick-up at 90% of nominal voltage.

LAKE SHORE ELECTRIC THREE PHASE STYLE

The Lake Shore voltage-sensing relay is field adjustable.

CALIBRATION:

1. Select proper voltage range.
2. Set pickup potentiometer full clockwise.
3. Set dropout potentiometer full counter-clockwise
4. Using a small screwdriver, turn the calibrate potentiometer fully clockwise.
5. Apply nominal input voltage to unit.
6. Slowly turn the calibration potentiometer counter-clockwise until the units picks up as indicated by the "energized" light.
7. Set pickup and dropout potentiometers to desired settings.
8. Unit is ready for operation.

Note: Field adjustment can only be considered approximate if potentiometers are set using the scale on the front of the unit. For an accurate setting of the pickup and dropout points, a variable voltage power supply must be used.

LAKE SHORE ELECTRIC SINGLE-PHASE STYLE

The single-phase voltage sensing relays are adjustable to 70 to 100% of the voltage range selected. Indication of pickup or dropout can only be verified by attaching a continuity meter to the common and normally open terminals. When the meter shows continuity, the PFR is picked up.

CALIBRATION:

1. Remove protective black plugs (if present).
2. Using a small slotted screwdriver, turn the dropout potentiometer fully counter-clockwise.
3. Using a small slotted screwdriver, turn the pickup potentiometer fully clockwise.
4. Apply required level of pickup voltage to the unit.
5. Turn the pickup potentiometer slowly counter-clockwise until the meter shows continuity.
6. Reduce the voltage to the required voltage dropout level.
7. Turn the dropout potentiometer slowly clockwise until the meter shows no continuity.

SUBSTITUTE SINGLE PHASE STYLE

The single-phase voltage sensing relays are adjustable to 0 to 80% of the voltage range selected. Indication of pickup or dropout can only be verified by attaching a continuity meter to the common, pin 11, and normally open, pin 14, terminals. When the meter shows continuity, the PFR is picked up.

8. TROUBLESHOOTING GUIDE

This guide is intended to assist an individual with a basic understanding of electrical circuitry to troubleshoot an automatic transfer switch as manufactured by Lake Shore Electric Corporation. Any questions relating to the use of this Manual should be referred to the Service Department of Lake Shore Electric Corporation, 205 Willis Street, Bedford, Ohio 44146, Phone (440) 232-0200, Fax (440) 232-5644.

CAUTION: WHEN WORKING ON EQUIPMENT OF THIS TYPE, EXTREME DANGER FROM ELECTRICAL HAZARDS EXITS. DO NOT ATTEMPT ANY REPAIRS OR ADJUSTMENTS TO THIS EQUIPMENT WITHOUT TAKING EVERY PRECAUTION TO PREVENT AN ACCIDENT.

WARNING!

IN INSTALLATION AND USE OF THIS PRODUCT, COMPLY WITH THE NATIONAL ELECTRICAL CODE, FEDERAL, STATE AND LOCAL CODES, AND ALL APPLICABLE SAFETY CODES. IN ADDITION, **TURN OFF POWER** AND TAKE OTHER NECESSARY PRECAUTIONS TO PREVENT PERSONAL INJURY AND EQUIPMENT DAMAGE.

WHEN WORKING ON EQUIPMENT OF THIS TYPE, EXTREME DANGER OF ELECTROCUTION EXISTS. THIS MAY RESULT IN INJURY OR DEATH. **DO NOT** ATTEMPT ANY REPAIRS OR ADJUSTMENTS TO THIS EQUIPMENT WITHOUT FIRST TAKING EVERY PRECAUTION TO PREVENT ACCIDENTAL INJURIES.

The following conditions **MUST** be met before attempting to troubleshoot a molded case transfer switch:

1. A wiring diagram for the switch must be available.
2. Normal and Emergency voltage and frequency must be available and within the correct operating limits.
3. Control fuses must be in proper working order.
4. Control circuit voltage (if transformers are used) must be 110 to 125 volts.
5. Connections to the PFR must be correct and the relay must be adjusted to pick up on the voltage at which the switch is operating. See voltage relay instructions on a Page 17.
6. All timers must be turned down or considerations given to them while the tests are being conducted.
7. If trip units are included in the switch, they must be reset if previously tripped due to an overload.
8. All electrical connections must be tight and in accordance with the wiring diagram.
9. All components must be free of obvious defects with the exception of normal usage.
10. The switch must be connected to a good earth ground.

When you are satisfied that all the above conditions are met, and all accessories are either working correctly or eliminated, the problem will be confined to:

1. The control relays and timers
2. The molded case switches.
3. The adjustment of the operating mechanism.
4. The motor and micro switches.

The troubleshooting procedures outlined here are designed to test the control circuit and the operating mechanism of the transfer switch. It is, therefore, necessary that all factors external to the transfer switch are correct, and that all accessory devices which are not imperative to switch operation either operate satisfactorily or be bypassed and jumped out of the circuit.

Many of the accessory devices described below may not exist in the transfer switch being examined. The proper wiring diagrams should be on hand before beginning work on the switch. We recommend that the entire manual be read before attempting to make any adjustment. Above all, **CAUTION** is recommended.

Many of the troubleshooting tests require a simulated failure of the normal source. This can be done with the Load Test Switch.

I) AUTOMATIC TRANSFER SWITCH WILL NOT TRANSFER TO EMERGENCY

1) **Improper Emergency Voltage**
Using an appropriately set voltmeter, check the emergency voltage on terminals EL1 and EL2 and EL2 to EL3 and EL3 to EL1. If each set of readings indicate the emergency's line to line voltage, continue to Step 2. If the readings do not indicate proper line to line voltage, further checks are required on the emergency source.

2) **Blown Fuse on Emergency Source**
Using an appropriately set voltmeter, check the output voltage on wires EA-1 to EB-1 and EB-1 to EC-1 and EC-1 to EA-1. If each set of readings indicate the emergency line to line voltage, continue to step 3. If the readings do not indicate line to line voltage, replace the defective fuse.

3) **Defective Emergency Control Transformer ECT**
Using an appropriately set voltmeter, measure the voltage from terminals X1 to X2 of the ECT. If this voltage is 120 Volts nominal, check the ECT transformer and/or return to step 2.

4) **Phase Failure Relay Not Functioning (PFR)**
Using an appropriately set voltmeter, check the voltage on the phase failure relay terminal C to N.O. If the voltage is 120 VAC nominal, the Phase Failure Relay Normal is defective and must be replaced. If the voltage is zero, continue to step 5.

5) **Defective ER Relay**
Using an appropriately set voltmeter, measure the voltage from wire 19 to wire 25. If this voltage is 120 Vac nominal, continue to step 6. If not, replace the defective ER relay.

6) **Defective TNR Relay**
Using an appropriately set voltmeter, measure the voltage from wire 18 to wire 25. If this voltage is 120 Vac nominal, continue to step 7. If not, replace the defective TNR relay.

7) **Emergency Microswitch (MSE) Defective**

a. Using an appropriately set voltmeter, check the voltage at terminals 18 to 25. If the voltage is 120 Vac nominal, continue to Step b; if voltage is not 120 VAC nominal, return to Step 6.
b. Using an appropriately set voltmeter, check the voltage at terminals 17 to 25. If the voltage is 120 VAC nominal, continue to Step 8; if voltage is not 120 VAC nominal, replace the defective microswitch.

8) **Transfer Motor (TM) Defective**
Using an appropriately set voltmeter, check the voltage at terminals 17 to 25. If the voltage is 120 VAC nominal, replace the motor gear box assembly; if voltage is not 120 VAC nominal, return to Step

II) AUTOMATIC TRANSFER SWITCH WILL NOT TRANSFER TO NORMAL

1) **Improper Utility Voltage**
Using an appropriately set voltmeter, check the utility voltage on terminals NL1 and NL2 and NL2 to NL3 and NL3 to NL1. If each set of readings indicate the utility line to line voltage, continue to Step 2. If the readings do not indicate proper line to line voltage, call the local utility.

2) **Blown Fuse on Normal Source**
Using an appropriately set voltmeter, check the output voltage on terminals NA-1 to NB-1 and NB-1 to NC-1 and NC-1 to NA-1. If each set of readings indicate utility line to line voltage, continue to step 3. If the readings do not indicate line to line voltage, replace the defective fuse.

3) **Defective Normal Control Transformer NCT**
Using an appropriately set voltmeter, check the voltage on terminals X1 to X2. If the voltage is 120 VAC nominal, check the NCT transformer and/or return to Step 2.

4) **Phase Failure Relay Not Functioning (PFR)**
Using an appropriately set voltmeter, check the voltage on the phase failure relay terminal C to N.O. If the voltage is 120 VAC nominal, the Phase Failure Relay Normal is defective and must be replaced. If the voltage is zero, continue to step 5.

5) **Load Test**
Verify that the Load Test Switch is in the “NORMAL” position.

6) **Defective T Timer**
Using an appropriately set voltmeter, measure the voltage from terminals A to B of the “TNR” Timer. If this voltage is 120 Volt Nominal, continue to step 7. If not, replace the defective “T” Timer.

7) **Defective TNR Timer**
Using an appropriately set voltmeter, measure the voltage from wire 15 to wire 25 of the “TNR” Timer. If this voltage is 120 Volt nominal, continue to step 8. If not, replace the defective “TNR” Timer.

8) **Normal Microswitch (MSN) Defective**

a. Using an appropriately set voltmeter, check the voltage at terminals 15 to 25. If the voltage is 120 VAC Nominal, continue to Step b; if voltage is not 120 VAC nominal, continue to Step b; if voltage is not 120 VAC nominal, return to Step 7.
b. Using an appropriately set voltmeter, check the voltage at terminals 16 to 25. If the voltage is 120 VAC nominal, continue to Step 9; if voltage is not 120 VAC nominal, microswitch MSN and its actuator should be checked and replaced if necessary.

9) **Transfer Motor (TM) Defective**
Using an appropriately set voltmeter, check the voltage at terminals 9 to 25. If the voltage is 120 VAC nominal, replace the motor gear box assembly; if voltage is not 120 VAC nominal, return to Step 8.

9. APPENDIXES

9.1. APPENDIX A

Tension Adjustment for Transfer Mechanism of Lake Shore Electric Transfer Switch

Refer to Figure 1, Page 15

When excess slippage occurs in the friction drive, it is necessary to increase the tension on the friction drive shoe lining. Turn the adjustment screw (3) clockwise to increase the tension. This action compresses the tension spring (9), and thus increases the friction. The adjustment screw should not be tightened all the way.

Proper adjustment of the tension on the drive shoe may be set by the following method. With the Automatic Transfer Switch in the Normal position, use a marker to make a line on the drive drum (8) along the edge of the drive shoe (12). Transfer the switch automatically either by the Load Test switch or interrupting the Normal source power.

After the switch has transferred to the Emergency position, observe the position of the line on the drive drum. The line position should be approximately 1/2" to 3/4" from the edge of the drive shoe indicating slippage. Transfer switches utilizing smaller circuit breakers are equipped with a single friction drive arm, as they require less force to activate. On these switches an idle arm with no adjusting screw replaces one of the drive arms. If both drive drums are used for transferring the switch, the spring tension on the drive shoes should be adjusted equally. Please note that this is an approximate setting and it may be necessary to try the transfer switch several times to assure that the adjustment is sufficient.

Do not tighten the adjustment screw to its limit as this will compress the spring entirely and cause the operating mechanism to jam. When this happens, the gears may strip or the roll pins inside the gearbox may shear. Sheared roll pins and/or stripped gears are indicated when the motor operates but does not turn the drive drum. This situation can only be remedied by replacing the motor gearbox.

Over a period of time, the spring may lose its tension. This is indicated when the motor operates and the drive drum turns, but the unit does not have sufficient friction to operate the circuit breakers. In this case, the spring must be replaced with a new one.

9.2. APPENDIX B

***FIELD CABLE SIZE & LUG TORQUE REQUIREMENTS**
USE COPPER WIRE ONLY
LINE-LOAD-NEUTRAL UNLESS OTHERWISE SPECIFIED

REQUIRED MAINTENANCE

The following cable lug torques are required to be checked every six months in order to maintain the Lake Shore Electric Corporation exclusive "one year" warranty.

I. TORQUE – SOCKET HEAD SCREWS

Socket Size (inches)	
Across Flats	**Torque (LB-IN.)**
1/8	45
5/32	100
3/16	120
7/32	150
1/4	200
5/16	275
3/8	375
1/2	500
9/16	600

Warning: Whenever bus and cable connections are being maintained, all power sources to the transfer switch must be disconnected and locked out.

9.3. APPENDIX C

INTERNAL MOLDED CASE TORQUE REQUIREMENTS

REQUIRED MAINTENANCE

The following lug torques are required to be checked every six months in order to maintain the Lake Shore Electric Corporation exclusive "one year" warranty.

I. <u>GENERAL ELECTRIC LUG TO MOLDED CASE SWITCH</u>

E150 LINE	30 IN. - LBS.
F225 LINE	90 IN. - LBS.
J600 LINE	60 IN. - LBS.
K1200 LINE	200 IN. - LBS.

II. <u>WESTINGHOUSE LUG TO MOLDED CASE SWITCH</u>

DA JA KA LB	6-8 FT. - LBS. 1/4" SCR 15 FT. - LBS. 7/16 SCR
LA LC	6-8 FT. - LBS. 1/4" SCR 15 FT. - LBS. 7/16" SCR CU TERMINAL 10 FT. - LBS. 7/16" SCR AL TERMINAL
MA MC	30-35 FT. - LBS.
NB NC	30-35 FT. - LBS.
KB HKB JB	6-8 FT. – LBS.

III. <u>EATON (CUTLER-HAMMER) LUG TO MOLDED CASE SWITCH</u>

K – Frame	6 – 8 LBS. – FT.
L – Frame	6 – 8 LBS. – FT.
N – Frame	31.25 – 37.5 LBS. – FT.

IV. GENERAL ELECTRIC TRIP TO MOLDED CASE SWITCH

F225 LINE	75 IN. - LBS.
J600 LINE	100 IN. - LBS.
K1200 LINE	100 IN. - LBS.

V. WESTINGHOUSE TRIP TO MOLDED CASE SWITCH

JA KA DA KCL LB	6-8 FT. - LBS.
MA MC NB NC LA LC LCL	15 FT. - LBS.
KB-HKB-JB	6-8 FT. - LBS.

VI. EATON (CUTLER-HAMMER) TRIP TO MOLDED CASE SWITCH

K – Frame	6 – 8 LBS. – FT.
L – Frame	10 – 12 LBS. – FT.
N – Frame	N/A Electronic Trip Unit

9.4. CLOSE DIFFERENTIAL UNDERVOLTAGE PROTECTION

UL 1008, the standard under which almost all automatic transfer switches in the United States of America are manufactured, states that an automatic transfer switch shall "initiate transfer from the normal supply to the alternate supply upon the interruption of any or all phases of the normal supply."

Lake Shore accomplishes this by providing a close differential undervoltage sensing relay (Model 26220) on the normal supply as a standard feature in all automatic transfer switches. The design of the Lake Shore Electric Corporation 26220 relay offers more that the monitoring of an undervoltage condition. It also provides additional protection of connected motors in the event of voltage unbalance.

Lake Shore recognizes that improper voltage conditions, undervoltage or voltage unbalance, may have several harmful effects, particularly when motor loads are involved. This article will address these issues and will limit the discussion to three phase systems since motor loads are predominantly used in such systems.

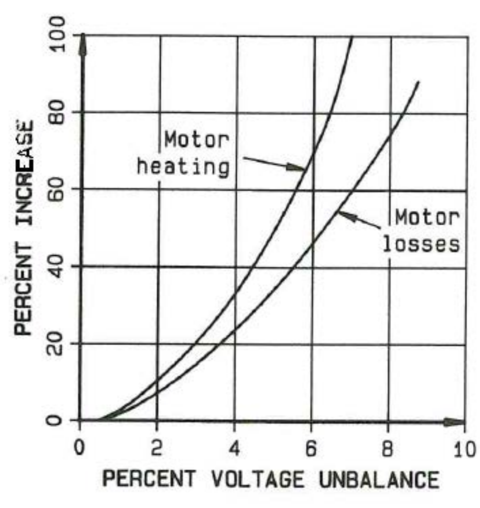
UNDERVOLTAGE PROTECTION – WHY IS IT NECESSARY?

An improper voltage condition on a single or three phase power system may have several harmful effects, particularly when motor loads are involved. This article will refer to three phase systems since motor loads are predominantly used in such systems.

EFFECTS OF UNDERVOLTAGE

During startup, a low voltage condition will produce a lower starting current and starting torque. Although a lower starting current may be desirable, a lower starting torque may not be acceptable. The torque produced by a motor is approximately proportional to the square of the voltage applied, that is, a motor that is started at 90% of rated voltage will produce a torque of $(.90)^2 = 1\%$ of rated torque. This may not be capable of starting the load.

If the undervoltage condition occurs while the motor is running, the result is a lower running torque, as described above, and a higher line current. The reason for the increased line current is as follows: a lower line voltage at a given load produces an increased slip. The increased slip produces a higher line current. The reason the starting current is reduced with a lower line voltage is because the slip at starting is unity; it cannot get any worse, therefore the starting current is proportional to the starting voltage.



EFFECT OF VOLTAGE UNBALANCE ON MOTOR HEATING AND LOSSES

Figure 1

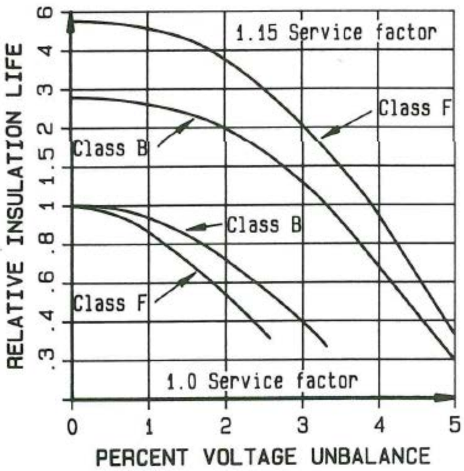
EFFECTS OF VOLTAGE UNBALANCE

Another less mention and much more harmful condition to motors is voltage unbalance. Voltage unbalance creates a decrease in efficiency, decrease in power factor, large increase in current, large temperature increase and a decrease of insulation life.

Voltage unbalance is defined as a percentage equal to 100 times the maximum deviation from the average voltage divided by the average voltage. Therefore, a system with phase voltages of 205, 216, and 208 has an average voltage of 209.7 and a maximum deviation of 6.3 thus giving it a voltage unbalance of 3%.

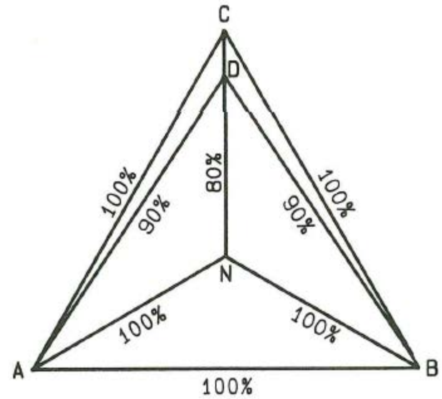
Unbalanced voltages applied to an induction motor cause unbalance currents to flow. The increase in temperature in the phase with the greatest current will be approximately two times the square of the percentage of voltage unbalance. The effects of voltage unbalance to increased motor temperature are shown in Figure 1.

This increase in temperature, created by the voltage unbalance, creates a decrease in insulation life as shown in Figure 2.



EFFECT OF VOLTAGE UNBALANCE
ON MOTOR INSULATION LIFE

Figure 2



VECTOR DIAGRAM OF A
3 PHASE VOLTAGE SOURCE

Figure 3

PROTECTION

Undervoltage and voltage unbalance protection is necessary to prevent the harmful effects as described above.

Undervoltage relays are typically of the close-differential type, that is, all three phases of the three-phase source must attain a value equal to, or greater than, the pickup setting of the undervoltage relay before its contacts change state. This value is typically set at 90% of nominal voltage since the utility supply can stabilize at anywhere from ±10% of nominal voltage. Once energized, the relay will not de-energize until any one of the three phases falls below the dropout setting of the undervoltage relay. This value is typically set at 80% of nominal voltage, however, this is where undervoltage relays differ. Many undervoltage relays strictly sense line to line voltage, while a Lake Shore undervoltage relay generates an internal neutral allowing it to sense a line to neutral voltage even in a three phase, three wire system. This is important for detecting a voltage unbalance condition.

Consider Figure 3. Triangle ABC represents a balanced voltage source. Triangle ABD represents a three-phase system in which one phase has dropped to 80% of its nominal voltage, giving this system a 6.1% unbalance. A line to line sensing undervoltage relay set at 90% pickup and 80% dropout would monitor the following voltages:

AB 100%
BD 90%
DA 90%

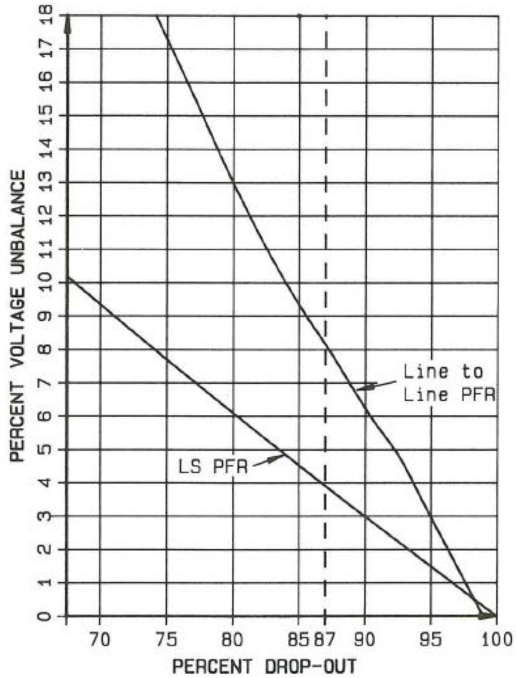
Since all three phases are equal to or greater that 90%, this relay would energize indicating a proper voltage condition.

Now consider a Lake Shore relay set at 90% pickup and 80% dropout. Since it generates its own neutral, it would monitor the following voltages:

NA 100%
NB 100%
ND 80%

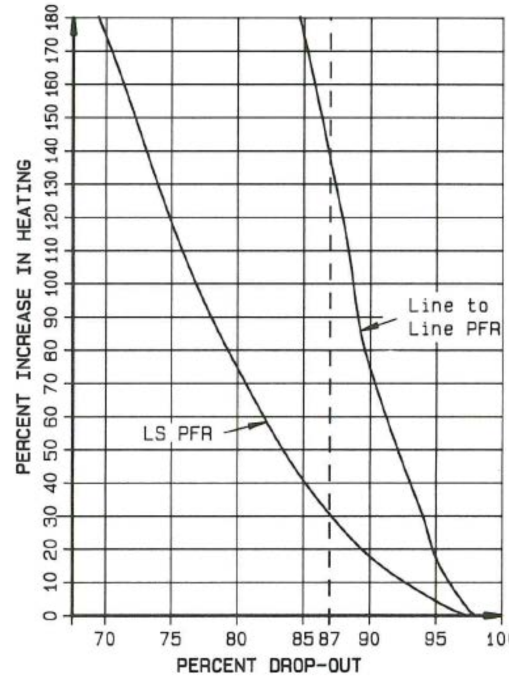
Since all three phases are not equal to or greater that 90%, this relay would not energize indicating an improper voltage condition. If all three phases are reduced in a balanced manner, both types of relays will behave identically.

The dropout point of a Lake Shore three phase voltage sensing relay can be set to protect a system for a given voltage unbalanced as shown in Figure 4 and thereby protect the motors connected to this load from the sever overheating associated with this voltage unbalanced as shown in Figure 5. A line to line type of voltage sensing relay (also shown in Figure 4) cannot accomplish this because the dropout point would have to be set so high it would cause nuisance undervoltage indications.



DROPOUT SETTING VERSUS PERCENT VOLTAGE UNBALANCE

Figure 4

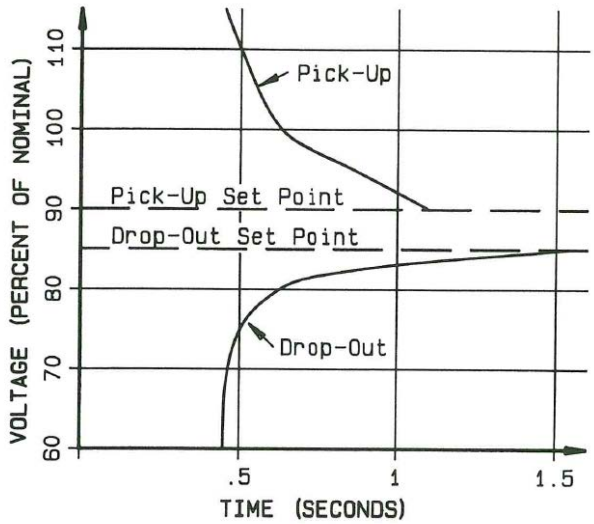


DROPOUT SETTING VERSUS PERCENT INCREASE IN MOTOR HEATING

Figure 5

The vertical line in Figures 4 and 5 indicates the protection undervoltage relays provide against voltage unbalance when it is calibrated for an 87% drop out. The Lake Shore Voltage Sensing Relay will drop-out on a 4% voltage unbalance, thus limiting the motor overheating to 32% above normal. A line to line type voltage sensing relay with the same dropout point will not dropout until the system has an 8.5% voltage unbalance, thus allowing a 140% above normal temperature rise on any motors connected to this system.

The Lake Shore undervoltage relay is also equipped with an inverse time delay on both "pickup" and "dropout" as shown in Figure 6. This time delay helps avoid nuisance undervoltage indications as may occur during system transients. The inverse time characteristic allows a 1.5 second delay before the relay de-energizes when any phase falls just below the dropout setting. A 0.4 second delay occurs when any phase falls well below the dropout setting (20% or more).



TIME DELAY CHARACTERISTICS OF A LAKE SHORE
3 PHASE VOLTAGE SENSING RELAY

Figure 6