

CHAPTER IX

ELECTRICAL

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#### A. GENERAL

The information contained in this section is designed to acquaint the plant operator with the basic electrical operation of the facility. Included are basic maintenance and trouble shooting guides; however, because of the complexity of the systems and the voltages involved. Any work done beyond routine maintenance and minor trouble-remedy procedure should be performed only by a qualified electrician experienced in this type of work.

The electrical service is 480 volts, 60 hertz, 3 phase run underground from a pad mounted transformer owned and maintained by the Utility Company. The main disconnect is a 1000 ampere circuit breaker in the main power distribution panel located in the building. This panel also houses the main disconnect for the emergency generator and necessary controls to energize the emergency generator upon failure of normal utility company power allowing the facility to remain in operation. The entire facility can be operated under emergency generator operations.

#### 1. Basic Electric Maintenance Procedure

##### a. Motors

The life of an electric motor to a large extent depends upon the maintenance performed on the unit. The following list will provide some basic elements of maintenance:

- i. Lubricate regularly according to manufacturer's instructions. In poor environments, change oil once a month. Never over-lubricate; excess grease or oil gets into windings and deteriorates insulation.
- ii. On essential or heavily used motors, check bearings daily using stethoscope, thermometer or vibration analyzer. Check oil rings. Watch for excessive endplay.
- iii. Check air gap between rotor and stator with feeler gages semiannually. Differences in readings indicate bearing wear. Take readings in four locations, 90 degrees apart, around perimeter of rotor.
- iv. Check belt tension. Belt should have play of about 1 in. Check drive-to-load alignment.
- v. Inspect brushes and commutator for excessive wear. Call service company to solve recurring problems of brush chatter, excessive brush wear or sparking, streaking or threading of the commutator. Check spring pressure of brush holders. Pressure should be about 2 to

2-1/2 lbs. per sq. in. of brush cross-section area. Be sure brush shunts are in good condition and that brushes are seated properly. All single phase motors have brushes.

vi. Keep the motor clean. In poor environments, blow out dirt frequently with dry compressed air (not more than 50 lbs. pressure). Pull important motors during shutdowns or during other down periods for thorough cleaning or reconditioning.

vii. Perform insulation resistance tests annually. Correlate with humidity and temperature readings to obtain indication of insulation condition. Check that equipment ground connections are tight.

#### b. Control Equipment

The control equipment referred to herein is further defined as motor controllers, magnetic contactors, relays, switches, circuit breakers, etc. Proper maintenance procedures include:

i. Keep control equipment clean. In poor environments, blow out dirt weekly, otherwise clean out quarterly or semiannually in accordance with degree of contamination.

ii. Check for excessive temperatures, rust and corrosion, mechanical damage and worn gaskets, if any exist.

iii. Keep contacts smooth. Never lubricate contact surfaces. (This causes dirt or other contamination to collect on contacts resulting in poor contact and undesirable burning.) Do not file silver contacts. Check coil and arc chutes for signs of burning or overheating.

iv. Check for freedom of movement of mechanical parts. Watch for frayed flexible leads. Do not oil contactor or relay bearings.

v. Check contact pressure with spring scale. Pressure should be the same on all contacts. If variation in pressure is found, replace springs. On important controls, contactors and circuit breakers, check contact resistance with low-resistance tester.

vi. Make sure that all electrical connections are tight, especially on equipment subject to vibration.

#### c. Circuit Conductors

Maintenance items to be conducted on circuit conductors are listed here to assist in getting maximum performance out of the systems.

i. Perform insulation resistance tests annually; on important circuits perform tests semiannually. Be sure to record humidity and ambient temperature readings for meaningful test readings.

ii. Keep conductors free of dirt, oil and other contamination, particularly at terminals. Provide good mechanical protection. Check tightness of connections particularly on equipment subject to vibration. Consider high-voltage tests on top-priority circuits.

d. Fuses (On equipment & at disconnects)

Normally checking fuses is done only when trouble develops in the operation of electrical equipment. It is recommended that the following maintenance be performed:

i. Check for proper fuse ratings. Assure that replacement fuses are rated properly.

ii. Keep fuse clips clean and tight to prevent overheating and needless blown fuses.

iii. Be sure renewable fuse links are of proper size. Make sure renewable fuses are assembled properly.

iv. Keep fuse enclosures tightly closed and secured to prevent possible sparks from escaping when fuses blow.

v. Keep three spare fuses of each size installed so that equipment won't be out of service due to lack of replacement fuses.

2. Preventive Maintenance

Preventive maintenance is essential to trouble-free plant operation. The following table is intended only as a guide; the successful Plant Operator will wish to elaborate on it, and possibly, set up a Preventive Maintenance Schedule tailored to his knowledge, ability, and available time.

MOTOR-CONTROL PREVENTIVE MAINTENANCE GUIDE

What to inspect

What to Inspect for

Exterior and Surroundings

Dust, grease, oils; high temperature; rust and corrosion; mechanical damage; condition of gaskets.

Interior of Enclosure, Nuts and Bolts

Same as for No. 1 plus: excess vibration which may have loosened nuts, bolts or other mechanical connections.

## What to Inspect

## What to Inspect for

Contactors, Relays, Solenoids  
General

Check control circuit voltage; inspect for excess heating of parts evidenced by discoloration of metal, charred insulation or odor; freedom of moving parts dust, grease, and corrosion; loose connections.

Contact Tips

Check for excessive pitting, roughness, copper oxide; do not file silver contact

Springs

Check contact pressure; is pressure same on all tips.

Flexible Leads

Look for frayed or broken strands; be sure lead is flexible-not brittle.

Arc

Check for breaks or burning.

Bearings

Check for freedom of movement.

Coils

Look for overheating, charred insulation or mechanical injury.

Magnets

Clean faces: check shading coil; inspect for misalignment, bonding.

Fuses and Fuse Clips

Check for proper rating, snug fit; if copper, polish ferrules; check fuse clip pressure.

Overload Relays

Check for proper heater size; trip by hand; check heater coil and connection; inspect for dirt, corrosion.

Pushbutton Stations and  
Pilot Devices

Check contacts, inspect for dirt, grease and corrosion.

Dashpot-Type Timers and  
Overload Relays

Check for freedom of movement, check oil level.

Resistors

Check for signs of overheating; loose connections; tighten sliders.

Connections

Tighten main line and control conductor connections; look for discoloration of current-carrying parts.

Control Operation

Check sequence of operation of control relays, check relay contacts for sparking on operation; check contactors for flash when closing; if so, adjust to eliminate contact bounce; check limit switches, pressure switches, temperature switches, etc.

### 3. Troubleshooting

The extent to which a Plant Operator is able to carry out trouble shooting and repair of the equipment in his care is dependent on those skills he brings to the job and those he acquires on the job.

The following table is intended only as a guide; many books and periodicals are available to expand on the information contained here.

Electricity can kill: It is essential that any electrical work done by the Operator be within his knowledge. If there is ever any question in his mind, the Operator shall seek out the services of a qualified, licensed electrician equipped with the knowledge, tools, and equipment to safely diagnose and correct any problems in the electrical system.

#### MOTOR-CONTROL TROUBLESHOOTING GUIDE

trouble	Possible Cause	Remedy
CONTACTS Contact Chatter	1. Broken pole shader. 2. Poor contact in control circuit. 3. Low voltage	1. Replace 2. Improve contact or use hold circuit interlock (3-wire control). 3. Correct voltage condition. Check momentary voltage dip during starting.
Welding or Freezing	1. Abnormal inrush of current. 2. Rapid jogging. 3. Insufficient tip pressure. 4. Low voltage preventing magnet from sealing. 5. Foreign matter preventing contacts from closing. 6. Short circuit.	1. Use larger contactor or check for grounds, shorts or excessive motor load current. 2. Install larger device rated for jogging service or caution operator. 3. Replace contact springs; check contact carrier for damage. 4. Correct voltage condition Check momentary voltage dip during starting. 5. Clean contacts with approved solvent. 6. Remove short fault and check to be sure fuse or breaker size is correct.
Short Contact Life or Overheating of Tips	1. Filing or dressing.	1. Do not file silver-faced contacts. Rough spots or discoloration will not harm contacts.

## MOTOR-CONTROL TROUBLESHOOTING GUIDE

Trouble	Possible Cause	Remedy
Short Contact Life or Overheating of	<ol style="list-style-type: none"> <li>2. Interrupting excessively high currents.</li> <li>3. Excessive jogging</li> <li>4. Weak contact pressure</li> <li>5. Dirt or foreign matter on contact surface</li> <li>6. Short circuits.</li> <li>7. Loose connection</li> <li>8. Sustained Overload</li> </ol>	<ol style="list-style-type: none"> <li>2. Install larger device or check for grounds, shorts or excessive motor currents. Use silverfaced contacts.</li> <li>3. Install larger device rated for jogging or caution operator.</li> <li>4. Adjust or replace contact springs.</li> <li>5. Clean contacts with approved solvent.</li> <li>6. Remove short fault and check for proper fuse or breaker size.</li> <li>7. Clean and tighten.</li> <li>8. Install larger device or check for excessive load current.</li> </ol>
COIL, OVERHEATED	<ol style="list-style-type: none"> <li>1. Overvoltage or high ambient temperature.</li> <li>2. Incorrect coil</li> <li>3. Shorted turns caused by mechanical damage or corrosion.</li> <li>4. Undervoltage, failure of magnet to seal in.</li> <li>5. Dirt or rust on pole faces increasing air gap.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check application and circuit.</li> <li>2. Check rating and if incorrect, replace with proper coil.</li> <li>3. Replace coil.</li> <li>4. Correct system voltage.</li> <li>5. Clean pole faces.</li> </ol>
OVERLOAD RELAYS Tripping	<ol style="list-style-type: none"> <li>1. Sustained overload</li> <li>2. Loose connection on load wires.</li> <li>3. Incorrect heater.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check for grounds, shorts or excessive motor currents.</li> <li>2. Clean and tighten.</li> <li>3. Relay should be replaced with correct size heater unit.</li> </ol>
Failure to Trip (Causing Motor Burn-Out)	<ol style="list-style-type: none"> <li>1. Mechanical binding, dirt corrosion, etc.</li> <li>2. Wrong heater, or heaters omitted and jumper wires used.</li> <li>3. Motor and relay in different temperatures.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean or replace.</li> <li>2. Check ratings. Apply proper heater.</li> <li>3. Adjust relay rating accordingly, or make temperature same for both.</li> </ol>

## MOTOR-CONTROL TROUBLESHOOTING GUIDE

Trouble	Possible Cause	Remedy
Failure to Trip (Causing Motor Burn-Out)	4. Wrong calibration or improper calibration adjustment.	4. Consult factory.
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<b>MAGNETIC &amp; MECHANICAL PARTS</b>		
Noisy Magnet (humming)	1. Broken shading coil. 2. Magnet faces not mating.  3. Dirt or rust on magnet faces. 4. Low voltage.	1. Replace shading coil. 2. Replace magnet assembly or realign. 3. Clean and realign.  4. Check system voltage and voltage dips during starting
Failure to Pick- up and Seal	1. Low Voltage.  2. Coil open or shorted. 3. Wrong coil. 4. Mechanical obstruction	1. Check system voltage and voltage dips during starting 2. Replace. 3. Check coil number. 4. With power off, check for free movement of contact and armature assembly.
Failure to Drop-Out	1. Gummy substance on pole faces. 2. Voltage not removed. 3. Worn or rusted parts 4. Residual magnetism due to lack of air gap in magnet path.	1. Clean with solvent.  2. Check coil circuit. 3. Replace parts. causing binding. 4. Replace worn magnet parts.

### B. POWER SOURCE

#### 1. Electric Utility Company

The utility company is the Southwest Central Rural Electric Cooperative Corporation R.D. #4 Airport Road, Indiana, Pennsylvania 15701. Telephone 412-349-4800.

#### 2. Main Transformer

The main transformer is a 300KVA pad mounted type and is owned and maintained by the Utility Company. The owners responsibility begins with the underground service to the building .

#### 3. Maximum Short Circuit Current

The available interrupting short circuit current at the utility company's transformer secondary is 12,900 amperes.



#### 4. Protective Devices

The bus in the main distribution panel is rated at 50,000 amperes symmetrical short circuit current. The main breaker is rated at 65,000 amperes symmetrical short circuit current.

### C. POWER DISTRIBUTION

#### 1. Main Distribution Panel

The main distribution panel is a 1000 ampere 480 volt, 3 phase 60 hertz dead front, free standing switchboard. It contains a 1000 ampere main breaker and a 800 ampere standby breaker which are automatically interlocked to transfer from the main breaker to the standby breaker (fed from the emergency generator) upon a loss of normal power. Both breakers are ITE Imperial Corporation "ACCUTRIP" solid state breakers containing adjustable current and time delay solid state characteristics for overcurrent, short circuit, and ground fault protection. The main and standby breakers are drawout mounted and contain motor operators. The main distribution panel also contains several circuit breakers used to feed the power panels, heating panels and motor control centers located in the building.

#### 2. Distribution Panels

The major electrical distribution panels are designated as follows:

- i. Motor Control Center #1
- ii. Motor Control Center #2
- iii. Motor Control Center #3
- iv. Panel "A"
- v. Panel HP-1
- vi. Panel HP-2

#### 3. Motor Control Center #1

Motor Control Center #1 is a 600 ampere, 480 volt, 3 phase, 60 hertz, NEMA 1 circuit breaker type motor control center with motor starters and individual control transformers. This motor control center contains combination starters for the following motors: Flash Mixers #1 and #2, cable hoist; Aerator #1 and #2; Lime slakers #1, #2 and #3; settling tanks #1, #2, #3, and #4, utility water pumps #1 and #2; air compressor; sludge recirculation pumps #1, #2, #3 and #4. It also contains the disconnect for the site lights.

#### 4. Motor Control Center #2

Motor Control Center #2 is a 600 ampere, 480 volt, 3 phase 60 hertz NEMA 1 circuit breaker type motor control center with motor starters, individual control transformer, and variable frequency control modules. This motor control center contains combination starters

for the four clarifier motor drives, and variable frequency controls for the four sludge recirculatory pumps and the two waste sludge pumps.

#### 5. Motor Control Center #3

Motor Control Center #3 is a 600 ampere 480 volt, 3 phase 60 hertz, NEMA 1, circuit breaker type motor control center with motor starters and individual control transformers. This motor control center contains combination motor starters for the following motors: Waste sludge pumps #1 and #2; Lime slurry pumps #1, #2 and #3; raw water pumps #1, #2, #3, #4, #5 and #6; sump pumps #1 and #2. This motor control center also contains the autosensory module that indicates levels in the wells, slime slurry tank, lime solution tank, sludge wells, sump basin and the final tank.

#### 6. Panel "A"

Panel "A" and its sub panel are circuit breaker panels and are rated at 120/208 3 phase 60 hertz, they are fed by a 75 KVA Dry type transformer. These panels feed all the lighting, convenience outlets, and 120 volt equipment located at the facility.

#### 7. Panels HP-1 and HP-2

Panels HP-1 and HP-2 are 480 volt, 3 phase, 60 hertz circuit breaker type panel boards and distribute power to all the heating units in the building.

### D. CONTROL AND MONITORING SYSTEMS

The operating console is the heart of the control and monitoring system for the facility. It contains a graphic which is lighted to identify system functions and equipment. Also it contains on-off pushbuttons, hand-off automatic switches, Ammeters, elapsed time meters, indicators and tachometers - for the system equipment. Complete information on the operating console is given in Autocon Industries shop drawings D 152044-12 to 28. Complete information on the motor controls can be found in Autocon Industries shop drawings D 15044-1 to 11.

### E. ALTERNATE POWER SOURCE

Stand by electrical power is provided for the facility in event normal utility power is interrupted. The emergency power system will automatically be energized upon loss of normal power and operate the plant as normal. The emergency generator set is a caterpillar D348 rated at 565 KW, 706 KVA, 480 volt 60 hertz 1800 RPM Auda and a 0.8 power factor. Accessories to the emergency generator set include the following: Modine Model FK3-15 remote radiator, Enercon Engineering Inc. control panel, Maxim Model M21 silencing Muffler, LA Marche Model A-46 battery charger, Simplex 25 gal day tank assembly, and a 1,000 gallon fuel oil storage tank.