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# MAINTENANCE PLANNING AND MANAGEMENT (INSIGHTS INTO THE SET-UP AND CONTROL OF MAINTENANCE ACTIVITIES)

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By

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## **Abstract**

*Plants and equipments are central to production and their acquisition and maintenance must be taken very seriously. Companies buy robust plants and equipments which have been tested. Standardization of plants and equipments is one important factor which is always taken into account in new acquisition. In developing countries, this is a priority because the breakdown of equipment which has no ready spare parts can result in huge financial losses in addition to prolonging the project period. New equipment needed to be designed, purchased, installed and maintained. In the light of the foregoing, this paper highlights the maintenance program and procedure for their set up in areas of planned, preventive and corrective maintenance, purchasing, storekeeping and the levels of logistic support resources required for sustaining system life cycle. Finally some recommendations are put forward aimed at improving maintenance planning and management in industries, workshops, laboratories etc.*

Industrial establishment invest heavily in the purchase of capital equipments. In order to acquire the technical know-how and skills of work to be done on these capital equipment, it is necessary to plan for their maintenance. Maintenance planning is a plan or scheme devised by a person or group or management responsible for maintenance.

It is a plan which includes all planning and analysis associated with the establishment of the requirement for the overall support of the system or project through its programmed life. Maintenance planning constitutes a sustaining level of activity beginning with the development of the maintenance concept and continuing through the accomplishment of logistic support analysis during design and development, the

procurement and acquisition of support items. Maintenance planning is accomplished to integrate the various other facets of support for sustaining system life cycle.

The challenges faced by most developing countries are the installation and maintenance of imported technologies (equipment). Most imported technologies came as a result of bilateral agreements or purchased directly by the owners of the companies. To maintain these equipment, a sound and well trained personnel in theory and practice in maintenance techniques must be on ground (White E. N, 1979).

However, it is sad to note that in recent times equipment maintenance has not been taken seriously by most companies or establishments. This has given rise to abandoned and obsolete equipment and vehicles lying waste around company premises waiting to be auctioned as scraps.

For maintenance planning and management to be very effective and functional in any organization, well trained staff and adequate funds must be provided for purchase of modern tools and replacement of old machineries.

### **Definition of Maintenance**

Maintenance can be defined as the act of putting plants and equipment in good working conditions so as to achieve specific levels of efficient and reliable performance.

**OR**

The 'care' or attention given to appliances, machines, buildings structures and other facilities so that they will serve for long time.

### **Objectives of Maintenance**

B.E. Okah – Avae, (1995) stated the objectives of maintenance as follows:

1. Enable product quality and consumer satisfaction to be achieved through serviced and operational equipments.
2. Maximize the useful life of equipments.
3. Keep equipments safe and prevent the developments of safety hazards.
4. Minimize the total production cost directly attributed to equipment services and repair.
5. Minimize the frequency and severity of interruptions to operating processes.
6. Minimize production capacity from the given equipment resources.

### **Elements of Maintenance**

- (a) Change of faulty parts.
- (b) Setting the components to the correct size or dimension.
- (c) Using correct working devices during servicing.
- (d) Preparation of maintenance schedule.
- (e) Making use of correct materials during servicing and
- (f) Use of servicing manuals.

### **Types of Maintenance**

Maintenance is divided into two major parts viz Preventive and Corrective maintenance (Terry Hill, 1983, 1991); Agbamu, E.A. (1999). From these two major parts in maintenance, there are other types of maintenance which are as follows:

- (a) Running
- (b) Break-down
- (c) Emergency
- (d) Planned/schedule
- (e) Opportunity
- (f) Design-out

### **Preventive Maintenance**

This type of maintenance is carried out on machines or equipment in order to avoid the breakdown of its components. These include overhauling, regular clearing and oiling, greasing and general servicing.

Formal preventive maintenance may take four different forms:

- a) Time – based-Doing maintenance at regular intervals.
- b) Work-based-Maintenance after a set number of operating hours or volume of work produced.
- c) Opportunity based – Where repairs or replacements take place when the equipment or system is available – e.g. during holiday closure.
- d) Condition – based maintenance-This relies on the planned inspection to reveal when maintenance is prudent e.g. replace a brake pad.

### **Elements of Preventive Maintenance**

Newbrough, E.T. (1967) in his book titled Effective Maintenance Management, stated the element of preventive maintenance as follows:

- a) Inspection or checkups i.e to inspect the machine or plant frequently.
- b) Lubrication i.e sliding and other friction surfaces are systematically lubricated.
- c) Planning and scheduling I.e. work should be pre planned in details and schedule program to be prepared which should be followed strictly.
- d) Records and analysis I.e. keeping good records or work carried out is essential.
- e) Training of maintenance staff i.e sound training is essential for maintenance personnel and staff.
- f) Storage of spare parts i.e keeping of spare parts so as to avoid loss of production.

### **Preventive Maintenance Requirements**

- a) Good supervision.
- b) Good maintenance administration department
- c) Operators should be well trained.
- d) Good lubrication program.
- e) Proper maintenance records.
- f) Adequate stock of spare parts should be kept.
- g) Correct clear and detailed instructions should be given to the maintenance crew and also to the operators.
- h) Surroundings should be clean, ample ventilation and illumination.
- i) Manuals and other data should be consulted as and at when required.
- j) Maintenance departments should be in cordial contact with production and purchasing departments.

### **The Advantages of Preventive Maintenance**

Husband, T.M. (1976), and Awe, S.K. (1983) stated the advantages of preventive maintenance as follows:

- a) Reduction in production down-time.
- b) Lesser over-time pay for the maintenance crew.
- c) Lesser numbers of stand-by equipment are needed.
- d) Less expenditure on the repairs.
- e) Lesser spare parts are needed to remain in the store at all times and
- f) Greater safety to employees because of reduced break-downs.

**Corrective Maintenance:** Is the maintenance or care carried out on machines or plants in order to put such equipment back to its normal operating condition after the equipment had failed e.g. change of a broken crankshaft of an engine.

**Running Maintenance:** Is the maintenance or care which takes place when the plant or machine is still in operation e.g. topping up a car battery, setting of engine valves, rectifying radiator hose leakage. It falls into the preventive maintenance group.

**Break-down Maintenance:** The breakdown of plant or machine can occur due to the following two reasons:

- i. Unpredicted failure of components which cannot be prevented.
  - ii. Gradual wear and tear of the parts of the plant or machine.
- Breakdown Maintenance is the actual repair work carried out on a machine or plant in order to restore it to the operational condition e.g the replacement of worn parts of an engine. It falls into the corrective maintenance group.

**Emergency Maintenance:** Is the maintenance or care which is unforeseen and unplanned for carried out on a machine or plant e.g. resetting of the contact point of a

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car, cleaning and setting of spark plug of car. It falls into the corrective maintenance group.

**Planned/Schedule Maintenance:** Is the maintenance or care carried out on machine or plant with fore knowledge control and records, which may be weekly, monthly or annually see table 1.

**Opportunity Maintenance:** Is the maintenance or care that is carried out on machine or plants by chance e.g replacement of parts which are at the end of their useful life like gasket, oil seal, bearings, sprocket, and so on.

**Design- out Maintenance:** Is the maintenance or care through modifications carried out on machine or plant which fails regularly for the better e.g. Provision to hold a component that opens during sudden engine surge.

**Table 1: A Typical Periodic Maintenance Schedule**

<b>Location Floor: A</b>	<b>Periods</b>	<b>Plant No: AEA NO 0345</b>
3 Months	6 Months	12 Months
<b>Check and replace parts</b>	<b>Check and replace part more elaborate</b>	<b>Overhauling</b>
<b>Remarks:</b> Plant was thoroughly checked and all defects noticed were rectified. Tested and put into operation. The plant should be shut down for major maintenance overhaul after 12 months.		
<b>Signed: REO</b> <b>Rank: Maint. Supt.</b>	<b>Name: Engr. Roland E. Okundaye</b> <b>Date: 30/5/96</b>	

**Planned Maintenance Programme**

Planned maintenance program can be set up as follows:

- a. List all the works which are required to be carried out by external authorities.
- b. List with the frequency required, all work deemed desirable by the appropriate manager. This will include the overhaul and servicing of all machines and items of the plant e.g. office equipment, cars, computers.
- c. Prepare standard documentation and instructions covering the maintenance required on each item listed. These instructions should be in detail form.
- d. Prepare a plan of work covering at least 12 months in such a way that no maintenance section is in any way overloaded. This is very conveniently done on a Gantt chart.

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- e. From the plan, issue instructions to the appropriate staff when necessary, requiring them to carry out work and record on the plan when the work has been done.
- f. Carry out post maintenance audits to verify the times allowed for various tasks and to provide information for future policy making.

To ensure that all items of equipment are included, it is desirable to number them and then to make a plant register. The effectiveness of a maintenance policy and program should be judged not by the vigor with which emergency repairs are carried out but on the freedom from such emergencies.

Maintenance planning requires some essential core responsibilities for sustaining system life cycle:

- a) Specification and ordering of equipment, their spare parts and materials.
- b) Receipt and acceptance of new equipment, their spare parts and materials.
- c) Day to day care, routine servicing and planned maintenance of equipment and.
- d) Repair of faulty equipment.

**Maintenance Procedure**

This should be done according to the manufacturer’s specifications. Details shown in table 2 summarize two maintenance procedures i.e Daily and periodic. Daily maintenance is done by the operators themselves, which include cleaning, oiling, greasing etc. Before operator starts work either normal or shift, daily maintenance is essential. Periodic maintenance is conducted by the maintenance crew based on past experiences and operating instructions found in the manuals. During these periods, both inspection and lubrication schedules should be strictly followed and any defects should be rectified immediately. Nothing should be left for a later date.

**Table 2: A Typical Daily/Periodic Maintenance Job Schedule**

<b>Maintenance Schedule Card</b>						
<b>Location: Floor C</b>			<b>Plant No: MPE/042</b>			
<b>Schedule: MLX 042”</b>						
s/n	Job description	Availability	Job Ref No.	Trade /Rank	Time	Remarks
1.	Daily Cleaning oiling and greasing	Immediate	“	Operator	10 min	Must be done
2.	Weekly cleaning, checking.	“	001	Artisan	20min	“

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3.	Monthly-No 1, and 2, check bearing, belt, oil sump etc	“	002	Filter	30min	Replace effective components amend if necessary
4.	6 months, No 1,2,3, check foundation bolts coupling, alignment, oil filter, pump, etc.	“	003	Craftsman	50 min	As above correct alignments.
5.	Annual Over hauling	“	004	Crew from Artisan to Foreman	Hours	Repair, replace, necessary parts drain and refill lube oil, test plant
Signature DAA			Name Daniel A. Aliyu Date: 03-05-96			

**Cards:** In every maintenance job, one has to keep record of what has been done. It is either in form of job report cards. (Ref table 2 and 3).

Job report cards as the case may be are different or similar in the individual factory or workshop.

**Table 3: A Typical Maintenance Trouble Shooting**

Job Report Card		
<b>Location: Floor B</b>		
<b>Plant No: M39</b>		
S/N	Defects found and cause	Action taken or required
1	Tailstock main spindle sticky	Serviced and tested for free movement Dismantled, repaired, and tested, None. Kerosene 2 liters: Oil 2 liters Grease 10gm: Rag 5kg, 2 sheets of emery cloth.
2..	Compound slide sticky	
3.	Spare parts used	
4.	Materials used	
Signed: NAA NAME: N,A Aluyi		Date: 02-04-96

**Trouble Shooting:** Most equipment develop faults during their normal life span which can be attributed to wear, incorrect use and bad design. Most equipment have trouble shooting charts which serve as a guide for the maintenance crew to correct certain faults detected when the equipment is in operation or about to start see table 4.

**Table 4: Trouble Shooting and Remedy**

S/n	Faults	Cause	Remedy
1.	OIL IN COOLING SYSTEM.	Defects in core of oil cooler. Defects in head gasket	Install a new core in the oil cooler. Install a new head gasket.
2.	Mechanical noise (knock) in engine.	Failure to bearing. Damage to timing chain or gear. Damage to camshaft.	Inspect the bearing and replace. Install a new chain or gear. Install a new camshaft.
3.	Starter motor does not run or crank	Battery weak or bad. Starter motor not good.	Check battery condition. Repair or replace starter motor
4.	Pump fails to deliver fuel.	No fuel in tank. Wrong direction of pump rotation. Poor power supply. Air in system	Refill fuel tank. Change direction of pump rotation. Sufficient power supply. Clear air from system I.e. priming

### **Purchasing**

In plant services and maintenance duties, the term PURCHASING applies mostly to the order of spare parts, new machines or plants and other equipment. As technical personnel it is your responsibility to be involved in the purchasing, because you determine the specification of purchasing needs, compiles orders and specification of various needed equipment and talk to vendors I,e the manufacturer’s representatives on technical points. In selecting the suitable equipments to meet the needs, one has to consider the following;

- a) Is equipment easy to install?
- b) Is maintenance straight forward?
- c) Are spare parts available at low cost?
- d) Does the vendor promise installation after sales?
- e) Does the vendor promise training of personnel?
- f) Does the vendor promise after sales services for certain period?

Also in compiling orders and specifications of equipment, one has to state the following:

- a) The full title as indicated in the vendor brochure.
- b) The full model number and any additional number.
- c) All known specification in detail such as the user and maintenance manuals, installation drawings, commissioning details, training program arrangement, model number or spare parts and so on.

In addition to the needs placing order for new equipment, one also needs to consider the following:

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Electricity, Water supply, Gas, Compressed air, Steam, Enough space, Existing doorways, Existing foundation plan, Facilities for waste removal

#### **Storekeeping**

According to Newman R.G, (1985) and Tombari, H.A. (1982) storekeeping in maintenance engineering occupies an important position and it involves the followings;

- a) Receiving, examining and booking in the goods or spare parts, returning faulty goods if necessary.
- b) Storing stock in conditions which protects the stock from damage, deterioration and pilfering. The stock should be stored methodically such that each item can be easily located and retrieved. The storage method employed should ensure that stock does not become source of danger to personnel.
- c) Issuing stock and keeping records of stock quantity and movements using
  - i) Stock level to control consumables, spare and materials,
  - ii) Multi-item stores issue form for small tools and small items,
  - iii) Simple item Stores issue form for major items of tools and equipment.

Generally, un-worked materials are known as Store and where they are housed is called store-room, while finished products ready for sales are called stock and the place where they are housed is called Stock-room. Stores are of the following categories;

- (a) Consumable
- (b) Raw materials
- (c) Machinery/Equipment
- (d) Furniture
- (e) Scraps
- (f) Empties/Packages
- (g) Inflammable item
- (h) Chemical items
- (i) Hand tools
- (j) Finished products
- (k) Un-serviceable items

The purposes of store keeping are to ensure that stock of number of items at any time does not fall below the prescribed minimum or goes in excess of the fixed maximum use. To arrange for a systematic and efficient storing of items and materials.

**Duties:** To keep record of items and materials. Check the balance of items and materials from time to time.

### **Integrated Logistic Support (I.L.S) Plan**

Integrated logistic support is a management function providing the initial planning, funding and controls which help to assure that the ultimate consumer will receive a system/product that will not only meet performance requirements but can be expeditiously and economically supported throughout its programmed life cycle. This plan should cover Maintenance, Supply Support, Test and Supply, Transportation and Handling, Performance and Training, Facilities, Data, Computer Resources.

### **Conclusion**

This paper discussed maintenance planning and management, highlighted different types of maintenance, maintenance scheduling, and equipment ordering trouble shooting, store keeping, purchasing and logistic support. For efficient maintenance management, rules governing maintenance programme or work should be strictly followed and some of these rules are:

1. All requests for formal maintenance work must be made to one central control point.
2. Maintenance stores must be carefully controlled as any other of the company store.
3. Record of all works carried out, including a statement of materials required should be kept as these may assist in setting rational maintenance, replacement and depreciation policies.

These rules cannot be completely exhausted in this paper as they are largely dependent on the types of maintenance programme in place in the individual company or organization. However certain suggestions are advanced, that will enhance the maintenance planning and management in industries.

### **Recommendations**

To promote good and effective maintenance planning and management in industries the following recommendations are advanced.

1. Provision of an adequate staffed and supervised engineering groups
2. A sound and well drawn maintenance program for each equipment.
3. Provision of a ware house or storage facilities to store spare parts.
4. Provision of adequate technical manual with each technology supplied or bought so as to refresh maintenance crew.
5. Regular training courses should be organized for maintenance crew (Skilled and unskilled) according to their disciplines from time to time to Update their knowledge to modern technologies.
6. Sufficient funds should be provided or made available for purchase of Maintenance tools, materials or spare parts e.t.c.
7. Continuous investigations into the cause for and remedies of emergency breakdown.

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