UNIT – IV REPLACEMENT AND MAINTENANCE ANALYSIS

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MAINTENANCE

- Definition : Maintenance is defined as the action taken by the user to maintain an existing facility in operating condition.

OBJECTIVES OF MAINTENANCE

- To achieve minimum break down
- To keep a plant in good working condition at the lowest possible cost.
- To keep machines at their optimum cost without any hindrance.
- To ensure the availability of machineries, buildings and services.
- To achieve efficient functioning of machines.
- To reduce operation and maintenance cost.

TYPES OF MAINTENANCE

- Corrective (or) Break down Maintenance
- Scheduled Maintenance
- Preventive Maintenance
- Predictive Maintenance

CORRECTIVE (OR) BREAK DOWN MAINTENANCE

- This implies that repairs are made after the equipment is out of order and it can not perform its normal functions any longer.
- Production Dept ⟶ Maintenance Dept to rectify the fault.
- Maintenance Dept ⟶ checks into the difficulty and makes the necessary repairs
- After removing the fault the maintenance engineers do not attend the equipment until another failure occurs

CAUSES FOR EQUIPMENT BREAK DOWN

- Failure to replace the worn out parts.
- Lack of lubrication
- Neglected cooling system.
- Not attending minor faults.
- External factors such as low or high voltage, wrong fuel
- Not attending unusual sounds, vibrations etc.

SCHEDULED MAINTENANCE

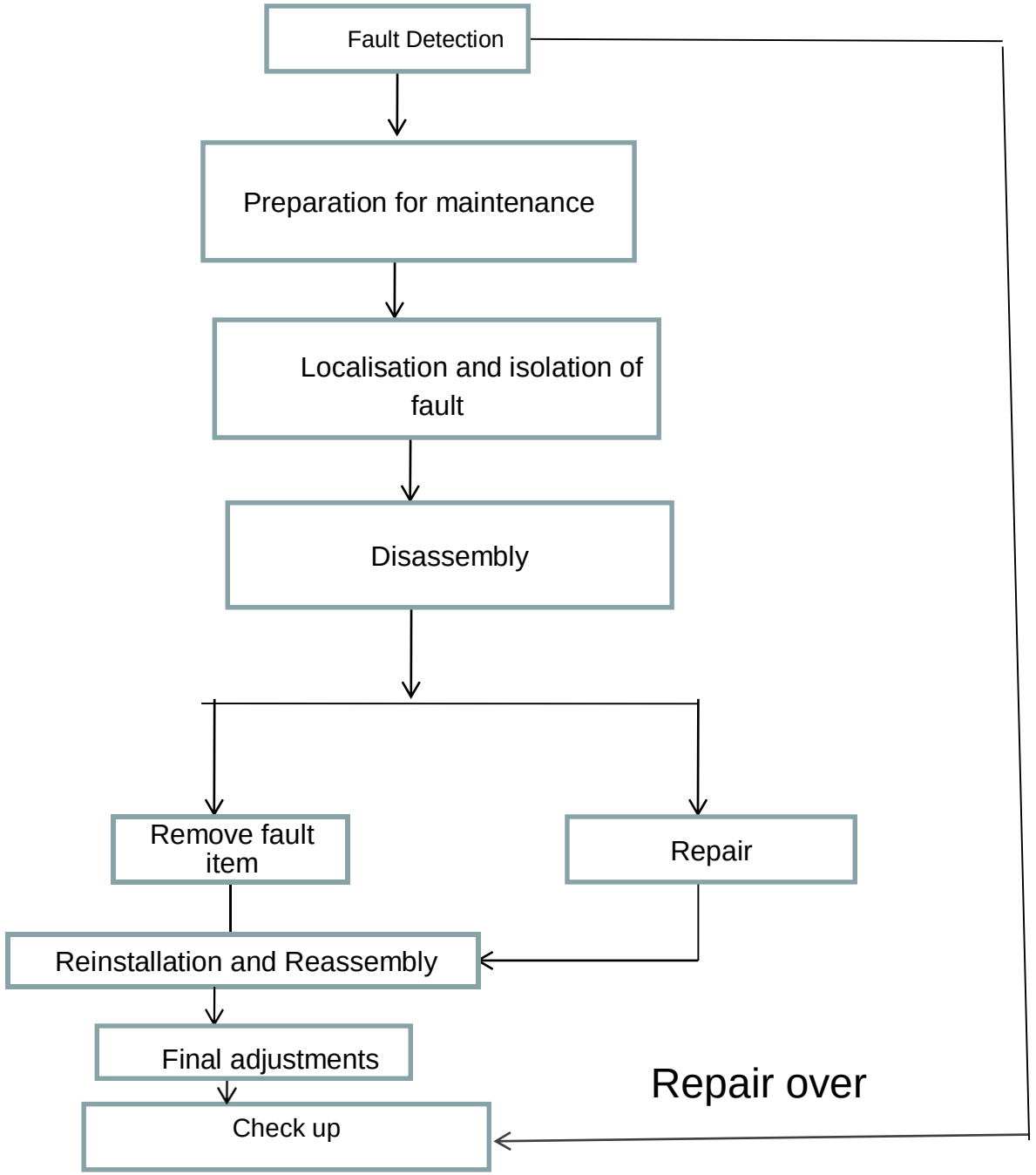
- Scheduled maintenance is concerned with the time schedule to avoid breakdown.
- This maintenance includes inspection, repair, overhaul etc which if neglected can result in serious issues.

PREVENTIVE MAINTENANCE

- It is defined as an action performed in an attempt to keep the machine in a specified operating condition by means of systematic inspection, detection and prevention of failures.
- It works on the principle of “Prevention is better than cure”
- It locates weak spots in all equipments provides them with regular inspection and minor repairs and thereby reduces the danger of unanticipated breakdown

OBJECTIVES OF PREVENTIVE MAINTENANCE

- To keep the equipment always available.
- To maintain the value of the equipment by periodic inspection, repairs and overhauls.
- To maintain optimum production η of the equipment.
- To ensure safety of the workers
- To reduce the work content of maintenance jobs.


Fault Detection
Preparation for maintenance
Localisation and isolation of fault
Disassembly
Remove fault item
Repair
Reinstallation and Reassembly
Final adjustments
Check up
Repair over
Preventive maintenance

PROCEDURE OF PREVENTIVE MAINTENANCE

- Inspection or checkups
- Lubrication
- Planning and scheduling
- Record keeping and analysis
- Training of maintenance personnel
- Storage of spare parts
- Control and evaluation of preventive maintenance.

ADVANTAGES OF PREVENTIVE MAINTENANCE

- Reduction in production down time.
- Less overtime pay for maintenance personnel
- Lesser expenditure on repairs
- Fewer repetitive repairs
- Better product quality and fewer rejections.
- Lesser number of standby equipments are needed

PREDICTIVE MAINTENANCE

- Newer maintenance technique
- It uses human sense organs or some sensitive instruments such as audio gauges, vibration analysers, amplitude meters etc to predict troubles before the equipment fails.
- Equipment conditions are monitored periodically and thus enables the maintenance men to take timely action such as repairs and overhauls.
- Extends the service life of an equipment without the fear of failure

REPLACEMENT

- Replacement can be defined as the decision problems involving the replacement of existing obsolete or worn out assets
- Causes of replacement :
    1. Deterioration
    2. Obsolescence
    3. Inadequacy
    4. Working conditions

TYPES OF REPLACEMENT PROBLEM

- Replacement of assets with deteriorate with time
  - (a) Economic Life of an asset
  - (b) Replacement of an existing asset with a new asset
- Simple probabilistic model for assets which fail completely.(replacement due to sudden failure)

PROBLEM

- The following table gives the operation and maintenance cost and salvage value at the end of the every year of a machine whose purchase price is Rs 20,000. Find the economic service life of the machine assuming interest rate

  i = 15%

PROBLEM

END OF YEAR	OPERATING COST (RS)	MAINTENANCE COST (RS)	SALVAGE VALUE (RS)
1	3000	300	9000
2	4000	400	8000
3	5000	500	7000
4	6000	600	6000
5	7000	700	5000
6	8000	800	4000
7	9000	900	3000
8	10000	1000	2000
9	11000	1100	1000
10	12000	1200	0

SOLUTION

PROBLEM

- A firm is considering replacement of an machine whose cost price is Rs 1,20,000 and the scrap value is Rs 10,000 at the end of the first year and declines each year by rs 1000 from the previous years scrap value. The operating cost is as follows

Year	1	2	3	4	5	6	7	8
Operating cost	2000	5000	8000	12000	18000	25000	32000	40000

SOLUTION

End of year	Operating cost	Cumulative operating cost	Scrap value	Total cost FC + COC-S	Average cost = TC/n
1	2000	2000	10000	112000	112000
2	5000	7000	9000	118000	59000
3	8000	15000	8000	127000	42333.33
4	12000	27000	7000	140000	35000
5	18000	45000	6000	159000	31800
6	25000	70000	5000	185000	**30833.33**
7	32000	102000	4000	218000	31142.85
8	40000	142000	3000	259000	32375

REPALCEMENT OF EXISTING ASSET WITH NEW ASSET

- Annual equivalent cost of existing asset and the new asset is calculated.
- The alternative which gives the least value is considered as the best alternative.
- The formula to calculate the annual equivalent cost is

  $AE = (P-F)(A/P , i, n) + F \times i + A$

PROBLEM

Two years ago a machine was purchased at a cost of Rs 2,00,000 to be useful for eight years. Its salvage value at the end of the life is Rs 25,000. The annual maintenance cost is Rs 25,000. The market value of the present machine is Rs 1,20,000. Now a new machine to cater to the need of the present machine is Rs 1,50,000 to be useful for six years. The annual maintenance cost is Rs 14,000. The salvage value of the new machine is Rs 20,000. Using the rate of 12% find whether it is worth replacing the present machine with the new machine

SIMPLE PROBABILISTIC MODEL FOR ASSETS WHICH FAIL COMPLETELY

- A system usually consists of a large no of low cost items that are increasing liable to failure with age.
- The cost of failure is > the cost of item itself.
- Two types of replacement policies are considered

  a. Individual replacement policy

  b. Group replacement policy

SIMPLE PROBABILISTIC MODEL FOR ASSETS WHICH FAIL COMPLETELY

- For a given problem the individual & group replacement policies are evaluated and the most economical policy is selected for implementation.

PROBLEM

- The failure rates of transistors in a computer are summarized in the following table. The cost of replacing an individual failed transistor is Rs 8/-. If all the transistors are replaced simultaneously it would cost Rs 4 per transistor. Find the optimum replacement policy

End of week	1	2	3	4	5	6	7
Probability of failure	0.09	0.17	0.27	0.50	0.65	0.90	1.00

SOLUTION

- Let N_i = The number of transistors replaced at the end of the i^{th} week.
- N_0 = Number of transistors replaced at the end of the week 0.

$N_1 = N_0 \times P_1 = 100 \times 0.09 = 9$

$N_2 = N_0 \times P_2 + N_1 \times P_1$

$= 100 \times 0.08 + 9 \times 0.09 = 8.81$

$N_3 = N_0 \times P_3 + N_1 \times P_2 + N_2 \times P_1$

$= 100 \times 0.1 + 9 \times 0.08 + 8.81 \times 0.09$

$= 11.51$

SOLUTION

$N_4 = N_0 \times P_4 + N_1 \times P_3 + N_2 \times P_2 + N_3 \times P_1$

$= 100 \times 0.23 + 9 \times 0.1 + 8.81 \times 0.08 + 11.51 \times 0.09$

$= 25.63$

$N_5 = N_0 \times P_5 + N_1 \times P_4 + N_2 \times P_3 + N_3 \times P_2 + N_4 \times P_1$

$= 100 \times 0.15 + 9 \times 0.23 + 8.81 \times 0.1 + 11.51 \times 0.23 + 25.63 \times 0.09$

$= 21.17$

$N_6 = N_0 \times P_6 + N_1 \times P_5 + N_2 \times P_4 + N_3 \times P_3 + N_4 \times P_2 + N_5 \times P_1$

$= 100 \times 0.25 + 9 \times 0.15 + 8.81 \times 0.23 + 11.51 \times 0.1 + 25.63 \times 0.08 + 21.17 \times 0.09$

$= 33.47$

$N_7 = N_0 \times P_7 + N_1 \times P_6 + N_2 \times P_5 + N_3 \times P_4 + N_4 \times P_3 + N_5 \times P_2 + N_6 \times P_1$

$= 100 \times 0.1 + 9 \times 0.25 + 8.81 \times 0.15 + 11.51 \times 0.23 + 25.63 \times 0.1 + 21.17 \times 0.08 + 33.47 \times 0.09$

$= 23.47$

SOLUTION

- Expected life of the transistor $= \sum_{i=1}^{7} i \times P_i$

  = 1 x 0.09 + 2x 0.08 + 3 x0.1+ 4 x 0.23 + 5 x 0.15 + 6x 0.25 + 7x 0.1

  = 4.42 weeks

- Average number of failure per week = 100/4.42
  = 23
- Cost of individual replacement

  = Number of failures/week x Individual replacement cost/transistor

  = 23 x 8

  = **Rs 184**

SOLUTION

- GROUP REPLACEMENT COST

End of Week	Group replacement cost	Cost of individual replacement	Total Cost (Rs)	Average Cost (Rs)
1	4 x 100 = 400	9 x 8 = 72	472	472
2	400	(9 + 8.81) x 8 = 142.48	542.48	271.24
3	400	(9 + 8.81+11.51) x 8 = 234.56	634.56	211.52
4	400	(9 + 8.81+11.51+25.63) x 8 = 439.60	839.60	209.90
5	400	(9 + 8.81+11.51+25.63+21.17) x 8 = 608.96	1008.96	201.79
6	400	(9 + 8.81+11.51+25.63+21.17+ 33.47) x 8 = 876.72	1276.72	212.78
7	400	(9 + 8.81+11.51+25.63+21.17+ 33.47+ 23.47) x 8 = 1064.48	1464.48	209.21

SOLUTION

- Individual replacement cost /week = **Rs. 184/-**
- Group replacement cost /week = **Rs. 201.79/-**

Since the individual cost/week is < group replacement cost the individual replacement cost is adopted