Spare table—An effective tool for spares management

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SUMMARY

The article deals with inventory control in a paper industry for a consistent protection to continuous production. In paper industries, 50% of the total investment in inventories constitute stock of spares if forest raw material is excluded and 50% of these spares are non-moving, as a result we end up with too much of protection for many items and too little protection to some items. Hence in this article it has been attempted to find a more simpler analytical approach to arrive at the three key decisions (viz) what to buy when to buy and how much to buy.

Among the various categories of inventory that an Inventory Manager is expected to control, the spare parts management has always posed a problem to him, irrespective of any type of industry he works with. In particular, the Inventory Manager in a Paper Industry finds it extremely difficult to control this vital area because of the severity of various constraints that are before him. As you all will agree, there is no ready-made technique available today that can supply him with the necessary guidlines, when he is confronted with a critical situation in the management of spares.

What to buy, when to buy, how much to buy—it is very difficult to arrive at these three key decisions with reference to spare parts in a paper industry.

Most of the paper mills in India use only Imported paper machines, associated with imported equipments. Today the bulk of the non-moving spares in paper industries is constituted by imported spares which were supplied alongwith the original equipments. The absence of standardisation at the initial stage has resulted in the Paper industries going in for too many varieties of equipments with too many spares.

If we assume that the reliability of a spare is 97%, then the non-reliability is 3% or 0.03. If Cu is the cost of not stocking the spare and Co is the cost of the Insurance spare plus cost of carrying the spare in stock for a period almost equal to that of parent equipment,

$$0.03\ Cu = Co$$

$$\text{or}\ Cu = \frac{Co}{0.03}$$

In this case the optimum stocking policy is to carry no stock at all for situations in which the cost of not stocking is upto $\frac{Co}{0.03}$ and carry a stock of one unit if the cost of not stocking is beyond $\frac{Co}{0.03}$

Apart from the above, the decision to carry an insurance spare in stock should be based on facilities available to manufacture the spare in one's own plant, the availability of the spare in the market, the economics of make or buy strategy, technological experience on the reliability of the insurance spare, etc.

In the process of giving consistent protection to continuous production, we end up with too much of protection for many items and too little protection to some items. Hence the problem of redundant stock of spares on one hand and crisis of spares on the other.

The problem, therefore, is how to maintain optimum level of inventory on spares, simultaneously eliminating/minimising the stock out situations, which always prove to be costlier.

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SCOPE OF THIS PAPER

As you all will see before the conclusion of this paper, there are various categories and characteristics of spare parts in a paper industry. We have analysed in this paper only that category of spare parts that fit into the following qualities:—

1. the spare parts having a very low usage rate compared to regular consumable items.
2. the requirement of which cannot be forecast using statistical approach due to either non-availability of statistics or the available statistics being erratic
3. they have a very complicated and uncertain failure pattern
4. the manufacture of these spare parts involve intricate forgings of castings and is labour consuming.

The main reason for our selecting the above category of spare parts is that, most of the literature available today do not discuss this vital area. And even the available papers in this area discuss this problem in the line of formulating a probability table for assessing the stock-out costs and thereby deciding how much to keep in stock. Since computation of stock-out costs using probability theory in real life situations in a paper industry is highly complicated and often unquantifiable, we have attempted, through this paper, a more simpler analytical approach to arrive at the three key decisions (viz) what to buy, when to buy and how much to buy.

INTRODUCTION TO SPARE PARTS

The various categories of spare parts include :

1. Fast wearing parts whose service life do not exceed the period between two consecutive planned repairs
2. Parts whose life exceed the period between the two consecutive repairs, but are in large quantities due to the presence of similar parts in a machine or due to large number of machines of the same model/type
3. Large complicated and labour consuming parts, whose manufacture involves the use of intricate forgings or castings and parts to be manufactured outside the plant
4. Replacement parts of specialised and precision machines, irrespective of their service life
5. Standard parts, assemblies, apparatus such as bearings, belts, chains, oil seals, hydraulic equipments, pumps, etc.

The various characteristics of spare parts can be described as below :

1. Spare parts flow in as new items and flow out again as scrap. The flow is intermittent and takes place in several stages : hence the need for stocking the same.
2. They are specialised for use in one or limited number of equipments.
3. They are difficult to acquire immediately.
4. Manufacturing leadtime for making spares is longer.
5. They have a lower usage rate compared to regular consumable items.
6. Difficult to forecast their requirement because of their uncertain and complicated failure pattern.
7. They constitute a form of Insurance against downtime of the equipment.
8. Stock-out cost of a spare is generally out of proportion to the cost of spare.

STATUS OF SPARE PARTS IN THE INVENTORY STRUCTURE OF PAPER INDUSTRIES—NEED FOR AN EFFECTIVE CONTROL :

1. The total value of surplus and obsolete inventory in India, as revealed by the Union Finance Minister on 10th December, 1974, runs to Rs. 2500 crores. Out of this, the paper industries alone contribute to Rs. 40 crores approximately.
2. In view of such a huge lock up of money on spares, the Reserve Bank of India, through Tandon Committee, has stipulated that the spares Inventory value cannot exceed 5% of the total inventory.
3. The Inventory carrying cost in paper industries works out to anywhere between 25% to 30% of average value of inventory held. It is interesting to note that 30% of this inventory carrying cost is unnecessarily spent every year on non-moving stocks. In other words, Paper Industries in India are spending on an average Rs. 12 crores every year for maintaining dormant stock of spare parts.
4. In paper industries, 50% of the total investment in inventories constitute stock of spares if forest raw material is excluded, and 50% of these spares are non-moving.
5. The tendency for paper industries to stock more spares is born out of fear that the stock-out costs always outweigh the total cost of carrying the spares in stock.

Hence, an integrated scientific approach to solve the complex spares problem is very much essential.

FAILURE PATTERN OF AN EQUIPMENT

Figure 1 below shows the pattern of failure of an equipment from the time it is commissioned till the end of its life.

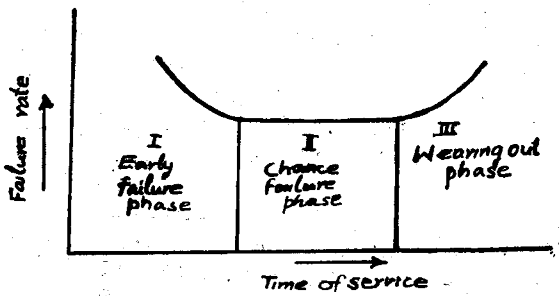

Fig 1

In the early failure phase I, the equipment being new, the failure rate comes down. At this stage the manufacturer's recommendation carries an important weight in deciding the requirement of spares. The second stage is often characterised by a constant failure rate and here only chance failures occur. The third part is characterised by an increasing failure rate and it is the period during which components fail because they are worn out.

From the above curve, it is obvious that *under normal operating conditions*, the failure pattern of an equipment and thereby some of the spares required in the second phase should be easy to assess. These spares are those that will be required for routine maintenance and there will be a definite pattern of consumption of the same. We suggest that these spares can be controlled by application of ABC analysis and conventional replenishment system using statistical approach.

For controlling the spares with uncertain failure pattern, we suggest to use the SPARES TABLE developed by us which is discussed in depth below.

SPARES TABLE FOR SELECTING DECISION ALTERNATIVES

STEP 1

As a first step, before we go into the method of applying the spares Table, let us describe the three *Decision Alternatives* any spare parts Manager has to choose as given below :

DECISION ALTERNATIVE I

Do not buy the spare and keep in stock—Buy only as and when required.

DECISION ALTERNATIVE II

Periodically order out under the replenishment system suggested in Appendix A and keep ready stock.

DECISION ALTERNATIVE III

Decide to buy or not one unit for one machine by the method suggested in Appendix B.

STEP 2

The second step is to classify the spares into the following nine categories :

Sl. No.	Category	Guidelines
	Unit cost	
1.	High cost (H)	Costing more than Rs. 25,000/-
2.	Medium cost(M)	Costing between Rs. 1000/- and Rs. 25,000/-
3.	Low cost (L)	Costing below Rs. 1000/-
	Availability	
4.	Scarce(S)	Manufacturing/procurement leadtime more than 3 months, no equivalents available, no alternative sources available for procurement, cannot be manufactured in one's own plant.
5.	Difficult (D1)	Manufacturing/procurement leadtime will be between one month and three months; one or two alternative sources available for procurement; can be manufactured in one's own plant with difficulty.
6.	Easy (E1)	Manufacturing/procurement leadtime is below one month; available either as off-the shelf or through many alternative sources; can be manufactured easily in one's own plant with the existing facilities.
	Criticality	
7.	Vital (V)	Stock-out of any of these spares will result in heavy losses and in some cases will lead to complete closure of the plant. The equipments to which these spares belong, necessarily have to be vital equipments, fitting the same definition as that for vital spares.

8. Essential (E2) — Stock-out of any of these spares will result in expensive procurement and cessation of work in a major area of the plant operations for which no stand-by facilities could be arranged.

9. Desirable (D2) — Stock-out of these spares may entail nominal expenditure in procurement and will cause minor disruptions for a short duration.

STEP 3

The third step is formulating the spares Table for selection of any one of the three decision alternatives described in Step 1 on the basis of the above nine classifications as given below :

Unit cost and Availability →

Criticality ↓	HS	HD1	HE1	MS	MD1	ME1	LS	LD1	LE1
V	III	III	III	II	II	II	II	II	II
E2	II	II	I	II	II	I	II	II	I
D2	II	I	I	I	I	I	I	I	I

Depending upon the classification to which a particular spare belongs, the decision alternative can be chosen from the above Spares Table.

CONCLUSION

The spares Table can be effectively applied at any one of the following four stages:—

1. At the design and project development stage.
2. At the time of deciding to buy the initial requirement of spares for the new equipments as recommended by the suppliers. This is more applicable for Imported spares.
3. At the time of procurement of spares for the equipments in the intermediate stage of their service life.
4. At the time of analysing the already committed inventory of spares for purposes of deciding to liquidate the dormant inventory.

Before the application of Spares Table, a comprehensive list of spares that may be required to be replaced during the entire service life of the respective equipment is to be prepared. It is logical to assume that such a list will not contain all the spares that assemble to form the entire equipment since it will ridiculously end up in stocking a duplicate plant itself in Stores. Therefore, the Spare Table suggests, on analytical steps, as to what to buy and what not to buy from this comprehensive list.

Application of the above spares Table will result in weeding out the unnecessary spares being kept in stock and accommodate only important spares which are to be necessarily kept to avoid any stock outs. Consequently it releases the capital laid up in idle inventory for better purposes. We have given below a hypothetical case in which the savings in Inventory are resulted by application of the above Table :

Let us assume that a selected few items form 70% of the total cost of spares thereby falling under High cost (H) category. The medium cost (M) category may contain 20% of the total cost of spares and the balance 10% of the cost of spares may be distributed among about 70% of the number of items forming the Low cost (L) category. The frequency of each of the three Decision Alternatives explained in previous chapters and the percentage of value of the consequent commitment can be projected as below in table 1 and Table 2 :

TABLE—1 (assuming that we always decide to buy the spare on all occasions under Decision Alternative III)

Decision Alternative	Frequency of Decision Alternative–Unit costwise			Percentage of financial commitment–Unit costwise			
	H	M	L	H	M	L	Total
I	4	4	4	—	—	—	—
II	2	5	5	15%	9%	5%	29%
III	3	—	—	23%	—	—	23%
					Total		52%

(i. e.) 48% of the value of requirement of spares need not be procured.

TABLE—2 (assuming that we decide not to buy the spare on all the occasions under Decision Alternative III)

Decision Alternative	Frequency of Decision Alternative Unit costwise			Percentage of financial commitment-Unit costwise			
	H	M	L	H	M	L	Total
I	4	4	4	—	—	—	—
II	2	5	5	15%	9%	5%	29%
III	3	—	—	—	—	—	—
					Total		29%

(i. e.) 71% of the value of requirement of spares need not be procured.

TABLE—1

Correction factor, k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of machines of similar type 'a'	1	2	3	4 to 5	6 to 7	8 to 9	10 to 12	13 to 15	16 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 50

Whenever the stock reaches minimum (i. e) N_2, an order should be placed for a quantity which is equal to N_1—N_2. If N_1 is one unit, as we have to necessarily keep a minimum stock which cannot be a fraction or below 1, it is suggested that N_2 can be made as one unit and N_1 as two units.

Of course, it goes without saying, that such techniques can be result yielding only in the event of the organisations focusing their specific attention for a planned maintenance under an efficient maintenance team.

APPENDIX A

Method of replenishment system under Decision Alternative II

Let,

n = number of same spares in one machine
a = number of similar machines in the plant
t = procurement time of the spare in months
s = service life of the spare in months

Then the maximum stock N_1 can be computed as $N_1 = \frac{na}{k} \times \frac{t}{s}$ and

Minimum stock : $N_2 = \frac{N_1}{4}$

APPENDIX B

Guidelines for making decision alternative III

As projected in the Spares Table, the spares coming under the decision alternative III belong to vital and High cost categories. These are also termed as Insurance spares whose life is very nearly equal to-but slightly less than-the operating life of the machine. These insurance spares will have a reliability of 97% to 99%. This may be decided by a detailed study of the failure pattern of the particular spare by referring to other users of that particular equipment. In the absence of any user of the same equipment, this information has to be collected from the manufacturer. The only decision we have to take is either to carry one unit for one machine or not to carry any unit at all in stock.

Since the spares coming under this decision alternative III are all prohibitively costly and very much vital, a wrong decision either way may lead to an uneconomical situation. In such cases, it is very much dangerous to compare only the cost of not stocking these costly spares with the cost of the spare, since cost of not stocking will always outweigh the cost of the spare. And consequently this will lead to conclusion of deciding to buy one unit and keep in stock, thereby straining the financial side of the company heavily. Therefore, we have to necessarily consider the reliability percentage of a spare's life while comparing the cost of not stocking a spare with the cost of the spare.

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k = correction factor, depending upon the number of machines of the same type (see Table 1 below)