UNIT 5 PLANNING OF WORK

Structure

5.1 INTRODUCTION

In Unit 4 you were told how the various costs involved in the operation of an equipment are to be considered. In this unit you will learn about the necessity of planning.

Before any construction work can be undertaken planning is required for various facilities. Besides the access roads and construction power, other infrastructure have to be planned. Planning can be done when the basic requirements are understood.

Objectives

By the end of this unit, you will know the various aspects of

- planning for construction power, and source of construction power,
- planning for compressed air,
- access road,
- water supply,
- other infrastructure,
- scheduling considerations,
- construction target,
- planning for spare parts inventory,
- planning for repairs and maintenance,
- planning for replacement, and
- standby arrangements.

5.2 PLANNING FOR CONSTRUCTION POWER

At the construction site, electricity is needed to drive plants and machinery and to provide lighting. Most large projects are heavily electrified and need large amounts of power. There is a growing need to use electrical drives instead of other types of power in driving construction equipment due to lesser pollution, and electrical engineering in construction projects is of considerable importance.

Planning of electric supply on construction projects presents some difficulties due to the nature of works involved. There are unavoidable surges and short circuits due to transient nature of load such as when an excavator is crowding or welding rod makes contact with the job piece. As some of the works are done for a few hours during the day only, high peaks of short duration exist. The conditions under which the electricity supply and use are done are rough and often unforeseen. The variety of tools used and their intermittent working present difficulties in correct assessment of electricity demand.

To overcome the above difficulties, the remedy is to design the system for a liberal capacity and to provide for ruggedness, simplicity, flexibility and safety in the system. Economy may be a secondary consideration but cannot be ignored completely.

Careful planning is needed in routing the supply and distribution cables around the construction site to prevent interference with machinery movements and ensure safety. Cables should not trail along the ground unless suitably encased in a tube or conduit, and even this method should not be used for long times. Overhead cables should be supported by hangers attached to a load bearing wire and should be marked with some indicators or flags to provide visual warning. Minimum height clearances for overhead cables are 5.2 m in positions inaccessible to vehicles, and 5.8 m where cable crosses an access road or any part of the site accessible to vehicles. Cables that are likely to stay in one position for a long time, such as supply to a crane, should preferably be buried underground at a minimum depth of 0.5 m and protected with tiles or housed in clayware.

Electrical installations on construction sites are subject to the country's laws, such as, the factory act or special regulations. Requirements of these statutory provisions must be met with.

The following plant and equipment are among the principal users of electrical power on construction projects–pumps, compressors, concrete mixers, crushers, belt conveyors, screens, hoists, cableways, derricks, cranes and excavators. There are workshop tools and welding requirements. A substantial load on the system is electric lighting. Large open areas of the dam site, project roads and tunnels need considerable electric power.

SAQ 1

i) What are the problems in planning for electric supply on a construction project?

ii) How will you route supply and distribution cables in a project area?

iii) Which equipment and plant are generally operated on electricity?

5.3 PLANNING FOR SOURCE OF CONSTRUCTION POWER

Electric power may be obtained from the existing grid or may be generated at site of work. When obtaining from the grid, the supply voltage, distance of transmission, availability of adequate power and its reliability are important things to be checked to satisfaction. At site, operation may be done with stationary or portable diesel generating sets. Large thermal stations have sometimes been installed. In exceptional cases, generation of small scale hydropower may be possible. Power generation at project site is usually costly, but ensures reliability of supply.

SAQ 2

What are the sources of electric power on a project ?

5.4 PLANNING FOR COMPRESSED AIR

Compressed air is a popular prime moving force in driving equipment and for construction operations. Air as a power medium has many advantages. It is light, non-toxic, cost-free, readily available, has low viscosity and is elastic so it can be compressed. Energy stored in air under pressure is potential energy which can be released and converted into work by expanding it. Compressed air works in the same way as steam. It is specially suited for linear motion while electricity is better suited for circular motion. Air operated equipment are lighter, compact, safer, sturdy, simple, easy to operate and repair, and low in cost.

Compressed air is mainly used in drilling rock. It is also used for handling materials like cement and concrete, and in operating pumps, winches, loaders, vibrators, etc.

A knowledge of the theoretical requirement of each appliance for which compressed air is needed as well as experiences of operating these equipment assist in estimating air requirement on the construction site. The total air required is not the sum of the air required by individual machines. It may happen that on large projects all equipment working with compressed air do not operate at the same time. An analysis of the job conditions and working pattern should be made to determine the maximum likely need for compressed air before designing the system. This expected air requirement is based on staggered operation of devices needing compressed air. Peaks can be considerably reduced by arranging staggered operation of equipment. The effect is taken into account through diversity (or capacity) factors for each type of equipment and for the overall project.

The pipelines for transmitting compressed air have to be chosen according to the volume of air supplied and the distance of transmission as shown in Table 5.1.

Table 5.1 : Recommended Pipe Sizes for Transmitting Compressed Air at 80 to 125 psig (5.63 to 8.79 kg/sq cm g)

Volume of Air, cfm (cum/min)	Length of Pipe, ft. (m)				
	50-200 (15-60)	200-500 (60-150)	500-1000 (150-305)	1000-2500 (305-760)	2500-5000 (760-1524)
	Nominal Size Pipe, in (mm)				
30-60 (0.85-1.70)	1.00 (25)	1.00 (25)	1.25 (32)	1.50 (38)	1.50 (38)
60-100 (1.70-2.83)	1.00 (25)	1.25 (32)	1.25 (32)	2.00 (50)	2.00 (50)
100-200 (2.83-5.66)	1.25 (32)	1.50 (38)	2.00 (50)	2.50 (64)	2.50 (64)
200-500 (5.66-14.2)	2.00 (50)	2.50 (64)	3.00 (76)	3.50 (89)	3.50 (89)
500-1000 (14.2-28.3)	2.50 (64)	3.00 (76)	3.50 (89)	4.00 (102)	4.50 (114)
1000-2000 (28.3-56.6)	2.50 (64)	4.00 (102)	4.50 (114)	5.00 (127)	6.00 (152)
2000-4000 (56.6-113.2)	3.50 (89)	5.00 (127)	6.00 (152)	8.00 (203)	8.00 (203)
4000-8000 (113.2-226)	6.00 (152)	8.00 (203)	8.00 (203)	10.0 (254)	10.0 (254)

Table 5.2 gives the size of hoses recommended for different pneumatic equipment.

Table 5.2 : Recommended Sizes of Hose, in inches (mm), for Transmitting Compressed Air at 80-125 psig (5.63 to 8.79 kg /sq cm g)

Volume of Air, cfm(cum/min)	Types of Air Tools	Length of Hose, ft (m)		
		0-25 (0-7.6)	25-50 (7.6-15.2)	50-200 (15.2-60)
0-15 (0-0.43)	Spray guns 0.25 in (6 mm) drills, Light chipping hammers 3/8 in (10 mm) impact wrenches	5/16 (8)	3/8 (10)	1/2 (12)
15-30 (0.43-0.85)	Chipping hammers 15 lb (6.8 kg) rock drills	3/8 (10)	1/2 (12)	1/2 (12)
30-60 (0.85-1.70)	Light grinders Small concrete vibrators*	1/2 (12)	3/4 (19)	3/4 (19)
60-100 (1.70-2.83)	Heavy grinders Large concrete vibrators	3/4 (19)	3/4 (19)	1 (25)
100-200 (2.83-5.66)	Wagon drills Winches and hoists	1 (25)	1 (25)	1.25 (32)

While it is necessary to provide as much compressed air as will be required to supply the needs of all operating equipment, it is unnecessary to provide more air capacity than will be needed. It is probable that all equipment nominally used on a project will not be in operation at any given time. An analysis of the job should be made to determine the maximum actual need prior to designing the compressed air system.

If 10 jackhammers are nominally drilling, it is probable that not more than 5 or 6 will be consuming air at a given time. The others will be out of use temporarily for changes in bits or moving to new locations. Thus, the actual amount of air demand will be based on 5 or 6 drills instead of 10. The same condition will apply to other pneumatic tools.

Capacity factor is the ratio of the average load to the maximum mathematical load that would exist if all tools were operating at the same time. This ratio is also referred to as diversity factor. For example, if a jackhammer required 90 cfm of air, 10 hammers would require a total of 900 cfm if they were all operated at the same time. However, with only 5 hammers operating at one time, the demand for air would be 450 cfm. Thus, the diversity factor would be 450/900 or 5/10 = 0.5.

The application of diversity factors in designing a compressed air system is illustrated in Table 5.3.

Air requirement of tools or machines that operate with compressed air are given in volume (cfm) of free air supplied at 90 psig (6.33 kg/sq cm). Handbooks and manufacturers' tables give these figures. One such table is given as Table 5.4.

Manufacturers of equipment specify the pressure of air supplied to pneumatic tools at 90-100 psig (6.33-7 kg/sq cm). A loss of this pressure distinctly reduces the production of the tools. To ensure that air reaches the tools at correct pressure it is essential to have the compressor of adequate capacity and also to design the air transmission and distribution systems satisfactorily so that transmission losses are minimised.

The effect of altitude is to reduce the capacity of the air compressors. Thus, if an air compressor is required to work at high altitudes, a compressor of higher capacity than working at standard atmospheric conditions will be needed. For a single stage compressor, output is not much affected upto an altitude of 300 m but beyond that height, rate of reduction is about 2% for every 300 m upto 3000 m altitude. Output of 2 stage compressors is not much affected by change in altitude upto a height of 1000 m. Output of rotary compressors is not affected upto 6000 m altitude.

Table 5.3 : Illustration of the Application of Diversity Factors in Designing a Compressed Air System

Equipment	Air Required per unit	No. of Units		Maximum Air Demand (cfm)	DF	Probable Air Demand (cfm)
		On Job	Working			
Wagon drills	200	6	4	1200	0.67	800
Jackhammers	100	16	8	1600	0.50	800
Drill sharpeners	160	2	1	320	0.50	160
Oil furnaces	80	2	2	160	1.00	160
Grinders	50	2	1	100	0.50	50
Sump pumps	160	3	2	480	0.67	320
Line loss				220		220
Total				4080		2510
Job diversity factor					0.80	
Total actual demand				2510 * 0.80 = 2008		

Table 5.4 : Quantities of Compressed Air Required by Pneumatic Equipment and Tools

Equipment or Tools	Capacity or Size	Air Consumption, cfm
1) Chipping hammer	Light Heavy	15-25 25-30
2) Clay diggers	Light, 20 lb Medium, 25 lb Heavy, 35 lb	20-25 25-30 30-35
3) Concrete vibrators	3 in needle 4 in needle 5 in needle	40-50 45-55 75-85
4) Hoist	Single drum, 2000 1b Double drum, 2400 1b	200-220 250-260

Air leaks in compressed air transmission system should necessarily be prevented. The loss of air through leakage in a transmission line can be very costly, apart from reducing air pressure.

Important aspects of planning compressed air system includes: decision to use centralized plant or decentralized plants; plant capacity needed; type and size of compressors; location of the plant; layout of transmission and distribution system; size of the pipeline and hoses used; and supervision of the system during operation.

SAQ 3

i) What are the advantages of compressed air as a prime mover?

ii) Explain how compressed air requirements for a number of equipment and tools are assessed.

iii) What is diversity factor?

iv) What are the important aspects of planning a compressed air system?

5.5 ACCESS ROAD

On large, heavy construction projects, it is often desirable and necessary to make preliminary layouts and designs of various construction facilities expected to be used. This is essential to facilitate estimating the various rates of construction.

For some projects, the location and access to job buildings and shops are important features to indicate on a site plan. This will show how well they will serve the various sections of the work. Principal access roads and haul roads often have to be designed for location, line, and grade. Plan layouts and profiles might be required.

Temporary bridges must be sketched to show construction details and weight limitations. Excavating and grading for plant sites, cableway runways, etc., require detailing. How the various cranes and handling facilities would reach the different sections of the work often must be illustrated. Plant foundations and supporting structures should be sketched up sufficiently to permit preliminary designs.

Project roads where most of the construction material is transported through heavy vehicles constitute a very important aspect of site planning. Apart from economy, the safety of the equipment and workmen and life of the machines working on these roads depend upon good layout, design, construction and maintenance of the haul roads.

The alignment of the roads would naturally aim at shortest length but considerations of grade and curves are overriding. Road cross slope, drainage, superelevation, and surfacing are other important aspects of haul road design.

The following guidelines are given for alignment of haul roads :

1) Avoid sharp horizontal curves at or near the crest of the hill.
2) Avoid sharp horizontal curves at the bottom of hill or a long sustained downgrade since a vehicle has high speed at these places.
3) If passing from opposite directions is expected, use long tangents or horizontal curves and no change of grade.
4) Avoid intersections near crest of vertical curves and sharp horizontal curvatures.
5) Provide sufficient width at curves if passing is required.

Tables are available for deciding upon road width, cross slopes and load bearing capacities of different soils for use in designing haul roads.

SAQ 4

i) How will you plan the access roads in a project area?

ii) What are the guidelines for aligning haul roads?

5.6 WATER SUPPLY

Water supplies on a construction project include: raw water, clean but unchlorinated water and treated water.

Raw water is needed for such cases as compaction, spraying on haul roads, washing of plant and work area, etc. If clean, the water could be used for other construction uses such as mixing with concrete and mortar, curing, cooling, etc. However, in most places river water turns muddy during rainy season, and flocculation is necessary before it can be used for construction purposes.

Treated water is needed for drinking purposes or other human needs. The planner must decide upon the water needs for each of these types while designing his water supply system.

Estimates for requirement of water must be based upon experience of similar works completed in the past or under execution at the time. Some handbooks suggest figures for water needs for each operation on the projects and these values may be taken as general guidelines. The peak requirements would be reduced due to staggered operation of water

Often large quantities for short durations are required on projects and storage becomes necessary. Storage is also needed to provide suitable head of water for certain operations such as jetting. The size of the storage reservoir has to be decided. Storage for 8 hours may be enough on most projects.

The location of the pumping station and of the storage tank are critical in controlling costs of the water supply system. These locations will decide head of pumping and length of piping system. Economics must be worked out. At the pump suction, availability of water during all seasons of the year must be ensured.

Another crucial factor for effective water supply service is the selection of pumps. Construction pumps usually work under severe conditions of weather and under different heads and discharge conditions. The nature of the water handled also varies occasionally. A single all purpose pump could be selected or several different pumps each meeting a particular situation could be bought. The size and design of the pump, prime mover, ease of maintenance, availability, dependability, etc. are other factors involved in pump selection. The basis for selection of centrifugal pumps is pump characteristics besides pump head curves. In designing the piping system the possibilities of increase in demand for water should be considered.

For planning the water needs on construction projects, the following need to be considered :

1) Use water directly from the river as far as possible for those works that are located near river bank and for which water can be easily pumped with independent pumps. As stored water is expensive, the use should be restricted for works where direct pumping from the river is not possible.

2) In locating riverside pumping station make sure that the suction end is always inside the pool of water at all times. Since the level of water in the river fluctuates during different times of the year, it may be necessary to change the elevation of the pump according to river water level.

3) If the work area is compact and a long transmission piping is not necessary to supply water to all units of the works, one central water tank may be used. Alternatively, if the work is scattered over a wide area, it may be necessary to have a number of smaller storage tanks suitably located.

4) Use a suitable elevation for each water tank. Water from a higher tank should not be used if it can be supplied from a lower one.

5) During rainy season, sedimentation arrangements should be made. The clean water should be used only for such needs as would require such water. For other uses, unclean raw water should be used. Separate headers may be needed for the two qualities of water.

6) Possibilities for any likely increases in demand should be considered while deciding the storage/sedimentation/conveyance capacity of the system.

7) Economic evaluation should be done of different alternatives while deciding upon sizes of pipe lines and fittings.

It is important that the piping be sized correctly, not only to meet existing conditions but also to anticipate future requirements. The water system should be designed as a loop, with sectionalising valves arranged so that, in case of interruptions, any one particular area can be shut off without shutting the entire system down.

Timers and shut off valves should be installed to prevent the continuous running or wasting of water.

The water system should be continuously monitored to prevent a shutdown during operating hours. Valves should be maintained and checked periodically. As corrosion and wear begin to show, corrective action or replacement should be made before a major breakdown in the water system occurs.

Backflow devices should be used whenever water lines run into tanks to prevent contamination of the water system in case of a backflow. These devices should be checked and certified once a year. Potable and raw water should never be crossed, and all lines should be properly identified, showing the direction of flow.

A water treatment plant should be put in effect to control hardness, filter out foreign particles, control algae in units such as process plants.

SAQ 5

i) Where do you require raw, clean and treated water on a project?

ii) Why is water required to be stored?

iii) How will you locate a suitable pumping station?

5.7 OTHER INFRASTRUCTURE

Table 5.5 is a general checklist for the construction planner which indicates the many local factors, most or all of which he must analyse in planning a job.

The checklist is not exhaustive and there may be many other local conditions which the planner must consider.

Table 5.5 : Checklist for the Construction Planner

Sl. No	Item	Features
1)	Topography	Camp location, plant layout, storage areas, spoil areas, anchorages, drainage
2)	Geology	Overburden, subsoil, ground water, springs, caves, rock, stratification, faults, physical character, solution channels
3)	Climate	Temperature, seasons, rainfall, snow, ice, storms, earthquakes, dust, cyclones, mud
4)	River Stages	Normal flow, low water, floods, rating curves, backwater, stage prediction
5)	Property	Adjacent owners, boundaries, access, purchase, riparian rights, mineral rights, timber rights, dumping rights, sanitary rights, fire hazards
6)	Shipping Facilities	Rail, highway, tunnels, bridges, curves, tariffs and taxes, transfers, terminals, waterway, locks, drafts, speed, return load, docks, loading and unloading facilities
7)	Power	Kinds, sources, characteristics, capacities, rates, transmission
8)	Compressed Air	Portable plants, stationary plants
9)	Water	Source, turbidity, stage, fluctuations, sediments, pumping requirements, storage tanks
10)	Housing Facilities	Nearest towns, camp, sanitation, food supply, water supply, hospital, schools, fire, police, gardens
11)	Labour	Regulations, wages, compensation insurance, availability, seasonal variations, local or imported, skilled or unskilled, race
12)	Public Relations	Political structure, owner's policies, local contracts, local purchase, visitors, public liability
13)	Coordination of Design	Possible changes, undefined work, extra work, sequence of work, heavy installations, inspection

SAQ 6

What are the various features to be considered in the planning of a project?

5.8 SCHEDULING CONSIDERATIONS

Scheduling for any construction job pertains to schedules for the job, and materials, equipment and labour required.

5.8.1 Job Schedule

The job schedule takes the form of a network diagram or the conventional bar chart. In the network diagram dependencies of works are clearly defined and the effect of delay in one activity on the start of another activity can be easily seen. Resource allocation and time cost trade off are other aspects of planning which can be investigated. The greatest advantage, perhaps, is the identification of works of strategic importances that control completion of work on time. In bar chart activity relationships remain obscure and degree of detailing is small. However, these charts are easily interpreted. The critical path network drawn on time scale provides the ease of bar chart and the detailing and accuracy of a network.

5.8.2 Material Schedule

The material schedule specifies the time when a material is needed and its quantity so that timely procurement can be made. Material should be delivered to a project before it is needed. On the other hand, excessively early delivery is not desirable because of the possibility that the materials might deteriorate or might congest working areas in which storage space is limited. In any case, procurement much before need involves blocking of capital which may be scarce.

5.8.3 Equipment Schedule

The equipment schedule establishes the types, quantities and dates for equipment needs. The bar chart or the time grid of network plan is, again, the principal source of information for equipment schedule; and the problem whether the plant should be purchased or hired, or if a balance of buying and hiring is most possible, will have to be considered at this stage.

5.8.4 Labour Schedule

The labour schedule establishes the number and trades of staff required for each period of time. The source of information for this is again the job schedule.

SAQ 7

(i) What is a job schedule?

(ii) Why is a material schedule required?

(iii) How is an equipment schedule prepared?

5.9 CONSTRUCTION TARGET

The construction target helps in selecting the number and size of equipment which is governed by the magnitude of work, working days available and the number of shifts worked in a day. The yearly target is based upon the requirements of the job. Suppose a dam is to be constructed in a particular valley. The dam must be raised sufficiently above the safe flood level before the onset of the monsoon to prevent damage to the equipment and the works already executed. At the bottom of the valley the length between the abutments is short whereas the base width of the dam along the direction of flow is long. As the dam rises, the length between abutments increases while the base width reduces.

The hourly production rate is obtained by finding the quantity of work to be executed in a year. This quantity is divided by the number of working hours in a year. The number of working hours in a year is 1200 hours with single shift working, 2000 hours with two shift working and 2500 hours with three shift working in a day.

SAQ 8

i) What is the usefulness of a construction target?

ii) How is the hourly production rate of a unit of work obtained?

5.10 PLANNING FOR SPARE PARTS INVENTORY

An inventory is a stock of usable but idle resources. Since the resources are usable in the future, they have economic value attached to them. A suitable stock of spare parts for construction equipment will enable project execution to proceed as planned, unhindered. It will also economise in costs relative to the acquisition and upkeep of the equipment.

In construction, equipment management comprises mechanical stores which include spare parts of machines and oils and lubricants for operation. The spare parts of machines tend to suffer from obsolescence, and thus, to fall in value considerably. The demand for the spare parts during different time periods is decided on the basis of the project schedule, and it is for the spare parts management organisation to meet this demand at minimum total system cost. The organisation should decide when to procure an item of spare parts, in what quantity the item should be procured and what would be the resulting system cost.

The principal types of costs associated with inventory procurement and upkeep are :

a) procurement or ordering cost,

b) holding or carrying cost, and

c) shortage or penalty cost.

The procurement or ordering cost is the element of cost which is incurred in processing of the procurement order, and in following up the procurement process, including receiving goods, inspecting, verifying and approving of bills for payment, etc. This cost is incurred on the entire lot purchased at one time, and therefore, varies per unit item of procurement depending upon the procured lot size.

The holding cost of inventory includes the storage cost in terms of space and building, handling cost, loss due to obsolescence and deterioration in quality, and costs incidental upon insurance, taxes, etc. Expenditure incurred on employing stores personnel and on administrative arrangement also fall in this category. Another important aspect of holding cost is the interest on invested capital.

The shortage cost is incurred when there is delay in meeting with the demand for an item or the demand is not met at all from the inventory. The shortage of an item may result in idle time of equipment or in a disruption in working schedule. Loss of goodwill, loss of profit and loss due to rush orders may also result from shortage of an item in the inventory. If shortage cost is ignored in analysis, it amounts to making the shortage cost infinite (so that no shortage is allowed to occur). The inventory cost for infinite storage cost case is greater than that for the case where shortages are allowed to occur. However, considering shortage cost as infinite simplifies the treatment of inventory problems.

The total cost of inventory system is the sum of all the above costs per unit of time, and varies with the level of stock purchased and maintained in the inventory. Bulk purchases result in smaller procurement cost per item of purchase, but cause overstocking and resultant increase in holding cost. Shortage costs may be small in such cases. On the other hand, smaller quantities purchased at frequent intervals increase the procurement cost and lower the holding cost. The shortage cost in this case may be high. Basically the decision is to be made on the level of stock to be carried in the inventory so that the total system cost per unit of time is minimum.

5.11 PLANNING FOR REPAIRS AND MAINTENANCE

Planning for repairs and maintenance embraces all activities necessary to plan, control and record all work done in keeping the equipment to the acceptable standard. This includes preventive maintenance and corrective maintenance, planned overhaul, planned replacement, spares provisions, workshop functions, repairs and renewals, equipment history compilation, plant modification to facilitate maintenance, spare parts manufacture, preventive maintenance on spare parts, etc. In a fully controlled situation only the time spent on emergency work is unplanned and this could be well less than 10 percent of the available man-hours in the maintenance department. The three basic requirements of a planned maintenance system are:

1) A programme of maintenance activity for the structure, plant and equipment.
2) Means of ensuring that the programme is fulfilled.
3) A method of recording and assessing results.

Table 5.6 lists the basic elements of a planned repairs and maintenance system which is represented in Figure 5.1.

Table 5.6 : Components of a Planned Repairs and Maintenance System

S.No.	Item	Description
1)	Costly System	Costly procedures to ensure adequate cost control and apportionment of costs in the maintenance department
2)	Equipment Register	A complete inventory of the plant and equipment to be maintained
3)	Liaison with Production	An effective system of agreeing with the use management when maintenance work can be done
4)	Maintenance Control System	A system which initiates the activities on the maintenance programme at predetermined intervals as listed on the main schedule
5)	Maintenance Records	A record of maintenance carried out and a system for reporting to management
6)	Maintenance Schedule	Schedules for inspection, lubrication and preventive maintenance of the items in the register. The schedules may also include planned overhaul
7)	Maintenance Support Organisations	The organisation of technical information, spare parts and tools, etc.
8)	Planned Overhaul	Provisions for ensuring the planned overhaul of plant, equipment, either on a regular basis in accordance with the maintenance schedule or in response to condition monitoring
9)	Resource Scheduling	A manpower allocation system to ensure that the resources are available to implement the maintenance requirements of the equipment and that optimum use is made of labour
10)	Training	The necessary training of operators and supervisors in the operation of the system
11)	Work Specialisation	Inspection cards or documents which identify exactly the tasks to be undertaken within the maintenance system

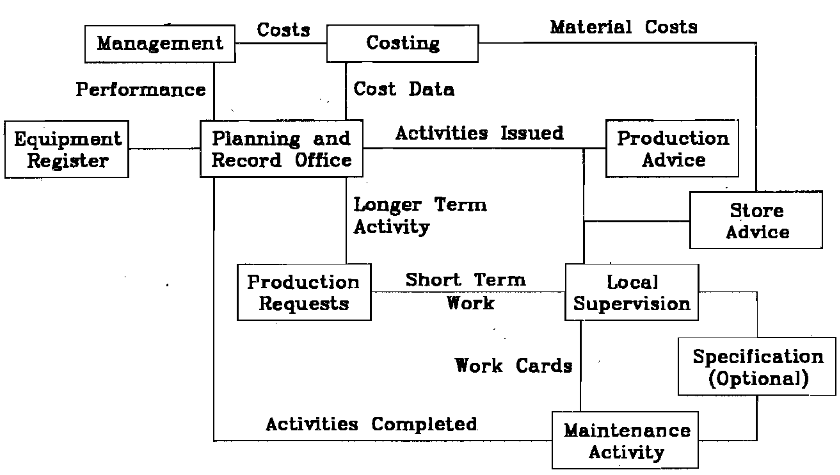

Figure 5.1 : Typical Maintenance Control System

SAQ 9

i) What is a spare [illegible]?

ii) What are the [illegible]

iii) What do you understand by [illegible]?

SAQ 10

i) How will you plan for repairs and maintenance of construction equipment?

ii) What are the components of a planned repairs and maintenance system?

5.12 PLANNING FOR REPLACEMENTS

Replacement of equipment has to be properly planned. When considering replacement of an equipment, the past may be used as a guide for the future. Replacement of an equipment due to its physical condition is distinct from displacement of the equipment due to obsolescence. Each new equipment and each improvement to existing equipment models raises the issue of an investment opportunity by displacement. Equipment owners generally consider equipment replacement when downtime becomes excessive or when the time for a major overhaul approaches. Some owners review their equipment condition when awarded a new job and make replacement decisions at that time. Other owners may review their equipment at year end and, based upon tax position and available capital, make their replacement decisions then. However, it may be solved, the problem of replacing equipment is a frequently recurring one.

Several general rules for replacement are followed. One is to replace when the anticipated operating and overhaul costs plus the decrease in salvage value during the next period of use are the same as or greater than the operating and fixed-charge costs for a new piece of equipment. A second rule is "as long as the average cost is greater than the marginal cost of extending the life of equipment by one additional year, do not replace as soon as the marginal cost of one additional years' service exceeds the average cost, replace the equipment". A third rule is that an equipment should be replaced when the cumulative cost per hour becomes progressively higher or lower with added machine hours.

In practice, each time an equipment is repaired, the cumulative cost per hour increases. The question arises whether the repaired equipment can then earn enough to provide economic justification for the repair. The decision is based upon previously established guidelines or upon a study of the specific equipment. Guidelines may be used as a matter of policy; for example, previous replacement studies may have consistently shown that the type of equipment in question should be replaced immediately prior to the second overhaul. By using such a policy, the losses are restricted to the dispersion of individual cases from the average.

SAQ 11

i) How will you plan the replacement of an equipment?

ii) What are the general rules of replacement usually followed?

5.13 STANDBY ARRANGEMENTS

In order that the work once started may go on smoothly inspite of breakdowns, provision should be made for spare equipment to take over in the event of any equipment going out of production. Such situations are handled by having additional equipment known as standby units. The number of standby units provided on a job depends on the number of shifts in a day during which the work is proposed to be executed. The norms for providing standby equipment should be as follows :

1) Shift operation = 10%
2) Shift operation = 20%
3) Shift operation = 30 %

SAQ 12

How will you provide for standby equipment?

5.14 SUMMARY

Before any construction work is taken up, planning is required for construction power, source of construction power, compressed air, access roads, water supply, spare parts inventory, repairs and maintenance and replacements. Provision for standby equipment should be made. Besides schedules for the various jobs, material procurement, equipment procurement and labour have to be arranged in keeping with the rate of construction for which appropriate schedules are to be prepared. These have been discussed in this unit. What are the principles followed in spare parts inventory and repairs and maintenance of construction equipment will be clear to you.

5.15 ANSWERS TO SAQs

Check answers of all SAQs with respective preceding text.