MAINTENANCE OF ELECTRICAL INSTALLATIONS

By

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1. ABSTRACT

This paper considered the maintenance of electrical installations by identifying the types, the components and the various possible schemes of maintenance. It went ahead to consider various aspects of the installation, various faults and possible remedy. The paper did not however deal exhaustively with certain aspects of electrical installations – more especially special installations for power stations, closed systems/alarms, substations, earthing, instruments, safety and meters. However, the paper adequately dealt with the fundamentals as a springboard to handling such other systems.

2. INTRODUCTION

By electrical installation we mean the sum total of the wiring subsystem, the various components (switches, lamps, fuses, CBs, motors, poles, transformers, generators) for a particular purpose. These can either be of the domestic or industrial types and such other special ones like marine, aviation etc for the purpose of providing lighting and for power requirements. Irrespective of the type common features abound. For the purpose of durability, reliability, safety and cost effectiveness there is need to take proper care and pay adequate attention to such installations. Also there is the need to protect the environment within which these installations are provided. The aforementioned is the business of maintenance so that the desired aims and objective of the installation would be attained. Various practices exist for the maintenance of electrical installations viz: breakdown (or corrective maintenance), preventive maintenance (scheduled, condition monitor, condition based) and design-out (or improvement) maintenance respectively. It is therefore of essence that the maintenance personal must of necessity be adequately trained so that a thorough understanding/knowledge of the system is at his/her disposal. This will guarantee
effective maintenance practice and management of the system such that availability will be guaranteed. Aside availability also, maintenance (which may involve repair, replacement or renewal of the system) will ensure that the installation functions at all times or most of the time as though it was new.

3. ELECTRICAL INSTALLATIONS

3.1 TYPES

They can generally be grouped as domestic, industrial and special installations respectively. Also these can be of the temporary or permanent type of installation. Irrespective of the type of installation the basic parts/components are about the same.

3.2 COMPONENTS

The make up of any electrical installation will include the controls (switches, sockets), the cables, the protective components (fuses, breakers), meters (energy meters, voltmeters, ammeters as the case may be); other accessories (saddles, clips, lamp holders) and the load points (lamps, cookers, water heaters, air conditioners etc). Maintenance will therefore be a function of what aspects are considered. However, the application of a certain maintenance scheme often times will be a function of the overseer of the installation and/or the corporate objective of the firm. Also for some heavy installation, transformers/substations will be involved.

4. MAINTENANCE SCHEMES

The name of the various schemes is a function of the desired goal and include: breakdown or corrective; preventive (scheduled, condition monitor, condition based) and design-out or improvement maintenance scheme respectively.

4.1 BREAKDOWN OR CORRECTIVE SCHEME

Here the system or component is allowed to fail before any attention is given to it. Electric lamps, loosely suspending lamp holders etc suffer this fate.

4.2 PREVENTIVE SCHEME

Irrespective of the sub-type, the system/component is routinely checked and any observed abnormalities are promptly attended to before failure occurs such as in the spring mechanisms of certain gear switches.
4.3 DESIGN-OUT SCHEME

This scheme aims to eliminate the cause of maintenance (whereas the earlier schemes aim at minimizing the effect of failure). This scheme therefore has a high scientific value and overall cost implications since it encourages the elimination, modification or replacement of certain parts that hitherto were problematic.

5. MAINTENANCE OF ELECTRICAL INSTALLATIONS

It is worthy to note here that natural aging, wear and tear beside maloperation of electrical installations are responsible for all the possible problems that may hereinafter be catalogued. Also how easy or difficult it is to maintain the installation is a function of how well or how bad the installation was effected. This in turn will dictate the extent of maintenance (repair, replacement or renewal) to be carried out. In very bad situations though, it will be very necessary/econoztical to replace the entire installation.

Generally, to maintain the system/component, one may need to carry out physical examination, tests (pre-repair/post repair) and take appropriate notes before and after each exercise. This will ensure continuity, and certainty and efficiency.

5.1 MAINTENANCE OF LIGHTING INSTALLATIONS

These include fittings, fans and all low power appliance (shavers etc) circuits.

5.1.1 MAINTENANCE OF SWITCHES, CEILING ROSES AND LAMP HOLDERS

1. SWITCHES

Common types include ON/OFF, push button, dimmer, rotary etc. The basic requirements/component parts are the same. Its function is to open or close the particular circuit. However, they require infrequent checks/maintenance. The commonest fault is loose connection due to improperly screwed screw which may lead to sparking, interference, improper performance of lighting fitting (sometimes leading to burnout). The remedy is to fasten the screw and/or replace the switch. Other faults include broken contact, broken ceramic casing, stiffness etc. Note that the switch quality will necessitate some of these problems. Bad
quality switches must be replaced with good ones. In switches with spring controls (such as a tumbler switch), grease maybe applied from time to time in order to enhance its operation.

2. LAMPHOLDERS

This holds the lamp in place properly such that the lamp experiences uniform pressure and also makes the required contact. This guarantees some life to the lamp. A lampholder that does not meet this standard must be replaced.

3. CEILING ROSE/JUNCTION BOXES

Ceiling rose serve as inter-links to lamps. Junction boxes serve as take-off sources/continuity points for some circuits. In both units there maybe loose connections resulting in sparking. This may burn the insulating ceramic casing. In case of loose contact, rescrew and replace all burnt units.

5.1.2 MAINTENANCE OF LAMPS

Lamps include filament (tungsten filament type) and discharge (fluorescent, high pressure mercury- vapor, sodium vapour) types respectively. Other lamps include high voltage sign and tungsten-halogen lamps. The light output from a lighting fitting is reduced by absorption by the fitting itself, by the wall and by the surface of the ceiling. Also, due to accumulation of dirt on reflecting surfaces and aging of the lamps, the amount of useful light is reduced, hence the need for maintenance.

Maintenance is required when the lamp ceases to light. The cause(s) of this is a function of the type of lamp and maybe due to the lamp itself and for fluorescent fitting, it maybe due to a fault in the auxiliary equipment (choke, starter, etc). Also, in large installations, fittings maybe installed at not very accessible positions. In such cases, group replacement of all lamps is recommended at regular prescribed intervals. At such intervals also, cleaning of fitting, is recommended. Failure in some lamps maybe due to an open circuit (high impedance across the choke) or short circuit (low impedance across the choke).

Table1 shows possible symptoms and possible causes of fault in fluorescent lamp circuits. Discharge lamp circuits have cokes and capacitors and
thus the fault symptoms, cause and recommendable cure may inadvertently be the same. Appendix I details some common problems and remedies for fluorescent Lamps.

6. MAINTENANCE OF POWER INSTALLATION

6.1 MAINTENANCE OF HEATING SYSTEM

These include:

1. Air Heaters
   (i) Storage or Indirect: Storage radiators, centrally sited warm air units, and underfloor warming.
   (ii) Direct Systems: Radiant fires, panel heaters, tubular heaters, oil-filled radiators, convector, fan, infra-red and ceiling heaters respectively.

2. Water Heating Systems
   (i) Immersion Heaters
   (ii) Electrode Heaters

3. Non-pressure storage Heaters

4. Instantaneous Water Heaters

Generally, heater installations may have the following components: heating element (heat source), heat exchanger, insulator, cables, switch control etc. In some types heat control (thermostats etc) are included. Central heating systems may incorporate grill, pipework, valves etc. From the aforementioned, maintenance of heating system will be a function of that component or subsystem that is faulty. This range from a faulty heating element, leakages due to break in power cable/heating element, or the insulating or refractory material. Due to the latter, excessive heat may be lost. Also, uneven heat distribution may be due to localized heating (resulting from break in parts of the element, poor grill orientation or faulty enhancement fan) in forced heating systems.

6.2 MAINTENANCE OF SWITCHGEARS, CHANGEOVER SWITCHES AND ISOLATING SWITCHES

In the absence of factory problems during design, manufacturing and/or assembly or transportation, these units hardly give problem. The same is true if
they are properly installed. However, even with the above such switches suffer due mainly to improper handling and installation respectively.

6.2.1 IMPROPER HANDLING

This has to do with the manner of switching itself. Most knife edge switches require to be homed-in if the contacts are to carry their rated currents. Most changeover switches and the like require to be homed-in after the handle has been moved and the failure to do this has resulted in several burnout of terminals especially in fully loaded heavy duty industrial changeover switches usually installed in very large establishments, factories etc. Note that inability to home-in properly maybe due to stiff springing mechanism(s) or loose contacts.

6.2.2 IMPROPER INSTALLATIONS

Improper terminations usually involving terminals that are not properly tightened leads to arcing. This results in excessive heating which finally fuses the threads and ruins the terminal block. Also, unnecessary vibrations may result in loose contacts.

6.3 DISTRIBUTION BOARDS

Various types exist namely: MCB (Miniature Circuit Breaker) Boards and fuse Boards. In choosing the appropriate MCB or fuse size overloads should be avoided by using at all times the correct fuse and/or circuit breaker rating. With additional loads, expansion of the board/or circuit should be embarked upon.

From time to time, short circuits may occur within the board (just like in junction boxes in lighting installation) due to an electrocution of a wall-gecko or rat or cockroach in the vicinity of the installation. To rectify such a fault may just require the removal of the electrocuted prey replacing the fuse or resetting the CB though if the board had been properly installed and the board cover securely in place, this fault might have been avoided.

6.4 SOCKET OUTLETS

Many outlets abound in the installation ranging from 5A to 15A at homes, offices and factories though the most common power socket outlet is rate 13A. The most common fault that can be experience is non-tightness of screw terminals. This may result in excessive voltage drop when supply is required of the socket. Re-tightening of the screw may remedy the situation otherwise, the entire socket unit maybe replaced. It is worthy to note that very bad quality units
exist in the market today resulting in damage due to excessive heat on the insulating casing and the contacts respectively. Such must be discarded and replaced.

7. MAINTENANCE OF CABLES

Cables are suppose to deliver rated current at full-load and at all times without overheating and excessive voltage drop. Many types of cables abound made up mainly of the conductor(s) and an insulating sheath(s) as the case maybe. It is required at all times that the cable be properly sized and installed to avoid over heating and excessive volt drop. Overheating may damage the insulation resulting in leakage of current to an otherwise dangerous area. This may also result in a short/open in the conductor.

8. MAINTENANCE OF MOTORS

Motors have been used for various drive operations today and they form a very vital basis for automation mass productivity in the industry. The importance of motors cannot therefore be over emphasized whether of the a.c. or d.c. types, single or three phase respectively. Their maintenance is a function of the component that is faulty and the symptoms and remedies are as detailed in Appendix II.

9. CONCLUSION

Electrical installation is very extensive and more involving than has been handled in this lecture. So too is the maintenance aspects. However, the paper has adequately covered fundamentals on most issues as they concern electrical installations. It is the view of the writer that proper training, installation and operation of such installations will go a long way to preserve the system. However, the undue presence of very inferior electrical components and accessories in the market has seriously affected on the practice and has even complicated maintenance management. However, with new and adaptive trends, there is some hope in the direction and business of equipment and infrastructure maintenance and management.

10 REFERENCES

- Atabekov, V., 'Repair of transformers and Electric Machines,MIR Publishers,
### Fault Finding in Fluorescent Lamp Fittings

If a fitting fails to operate correctly, check as follows:

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Test to be Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply and fuse</td>
<td>Check supply voltage at input to fitting. Check polarity of incoming supply and ensure frame is earthed. If fuse has blown, inspect circuit or components and find the fault before replacing fuse.</td>
</tr>
<tr>
<td>2. Lamp</td>
<td>Check lamp is a good fit and is proved faulty replace with a new lamp. Remember, never use a new lamp in a fitting which has faulty components or circuit.</td>
</tr>
<tr>
<td>3. Circuit</td>
<td>Examine wiring inside the fitting and if possible check against the wiring diagram. Check insulation resistance between the circuit and the metal frame of the fitting. The resistance should be above 2 megohms. If an earth fault is found, trace the cause, and replace the component.</td>
</tr>
<tr>
<td>4. Ballast Chokes</td>
<td>Examine for signs of overheating, if possible check continuity of windings and insulation resistance. Compare the impedance of inductors against a good replica.</td>
</tr>
<tr>
<td>5. Capacitors</td>
<td>Examine for leakage or damage. If possible check the capacitance and check that the discharge resistor has a value between 6-1 megohms.</td>
</tr>
<tr>
<td>6. Starter Switches</td>
<td>Check operation of starter in another good circuit and, if found faulty, fit a new replacement.</td>
</tr>
<tr>
<td>7. Ambient Conditions</td>
<td>Remember that normal fluorescent lamps may overheat if in an enclosure temperature is above 35°C.</td>
</tr>
</tbody>
</table>

*Note: Starter switching may be difficult with some types of circuits if the temperature is below 5°C.*
### Fault Finding in Switches

#### Fluorescent Lamp Circuits

<table>
<thead>
<tr>
<th>Faulty Lamp</th>
<th>Faulty Starter</th>
<th>Faulty Choke</th>
<th>Faulty P.F. Capacitor</th>
<th>Faulty Wiring or Circuit</th>
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<td>Loose connection</td>
<td>Weak filament</td>
<td>Loose connection</td>
<td>Open circuit</td>
</tr>
<tr>
<td>Arcs at contacts</td>
<td>Loose connector</td>
<td>Burnt filament</td>
<td>Loose connection</td>
<td>Short circuit</td>
</tr>
<tr>
<td>Complete break in arc</td>
<td>Loose terminal</td>
<td>Broken filament</td>
<td>Loose connection</td>
<td>Open relay</td>
</tr>
<tr>
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<td>Loose terminal</td>
<td>Shorted filament</td>
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**Remember:** Never try to repair lamps in a circuit. If the lamp blows, replace the lamp or starter. If the starter fails, replace the starter or starter circuit. If the choke fails, replace the choke or the circuit. If the P.F. capacitor fails, replace the capacitor or the circuit. If the wiring or circuit fails, check the wiring or circuit for loose connections or short circuits.

### Appendix I C

#### Fluorescent Lamp Circuits

<table>
<thead>
<tr>
<th>Faulty Lamp</th>
<th>Faulty Quick Start</th>
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**Check list:**
- Check for loose connections or short circuits.
- Check for proper arc formation at the contacts.
- Check for proper filament temperature.
- Check for proper choke saturation.
- Check for proper P.F. capacitor function.
- Check for proper wiring and circuit connections.

**Remember:** Never try to repair lamps in a circuit. If the lamp blows, replace the lamp or starter. If the starter fails, replace the starter or starter circuit. If the choke fails, replace the choke or the circuit. If the P.F. capacitor fails, replace the capacitor or the circuit. If the wiring or circuit fails, check the wiring or circuit for loose connections or short circuits.
Check that all holding-down bolts are tight; if direct coupled, look for the cause in the driven machine; unscrew the motor and check when running tight.

This trouble may be met with when replacement brushes are fitted: the real contact area of the brush must 'bed' positively on the commutator.

This is extremely unlikely to happen after a motor has been running satisfactorily; after a rush it may be discovered that the commutator is not true, or the fault may be due to some form of shrinkage due to faulty manufacture; in any case, the commutator must be turned true as a cure.

The obvious corrections is that the brush-maker must be rotated to the correct position as previously described.

This again is an unlikely occurrence in the normal run of events, but one which would cause permanent bad commutation. The best way to tackle a job of this description is separately to secure the field system, and then check the volt drop on each coil; the drop should be approximately the same, and any serious deviation, i.e., a low reading on one coil, will give an indication of the faulty coil.

This fault will give a very poor commutation on load and is rectified by regeneration, as in a previous example.

Various grades of brushes are fitted depending on the voltage, design and size of the machine. Always in the grade of brush recommended by the maker.

2-PHASE MACHINES.

c. The motor refuses to start.

(i) Open circuit in the line brought about by blown fuse elements, etc.
(ii) Open circuit in the motor starter winding.
(iii) Open circuit in the motor starting motor.

1. Check voltage with a voltmeter and examine for blown fuse elements.
2. Test the starter circuit for continuity by means of a 'magnet' or test lamp.
3. Test the starter circuit for continuity, including the starter winding itself.

On load, the motor overheats.

1. Overload.
2. Excessive amount of starting inrush.

1. Check over the entire line brought about by the current, which may have burned the motor.
2. On no account open any connections or disturb the windings of the three phases in contact with the motor under-test, the current and the normal amount for the motor, or better still, unscrew the starter motor.
3. Test for a short circuit or earth as previously described.

The motor starts with difficulty, and when load is applied there is an extremely drop in speed.

1. The motor brushes are worn.

2. Reconnect the field winding has an open circuit.

APPENDIX II C

Rectification

(a) Examine the rotor for cracks or loose bars.
(b) Test across all three slip-rings for equal voltage drop; examine the d.c. starter for breaks in the motor circuit; examine commutator, etc.

C. Indication

On closing the main switch, four-elements are blown in the main circuit-breaker trips. Do not simultaneously replace fuse-elements or test again. First look for a possible cause, there is a reason for everything.

Possible Cause

(a) A short circuit between stator phases or an earth.
(b) A short circuit in the leads between the main switch and the starter.
(c) The slip-rings of a slip-ring motor are short circuited.
(d) Some coil has left the starter handle too far in the full 'on' position.

Rectification

(a) Test for a short circuit or earth as previously described.
(b) Test for a short circuit in the connecting leads.
(c) This can be best discovered by lifting the motor brushes and applying a reduced voltage to the stator; if the motor runs at all then a short circuit exists.
(d) If the under-voltage release coil repaired at once; this malpractise of locking the starter handle over should always be stamped on, as it causes all kinds of under-voltage and overload protections to the motor.

APPENDIX II A

Common Faults and Their Rectification

The following notes are intended to act as a very general guide to the observation of the more common faults likely to be met.

Briefly, the observations fall into two classes: (A) The installation of new or repaired motors, (B) Apparent faults after a period of satisfactory service.

D.C. MACHINES

(A) THE INSTALLATION OF NEW OR REPAIRED MOTORS

1. Indication

At starting, excessive heat is generated in the rheostatic starter accompanied by a current surge on the test leads which probably shows the four-elements. The motor refuses to start.

Possible Cause

(a) The starting conditions are too heavy for the starter.
(b) There is a break in the field circuit.

Rectification

(a) Check the starting current, and either install a larger starter or reduce the starting current.
(b) Check for continuity of field circuit back in the motor and to the external rheostats.

2. Indication

At starting, as the starter handle is moved over, the motor runs fast in one direction, then stops and reverses direction of rotation.

Possible Cause

The commutating ring is reversed.

Rectification

Re-connect and check polarity of shunt and series windings.

3. Indication

On load, the motor overheats.

Possible Cause

The load is too much for the motor.

Rectification

Read motor current with an ammeter, check with the rating-plat, and either install a bigger motor or reduce the driven load.

4. Indication

Sparking on load.

(a) Worn voltage.
(b) Overload.
(c) Starter retracted.
(d) Wrong current.
(e) "Excessive"

(a) With a voltmeter, check the brushes, e.g., in accordance with the motor rating plate.
(b) With an ammeter, check the armature current, and if in excess, reduce the driven load or install a larger motor.
(c) Check connections and test the polarity of the commutator with a compass needle; with a motor these should be the same polarity as the preceding main pole taken in the direction of rotation.
(d) Check that the brushes are in the neutral position; this position is obtained when the white line on the brush-maker is indistinguishable.
(e) Interchange the positions of brushes, the actual neutral position being the one where the same polarity, by the actual neutral position but, nevertheless, the brush position is marked as above.

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3-PHASE MACHINES.

1. Indication The motor refuses to start.
   Possible Cause (a) Open circuit in one of the lines; resulting in single-phase connection.
   Rectification (a) Check line voltage with a voltmeter and examine for blown fuse元件.
   (b) See that motor circuit is complete from brushes to starter.

2. Indication The rheostat is excessively hot during the starting periods.
   Possible Cause (a) Rheostat not large enough for the starting conditions.
   (b) The starter has not been ordered to suit the motor volts and amps.
   (c) Oil has not been put in an oil-assisted starter.
   Rectification (a) Measure the starting current, and either change the rheostat or reduce the starting load.
   (b) Check that the name plate and amps are the same for both motor and starter.
   (c) Fill to the required level with insulating oil.

3. Indication On load, the motor overheats.
   Possible Cause The load is too much for the motor.
   Rectification Read motor current with an ammeter, check with name-plate and other instal a bigger motor or reduce the circuit load.

4. Indication Starting difficulty coupled with excessive slip on load.
   Possible Cause (a) Wrong voltage.
   (b) Motor being run in the star connection instead of delta connection.
   Rectification (a) With a voltmeter, check the supply voltage in accordance with the motor rating-plate.
   (b) Make the necessary alteration to the motor connections.

B) APPARENT FAULTS AFTER A PERIOD OF SATISFACTORY SERVICE

D.C. MACHINES.

1. Indication The motor refuses to start.
   Possible Cause (a) Motor often starts but fails to run, usually a blown fuse element.
   (b) Worn or sticking brushes.
   (c) Break in motor field circuit.
   Rectification (a) Examine and replace fuses where necessary.
   (b) Clean and replace worn brushes, then should be a sliding fit in the holders and there should be good commutator contact.
   (c) Cke the field field... etc.
   (d) Examine commutator and brushes.

2. Indication The motor starts with difficulty.
   Possible Cause (a) Shop or field circuit.
   (b) Incipient brush arcing.
   (c) The brushwork has moved from the correct position.
   Rectification (a) Check the whole field circuit for continuity.
   (b) Disconnect the motor and starter, lift the brushes, and with a "wedge", hold the fields and starter for earth.
   (c) Rest the brush position; should be in line, the markings should also be counter-clockwise.

3. Indication The commutator shows sparking.
   Possible Cause (a) Commutator segments are worn.
   (b) Commutator segments are too thick.
   Rectification (a) This is usually detected by sound or by visual inspection of the commutator segments.
   (b) If the brushes are worn, the commutator segments are too thick.

4. Indication The motor gives an erratic starting performance and takes an excessive current both at starting and running.
   Possible Cause The armature windings have developed a short circuit.
   Rectification Repair is inevitable: a motor should be replaced when an short circuit is detected. If the short circuit is not detected, the armature winding must be replaced.

5. Indication On load, the motor overheats.
   Possible Cause The load is too much for the motor.
   Rectification Reduce motor current with an ammeter; should this be excessive, then check over the driven load and endeavour to find out what has caused the overheating.

6. Indication On load the motor takes excessive current, and it is observed that certain armature coils heat up after a short period.
   Possible Cause Commutator bars are short circuited.
   Rectification Examine the commutator for a short circuit caused by foreign matter... etc.

7. Indication The motor sparks excessively with a "climbing" type of spark, the air between certain commutator segments is burnt.
   Possible Cause This is almost certain indication of an open circuit in the armature.
   Rectification Examine the armature to commutator connections for breaks, if a break cannot be seen then check the armature winding.

8. Indication On load, certain brushes overheated and spark, while others remain normal.
   Possible Cause Brushes of varying grade have been fitted.
   Rectification Replace the wrong brushes; for a given machine all the brushes should be of the same grade.

9. Indication On load, the motor sparks, with the result that the commutator is blackened.
   Possible Cause (a) Overheating commutator bars or high mica.
   (b) Incorrect spacing of brushes.
   (c) Brushes knocking in brush-boxes.
   (d) Brush holder reddening.
   (e) Contact between the brush and the commutator.
   (f) Wrong brushes.
   Rectification (a) This is usually detected by sound or by visual inspection...
   (b) If the brushes are worn, the commutator surface needs cleaning.
   (c) The brushes should be replaced when the commutator segments are too thick.

10. Indication The brushes wear excessively.
    Possible Cause (a) The brushes are running too close to the commutator.
    (b) The commutator segments are too thick.
    Rectification (a) This can be reduced by the elimination of dust...
    (b) When the brushes are worn, they should be replaced.