7. SPARE PARTS MANAGEMENT

INTRODUCTION

Spare parts Management plays an important role in achieving the desired plant availability at an optimum cost. Presently, the industries are going for capital intensive, mass production oriented and sophisticated technology. The downtime for such plant and machinery is prohibitively expensive. It has been observed in many industries that the non-availability of spare parts, as and when required for repairs, contributes to as much as 50% of the total down time. Also, the cost of spare parts is more than 50% of the total maintenance cost in the industry. It is a paradox to note that the maintenance department is complaining of the non-availability of the spare parts to meet their requirement and finance department is facing the problem of increasing locked up capital in spare parts inventory. This amply signifies the vital importance of spare parts management in any organisation.

The unique problems faced by the organisation in controlling/managing the spare parts are as follows.Firstly, there is an element of uncertainty as to when a part is required and also the quantity of its requirement. This is due to the fact that the failure of a component, either due to wearing out or due to other reasons, can not be predicted accurately. Secondly, spare parts are not that easily available in the market as they are not fast moving items. The original equipment manufacturer has to supply the spares in most of the cases. New models are introduced to incorporate the design improvements and old models are phased out. Hence the spares for old models are not readily available. Particularly, this is more so in case of imported equipment as the design changes are taking place faster in the developed countries. Thirdly, the number and variety of spare parts are too large making the close control more and more tedious. For instance, the number of items of spares in a medium scale engineering industry may be around 15,000 and that in a large scale chemical industry may be around 100,000. Fourthly, there is a tendency from the stage of purchase of the equipment to the stage of the use of the spare parts, to requisition spare parts more number than that are actually required and accumulation of spares takes place. Finally, the rate of consumption of spare parts for some are very high and for some are very low. These problems are to be faced by systematic spare parts management.

The objective of spare parts management is to ensure the availability of spares for maintenance and repairs of the plant and machinery as and when required at an optimum cost.

Also, the spares should be of right quality. There are many actions required to ensure the spare parts management effective.

There is a need for systematic actions while managing spare parts as given below:

a. Identification of spare parts

b. Forecasting of spare parts requirement

c. Inventory analyses

d. Formulation of selective control policies for various categories

e. Development of inventory control systems

f. Stocking policies for capital & insurance spares

g. Stocking policies for rotable spares or sub-assemblies

h. Replacement policies for spare parts

i. Spare parts inspection

j. Indigenisation of spares

k. Reconditioning of spare parts

l. Establishment of spare parts bank

m. Computer applications for spare parts management.

Every organisation should proceed systematically and establish an effective spare parts management system. Codification helps the organisation minimizing duplication of spare parts stocking thereby reducing inventory, aids the accounting process and facilitates the computerisation of spare parts control systems. The inventory analyses carried out on the basis of different characteristics of the spare parts, such as annual consumption value, criticality, lead time, unit cost and the frequency of use, help the company in establishing suitable policies for selective control. This also helps in focusing our efforts on real problem areas.

A good inventory control system will help systemizing the ordering procedure and also achieving an optimum level of inventory. In addition, selectively efforts should be made to evolve optimum replacement policies for selected spare parts, for which cost of down time and cost of replacement are very high. So, we have to identify such spare parts and carry out the exercise for evolving optimum replacement policies.

For the spare parts which are very expensive and those which are to be imported, it is essential that the useful life for such spares is extended by appropriate applications of reconditioning and repair techniques. Also, efforts should be made to indigenise the spare parts in view of the hard-to-get foreign exchange involvement. Also, for similar industries establishing of spare parts bank goes a long way in reducing the total inventory holding of the expensive spare parts and also reduces the stock holding cost. For different industries, it will be helpful to establish spare parts banks and a suitable information system for the exchange of spares. Lately, the application of computers for the processing of spare parts information and operating an effective spare parts control system will be very helpful for the organisation and will ensure timely actions for an efficient and effective spare parts management.

IDENTIFICATION OF SPARE PARTS

When a spare part is required to put back in operation an equipment which is under breakdown, it becomes necessary to identify the part for getting the same issued from the store or for purchasing the same from the vendor. While identifying it becomes essential to give the complete description including the size and type of the spare to draw from the stores and it becomes essential for all concerned ie., the maintenance personnel and stores personnel are aware of such description. If it is the vendor, he may not be satisfied with the description and he may also require the manufacturer's part number.

It is a cumbersome and time consuming task during every transaction to identify a spare part by its description and manufacturer's part number accompanied by the parent equipment's name, make and model designation. Therefore, it is essential to give a numerical name or code to each spare part. This process of giving code to each spare part is called codification. Since, the range of spares used in any organisation is too large and there are quite a few spares meant for specific equipment, it is always preferred to use codes which are significant ie., from the code number one will be able to find out

- the equipment type, make & model
- the type/class of the spare-part
- the size (in some cases)

If the spare part code is to incorporate the equipment type etc., then the codification of equipment becomes a prerequisite for spare part codification.

The number of digits required for spare part code depends on the actual requirement ie., the range of equipment in use and the types and number of spare parts in the organisation. It is very common to come across 9 to 16 digit codes for spare parts. For instance, a 10-digit code may signify,

1st digit - imported or indigenous

2nd, 3rd & 4th digits - machine type, make & model

5th, 6th & 7th digits - spare-part class

8th, 9th & 10th digits - size or serial number.

By classifying and codifying all the spare parts, it becomes easy to minimize the duplication of spare parts thereby effecting reduction in the inventory. Codification also helps easy accounting and computerisation in addition to easier communication between concerned parties.

In addition to codifying the spare part, it will be of immense benefit to codify the location of spare parts. Stock location number helps the stores personnel to locate the part and issue the same as and when the same is requisitioned. Also the stock verification and upkeep programme becomes less and less cumbersome.

After codifying the spare parts and assigning stock location numbers, all the users should be made aware of and should be supplied with the relevant codes and stock location numbers in the form of a spare parts catalogue.

The spare parts catalogue should contain the following information:

Spare parts codification plan
Spare part code
Spare part description
Drawing number
Manufacturer's code & part number
Stock location number.

The spare parts catalogue may be produced in sufficient copies so as to make available for all the users such as the maintenance personnel, stores personnel and purchase personnel. This is a very important aspect often neglected in the organisation.

The next step in identification of spare parts is to put an identification tag or mark with the code to enable the stores personnel identify during the time of issue. If sufficient care is not taken to incorporate the code, a lot of time is spent in locating the part and that time is actually added to the down-time which is really very expensive in case of vital spare parts. There are a variety of stickers which are scratch-proof, water-proof and temperature-proof available in the market. Efforts should be made by the organisations to make use of such identification tags and it will go a long way in reducing the downtime.

INVENTORY ANALYSIS AND SELECTIVE CONTROL

For the successful spare parts management, it is essential to analyze the spare parts inventory based on various characteristics such as the frequency of issues, the annual consumption value, the criticality, the lead time and the unit price. This is essential as it would not be possible to exercise the same type of control for all items and it may not really be effective. Inventory analysis aids selection of policies for selective control.

Commonly used inventory analyses are:

(1) FSN Analysis
(2) ABC Analysis
(3) VED Analysis
(4) SDE Analysis
(5) HML Analysis

FSN Analysis:

Classification based on Frequency of Issues/Use:-

F, S & N stand for Fast moving, Slow moving and Non moving items. This form of classification identifies the items frequently issued, less frequently issued for use and the items which are not issued for longer period, say, 2 years. For instance, the items can be classified as follows:

Fast Moving (F) = Items that are frequently issued say more than once a month.

Slow Moving (S) = Items that are issued less than once a month.
Non-Moving (N) = Items that are not issued\used for more than 2 years.

This classification helps spare parts management in establishing most suitable stores layout by locating all the fast moving items near the dispensing window to reduce the handling efforts. Also, attention of the management is focused on the Non-Moving items to enable decision as to whether they are required in the future or they can be salvaged. Experience shows that many industries which are more than 15 years old have more than 50% of the stock as non-moving spares.

Even if a few of them are disposed off and the locked up capital is made available, it will make available additional working capital to the organisation. Action for disposal should be taken based on the value of each item of spare.

SDE Analysis:-
Classification based on the lead time:

This classification is carried out based on the lead time required to procure the spare part. The classification is as follows:

Scarce (S) : Items which are imported and those items which require more than 6 months' lead time.

Difficult (D) : Items which require more than a fortnight but less than 6 months' lead time.

Easily available (E) : Items which are easily available ie., less than a fortnights' lead time.

This classification helps in reducing the lead time required at least in case of vital items. Ultimately, this will reduce stock-out costs in case of stock-outs. A comprehensive analysis may ultimately bring down lead time for more & more number of items. This will also result in streamlining the purchase and receiving systems and procedures.

VED Analysis:-

Classification Based On Criticality:

Several factors contribute to the criticality of a spare part. If a spare is for a machine on which many other processes depend, it could be of very vital importance. Also if a spare is, say, an imported component for which procurement lead time could be very high its non- availability may mean a heavy loss. Similarly spares required for fighter aircraft at the time of war could be of great value in terms of fighting capability. In general, criticality of a spare part can be determined from the production downtime loss, due to spare being not available when required.

Based on criticality, spare parts are conventionally classified into three classes, viz. vital, essential and desirable.

VITAL (V) : A spare part will be termed vital, if on account of its non-availability there will be very high loss due to production downtime and/or a very high cost will be involved if the part is procured on emergency basis. In a process industry, most spare parts for the bottleneck machine or process will be of vital nature.For example, bearings for a kiln in a cement plant will be considered vital.

ESSENTIAL (E) : A spare part will be considered essential if, due to its non-availability, moderate loss is incurred. For example, bearings for motors of auxiliary pumps will be classified as essential.

DESIRABLE (D) : A spare part will be desirable if the production loss is not very significant due to its non-availability. Most of the parts will fall under this category. For example, gaskets for piping connection.

The VED analysis helps in focusing the attention of the management on vital items and ensuring their availability by frequent review and reporting. Thus, the downtime losses could be minimized to a considerable extent.

ABC Analysis:-

Classification Based on Consumption:

Another method of classifying spares is on the basis of **annual consumption value.** As it is true for any inventory situation, Pareto's principle can be applied to classify maintenance spares based on consumption value.

Pareto principle : The significant items in a given group normally constitute a small portion of the total items in a group and the majority of the items in the total will, in aggregate, be of minor significance.

This way of classification is known as ABC classification.

CLASS A:	10% of total spares contributing towards 70% of total consumption value.
CLASS B:	20% of total spares which account for about 20% of total consumption value.
CLASS C:	70% of total spares which account for only 10% of total consumption value.

In a specific spares control system, it is quite possible that in a single year, many spares would not have been consumed at all. In such cases, it is better to perform ABC analysis on longer consumption period data, say 3 years. Then only spares will not be left out in this classification.

Policy for 'A' items

* Maximum control
* Value Analysis
* More than one supplier
* Control by top executives.

Policy for 'B' items

* Minimum control
* Bulk Orders
* More items from same supplier.

HML Analysis:-

Classification based on unit price:

This classification is as follows:

High Cost (H) : Item whose unit value is very high, say, Rs.1000/- and above.

Medium Cost (M) : Item whose unit value is of medium value, say, above Rs.100/- but less than Rs.1000/-.

Low Cost (L) : Item whose unit value is low, say, less than Rs.100/-.

This type of analysis helps in exercising control at the shop floor level ie, at the use point. Proper authorisation should be there for replacing a high value spare. Efforts may be necessary to find out the means for prolonging the life of high value parts through reconditioning and repair. Also, it may be worthwhile to apply the techniques of value analysis to find out a less expensive substitute.

Some other Classifications based on other characteristics:

A) Capital Spares:

These are vital spares for critical equipment. The stock-out cost for such spares is very high and the unit cost also is very high. The number of items consumed during the life time of the equipment may be 1 or 2 or 3. Hence, the decision has to be made as to the number of items to be stored.

B) Insurance Spares:

An insurance items is a spare part that will be used to replace a failed identical part in an operating equipment whose penalty cost for downtime is very high. Hence, by definition, it is an insurance against such failures for which the down time costs are very high. They do not become obsolete until the parent equipment is retired from service no matter if they do not move for many years.

C) Overhaul spares:

Spare parts which must be replaced every time the equipment is dissembled and re-assembled.

D) Wear and Tear Spares:

Spare parts which have regular wear and tear in the course of operation of the equipment and need to be replaced after definite number of hours of equipment operation.

E) Consumable spares:

These are regularly used items such as fasteners, seals, bearings,etc. These are to be stored by the materials department.

INVENTORY CONTROL SYSTEMS

Introduction:

To ensure smooth functioning it is essential to develop a suitable inventory control by which optimization of spare parts cost is achieved in a systematic way. As regards the fast moving and slow moving items are concerned, the following procedure can be followed taking into consideration various cost elements.

While managing the spare-parts inventory, basically there are four cost elements to be considered:-

1. Cost of the spare part
2. Cost of ordering
3. Cost of storage
4. Cost of stock-out.

The cost of storage includes

1. Rent for the stores
2. Depreciation on storage and handling facilities
3. Handling charges
4. Salaries of stores staff and clerks
5. Taxes
6. Insurance
7. Costs of stationery etc.

The cost of ordering includes:

1. Rent for purchase department
2. Depreciation for Office facilities
3. Salaries
4. Postage & Telephone expenses
5. Stationery expenses
6. Travel expenses
7. Incoming Inspection
8. Entertainment & Misc. expenses.

Concept of Economic Order Quantity

For ideal conditions there should be no stocks at all. Every item should arrive just before it is required in right quantity.This however is not practical for two reasons. Firstly, the supplies & requirements are not so certain and, secondly, the costs of placing orders and follow-up work will shoot up very high, if ordering in such small batches is resorted to. So, for a particular annual consumption as we go on increasing the quantity of order, the average stock increases and, hence, carrying charges go on increasing. Thus, the total cost of ordering and inventory carrying will vary as shown in the graph in Figure 4-1.

While the ordering quantity is varied it may be seen from the graph that at a particular ordering quantity, the total cost will be the lowest and that ordering quantity is called **Economic Ordering Quantity (E.O.Q).**

Figure 4-1.

It may be established mathematically that

Expressed Mathematically, $E.O.Q = \sqrt{\frac{2AS}{iC}}$

Where A = Annual consumption of items in Units

S = Cost per order in Rupees

i = Carrying charges per year expressed as fraction

C = Unit price

E.O.Q = Economic Order Quantity in Units.

Now if we consider an over-simplified procurement and consumption cycle for an item having a steady consumption all through the year and which is available instantaneously on placing an order (without fail), the procurement and consumption cycle can be shown as given in Figure 4-2.

Figure 4-2.

At time 'A' the stock is zero is and hence an order will be placed and (the delivery

being instantaneous) the stock will be brought up to a level 'Q'. The item will be steadily issued upto a time 'B' and another order will be placed at 'B' to bring up the stock to Q and so on. The average inventory in this model will be Q/2. Also the delivery of each order is instantaneous.
The computation of safety stock is done as follows:

If the fluctuation in lead time is predominant, then the safety stock can be computed by the following formula.

Safety stock = (Maximum Lead Time - Normal Lead Time) x Normal Consumption rate

If the fluctuation in consumption rate is predominant, then the safety stock can be calculated by using the following formula.

Safety Stock = K x $\sqrt{D}$

where K is a factor chosen on the basis of the assurance level required for protecting the item for stock out and D is the average consumption during lead time.

For various assurance levels, the values of K are as given below:

Assurance level (%)	50	75	80	85	90	98	99	99.9
Value of **K**	0	0.7	0.8	1.0	1.3	2.1	2.3	3.3

The following K-values are suggested for each item on the basis of ABC & VED classification.

K Values

	V	E	D
A	2	1	0.5
B	2.5	2	1
C	3	2.5	2

In a practical situation, the consumption over a period fluctuates. Having fixed up the ordering quantity based on EOQ system, the order has to be placed while the stock level is equal to the sum of average lead time consumption and safety stock.

Example:

The data regarding a particular type of bearing is given below
:

Annual consumption = 120 Nos.
Unit price = Rs. 100
Inventory carrying cost (variable) = 0.20
Ordering Cost (variable) = Rs.30

The suggested value of K is 2. The normal lead time is 2 months. If it is decided to follow EOQ system of inventory control, what will be the parameters for operating the system.The supplier will be supplying the bearing packs of 12 Nos.

Solution:-

$$EOQ = \sqrt{\frac{2\,A\,S}{i\,C}}$$

$$= \sqrt{\frac{2 \times 120 \times 30}{0.20 \times 100}} = 19$$

The ordering quantity could be either 12 or 24. This will be based on the estimated total costs for both cases.

If ordering quantity is 12,
then Total Cost = 12/2 x 100 x 0.20 + 120/12 x 30
= 420/-
If the ordering quantity is 24
Total cost = 24/2 x 100 x 0.20 + 120/24 x 30 = Rs. 390/-
Hence, the Ordering Quantity of **24 Nos.** is recommended.
Safety Stock = K X√D = 2 x √(2/12) x 120) = 10 Nos.
Reorder level = Safety Stock + Lead Time Consumption
= 10 + 20 = 30 Nos.
The average inventory in this system will be
= Safety stock + Ordering Quantity/2
ie = 10 + 24/2 = 22 Nos.

Periodic Review System:

In the EOQ system, we have to place the order as and when the stock level reaches the reorder level. That means that a continuous watch on the stock level is required and there will be orders released almost daily as there are large number of items. The possibility of combining more number of items in the same order for a supplier is very much reduced. Periodic Review system aims at eliminating such disadvantages. In this system, the stock level of all or a group of items are reviewed periodically. The review period and the replenishment level are fixed and order is placed while the stock level is less than the replenishment level. Ordering quantity is equal to replenishment level minus stock level.

Replenishment level = Safety stock + Consumption Rate x (Review period + Lead Time).

When stock level is reviewed periodically, the safety stock also should take into consideration the fluctuation in consumption during the review period.

Various other parameters for periodic review systems are as follows:
(1) Review period
(2) Replenishment level
(3) Safety stock

Review period is based on the ordering quantity as recommended for EOQ

system. ie., the duration for which the quantity can last. In the earlier example an ordering quantity of 24 Nos. bearings was recommended and the same can last for 10 weeks. Hence, the review period recommended will be 10 weeks. As the review period thus arrived may vary from item to item, review period should be suitably chosen for a group of items which is near optimal.
The safety stock may be computed as follows:

Safety Stock = K x Consumption during lead time and review period (if fluctuation in consumption rate is predominant).

As the number of items could be many and their annual consumption value may range widely, it may be necessary in many occasions to have different groups with different review periods. For instance, for A items review period may be one week, for B items review period may be four weeks and for C items the review period may be 12 weeks.This may result in near optimum results.

A graphic representation of Periodic Review System is given in Figure 4-3

Figure 4-3

CONCLUSION

Spare parts management will be very successful if the system is computerised and integrated with other systems. Computerisation will bring in all round improvement by streamlinining the process as well as reducing the total cost of stock holding, ordering and stock-out costs.

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