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## *Principles and Planning of Maintenance*

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Maintenance is the process by which any equipment or machinery can be maintained in a proper and efficient condition.

The electrical equipment or apparatus like any other electric machines requires carefully planned programme of checking and inspecting and also for preventing maintenance, if it is to give satisfactory and trouble-free service for a long time. It is necessary to keep the proper record of inspection, insulation resistance and all maintenance and repair operation etc. Only then, it will be possible to find out the chronic troubles, anticipate impending troubles, locate weak spots and adopt corrective action well in time. A machine should never be allowed to run without lubrication. Proper care should be taken for its cooling and overloading on the motor should be avoided. The motor should never be allowed to be overheated, otherwise, the winding may burn, smoke may occur and it may damage other parts even.

The machines must be saved from the dampness, humidity, dirt, oil etc. as these factors result in deterioration of insulation of windings and may result in rusting the various parts of the machines. The state of winding can be adjudged to a correct degree of accuracy by comparing the reading of insulation resistance taken previously under the similar conditions. If the present readings differ from previous, then the need of cleaning, drying and re-varnishing will occur.

The periodic inspection and maintenance details may vary with the type of machine and its working conditions but planning and inspection of different items at regular intervals will meet most of the requirements of the time.

The performance of any equipment or machine or apparatus must be particularly observed immediately after commissioning it in respect of its operating voltage, current, starting device, any unusual vibrations and noise. All connections and joints should be inspected for their looseness.

Some spare parts, sub-assemblies, lubricants depending upon the need and importance of the machine or apparatus or equipment. and some spare-coils, brushes, brush holders, starting, gears and bearings etc. should be kept ready in hand.

The planning of maintenance should be categorised in the following ways:

**1. Routine Maintenance.** Visual inspection, minor repairs, replacement of small parts and adjustment of the equipments, cleaning the electrical equipment of dust and dirt, cleaning of fittings, fixed and moving contacts of starters, bushing of transformers, tank cover etc., cleaning of carbon deposits, fused metal, changing of burnt contacts, washing and lubrication of bearings, changing of carbon brushes etc. are covered under the routine maintenance programme. Checking of oil level, inspecting the current, voltage and indicating lamps' light is also covered under the routine maintenance. It should be carried over daily if possible or on alternate days.

**2. Overhauling.** The replacement or renewal of the main units, parts of electrical equipment and assemblies, rewinding of motor stators and rotors etc. bushing, changing of starters are covered under overhauling. It should be carried out half-yearly or yearly.

**3. Preventing Maintenance.** The main elements of good preventing maintenance may be as under :

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| (a) Inspection,                             | (e) Engineering Records, |
| (b) Testing,                                | (f) Organisation,        |
| (c) Engineering Analysis,                   | (g) Tools and tackles,   |
| (d) Inventory control of stores and spares, |                          |

(a) **Inspection.** It may be visual or external inspection and detailed or internal inspection. Checking of vibration, wear and tear, fittings and clearances, abnormal sound and lubrication can be inspected visually. detailed inspection may be carried out during pre-planned shut downs. This inspection may be done monthly or quarterly or half yearly depending upon the nature of using the equipments and their operating conditions.

(b) **Testing.** The testing of electrical equipment and instruments connected at the site must be done very carefully and thoroughly as the performance of the equipments and instruments depends upon their accurate testing and setting. This may be done monthly or quarterly.

(c) **Engineering Analysis.** Sometimes some equipments require more frequent repairs as compared to others *e.g.* starters, circuit breakers, relays etc. so the reasons for frequent repairing may be known at the earliest by observing the following points :

- (a) Improper lay out of the equipment,
- (b) Misuse of equipment,

- (c) Unhealthy operating conditions,
- (d) Low quality material used in the equipment,
- (e) Defective design,
- (f) Poor Maintenance.

After checking the equipments for the reasons mentioned above, the equipment must be corrected at the earliest possible to prolong the life of equipment and for proper working.

(d) **Inventory Control of Stores and Spares.** The inventory of stores and spares is very essential as sometimes, when any important part is to be replaced and if it is available in the store that will save the time and labour and will avoid the lack of production and that can only be possible if the inventory of stores is maintained properly.

(e) **Engineering Records.** The quality of maintenance of any equipment depends upon particularly on the record of maintenance which is fulfilled and kept properly. The list of defects, gives a clear picture of over all condition of equipment which helps in establishing beforehand the exact amount to the speed and kind of repairs to be undertaken and the time to be taken for the repairing work. Separate forms are required for each type of equipment for filling up the different entries under the routine maintenance work and overhauling. Such a system simplifies the repairing work. Proper keeping of repair records promotes better planning of the work, gives clear idea of the working condition of the equipment and increase the production.

(f) **Organisation.** The maintenance of any equipment depends upon the proper organisation set up. It differs from industry to industry depending upon the working schedules, type of industry, size of industry, nature of production types of equipments available in the industry and main power etc. The organisation set up has to observe :

- (a) That the maintenance work should not be suffered at any cost. This will decrease the break down of the equipments.
- (b) That some experts engineers and technicians must be deputed for the maintenance work. This will maintain the proper functioning of the equipment.
- (c) That essential records of all types of maintenance should be kept properly and checked from time to time to maintain the production.

(g) **Tools and Tackles.** There must be arrangement of proper tools and tackles and of superior quality which reduce the amount of manual labour required for handling heavy equipment and save the time during the repairs work of any equipment. Jacks and fixtures must be available for lifting and handling the heavy and time consuming equipments.

**Advantages of Preventing Maintenance**

1. It avoids the untimely interruption to various machines and equipments and premature failures.
2. It gives the systematic system for maintenance and inspection for major and minor faults of any equipment.
3. It reduces break downs and increase the efficiency of equipments and machinery.
4. It reduces the cost of repairing.
5. It reduces the depreciation of the machinery and equipment.
6. It increases the life of working of equipments.
7. It helps in better working condition of the equipment.

**Maintenance of faults.** It should be carried out immediately as and when any fault occurs *i.e.* blowing of fuse, short circuit or over loading etc.

The following factors should be taken into consideration at the time of preparing the schedule for maintenance :

- (a) Checking of stationary parts.
- (b) Checking of movable parts.
- (c) Checking of working condition of equipment or machinery.
- (d) Checking of Surroundings in which the machinery or equipment has to work *i.e.* atmospheric conditions.
- (e) Checking of safety measures.
- (f) Checking of protective devices.
- (g) Checking of facilities available.
- (h) List of consumable and non consumable items to be used in the equipments and machinery.
- (i) Checking of stores and spared inventory.
- (j) Checking of tools, trackles, Jacks, and fixtures etc.

<i>Weekly</i>	<i>Maintenance and Check Programme of Electric Motors</i>
<b>1. Surrounding</b>	Care should be taken that amount of unusual dust, dripping water, acids, fumes may not enter the motor. Any board, cover, canvas should not be left open to avoid the hindrance to the ventilation or jam moving parts.
<b>2. Sleeve Bearings, Motor Lubrication, Wool Packing etc.</b>	Check the level of oil when oil gauge is used and if the level is down complete it to the gauge line level. Instruction book should be followed when there is any need of special lubrication <i>i.e.</i> for wool packed, disk and forced lubrication. Check the bearing housings, if dry, then oil them. Creeping of oil along the shaft towards winding should be avoided.

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<i>Weekly</i>	<i>Maintenance and Check Programme of Electric Motors</i>
3. <b>Ball or Roller Bearings.</b>	Check the bearings for noise, oil them little, add grease in the housings or replace them. Avoid creeping of grease entering inside the motors winding.
4. <b>Brushes and Commutator or rings.</b>	Note the colour and condition of the commutator and brushes when there is sparking. The pigtail of the brushes for loose connection should also be checked. Black spots or roughness on the commutator should be noticed. The surface of commutator should be smoothed with the help of sand paper and get it turned on the lathe machine. Clean the segments of commutator with the help of cleaning stick.
5. <b>Rotors and Armature</b>	The uniformity of air gap in the motor should be checked in which the sleeve bearings are used.
6. <b>Windings</b>	If the dust particles are noticed in the winding, blow it with blower. Clean the dust with dry cloth. Note for the moisture contents in the winding. If observed, dry them up. If any oil or grease has entered in the winding, clean the winding with a suitable solvent and dry it in a well-ventilated room.
7. <b>Mechanical Condition</b>	Sometimes there is unusual noise is heard from motor due to metal to metal contact or scorching varnish insulation. Stop the motor and check it and remove the defects.
8. <b>Mechanical Inspection</b>	Belt should be checked for suitable slackness and good surface condition. Check the gears for wear and tear. Excessive greasing or oil should be observed and should be avoided. The controlling devices should be checked thoroughly.

<i>Monthly/Quarterly</i>	<i>Maintenance and Check Programme of Electric Motors</i>
1. <b>Windings</b>	Winding should be checked for their proper insulation. It should be checked for insulation resistance, short circuit and earth or leakage. Moisture contents should also be checked. Coil and cable connections should be checked up for their tightness.
2. <b>Brushes</b>	Brushes should be checked for their proper fittings and free play in the brush holders. Brush spring pressure should be observed. Worn out brushes should be replaced.
3. <b>Commutator</b>	Commutator surface should be examined for high mica and high bars, scratches and roughness. Risers should be checked properly. Commutator surface should be smoothed with the help of emery paper and get it turned on lathe machine.
4. <b>Sleeve bearings</b>	Bearing should be checked for weariness, end play and its surface. If dirt or sludge is observed in the bearing, it should be flushed out with lighter oil before refilling with grease.

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<i>Monthly/Quarterly</i>	<i>Maintenance and Check Programme of Electric Motors</i>
<b>5. Ball or roller bearings</b>	The leakage of grease or oil from the bearing should be checked. If the leakage is observed, clean it.
<b>6. Couplings and other Drives</b>	Sometimes the belt becomes loose, adjust it. Chain lubricating system should be checked. It should be checked for wear and stretch also.
<b>7. Enclosed gears</b>	Oil in the gear box should be checked for the flow for the presence of sand, water or metal scale. If the oil is not found in good condition, drain it out, flush and refill it.
<b>8. Loads</b>	Changing load conditions should be checked i.e. controlling devices troubles, poor handlings or wrong adjustments.

### Half Yearly / Yearly

<b>1. Windings</b>	Windings should be checked for insulation resistance, dry cracks of insulation, dust particles and moisture contents etc. If needed, dry out winding, clean it, varnish it and bake it.
<b>2.Squirrel Cage Rotor</b>	Broken or loose bars of rotor should be checked thoroughly. Set them properly or get it soldered /welded if needed.
<b>3. Wound Rotor</b>	Collector rings, washers and connections should be checked. If there are spots on the rings or if they are found rough or eccentric, get them turned on the lathe.
<b>4. Armature stator</b>	Stator should be checked for open, short earth or leakage fault. Insulation resistance should also be checked. Oil or grease should be observed, if found. Clean it. Lamination cores should be checked for its corrosion or looseness clean or tighten them properly. In case of D.C. armature commutator should be checked for highmica since high bars or eccentricity. Smooth it with sand paper or get it turned on lathe.
<b>5. Air gap and bearings.</b>	Uniformity of air gap should be checked. Bearings should be checked for their noise, dust, excess greasing etc. If any fault is observed, correct it.
<b>6.Mechanical parts</b>	The inside and out side of frames and belts should be checked. If belt or chain need replacement, then should be replaced. The rotor should be checked for its rubbing or misalignment.
<b>7. Loads</b>	Motor should be checked with the instruments at no-load and full load. The mechanical conditions of the driven machine should be checked.