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Inventory Management- Enterprise Resource Planning

Companywide E-Interchangeability approach for Spare parts - An inventory cost reduction technique- Specific to downstream of Petroleum plants

Sandeep Sharda, Dr. Sanjeev Mishra

Research Scholar, Mechanical Dept. (Program of Management Studies), Rajasthan Technical University, Rawatbhata Road- Akelgarh, Kota- Rajasthan-324009(India)

Prof. & Head, *University Department of Mechanical Engineering, Rajasthan Technical University, Rawatbhata Road- Akelgarh, Kota- Rajasthan-324009(India)*

Abstract— *Spare parts stock control management is crucial areas of inventory research. In our research paper, we consider downstream plant of petroleum are Ethylene, Ethylene Glycol, Polypropylene, polyethylene & utilities located at same location of unit. E.g.: Reliance Industries in India & SABIC affiliates at Saudi Arabia. Cost economics policy for spare parts stock level control is based on companywide spare parts interchangeability of identical spare parts among equipment. It requires a dedicated review through sectional drawings for interchangeability maintenance history especially for rotary equipment. Study indicates current practice for spare parts stock levels are normally based on equipment in the individual plant. However, interchangeability of spare parts may exist equipment among plants. This work presents an approach of companywide technique for spare parts stock levels control. The Methodology is based on descriptive study of technical aspect of interchangeability of spare parts of equipment among plants.*

A. Basis of The Study Covers The Following

1) Cost reduction by rationalized stock levels for identical spare parts for installed quantity

2) Reducing duplication of item code for identical spare part using companywide technique

B. Working framework is based on the following dependent variables and necessary considerations.

1) Manufacture standardization among plants during the project stage for items like Mechanical seal, Pressure safety valves etc.

2) Stock level formulation using E SPIR (Electronic Spare Parts Interchangeability Record)

3) Considering, lead time is uniform and identical spare parts do not require in more quantity at same time

4) Data analysis is based on conceptual study however supported with example based on secondary data collected from one of affiliate SABIC plant KSA.(for a item)

5) Based on the study of related literature through journals, Publications, books are based on the techniques on EOQ, Reorder point; Demand forecasting (in manufacturing sector) and plant level interchangeability.

Index Terms--- Spare parts, companywide codification, stock control, E-SPIR, MRP classification, criticality ranking & lead time

I. INTRODUCTION

Spare parts are significant resources for continuous equipment availability [1]. Keeping in view of prime objective inventory management system, which is to obtain sufficient service level with minimum inventory investment and administrative cost [2]. It is envisaged that spare parts inventory need should be treated as different from work in process (WIP) and other finished product inventories in inventory stock control and inventory control approaches [3]. With a reference to petrochemical plants in a campus, based on the normal practice the stock level cost of spare parts 2-4% of the plant cost. Average Cost of a Petrochemical Complex about $36.0 billion 2015[4].Include two ethylene and a propylene plant, Hence needs a rigorous exercise for spare parts stock control to minimize spare parts inventory cost for the company.

A. Objective

For the above it is conceptualize after review of papers that complex wise codification is one of the methods by following could be achieved:

1) Reduction of stock levels of spare parts

2) Reduction in duplication of codification

3) Cost reduction of spare parts inventory.

B. Conceptual Preparatory Work

General and Current codification structure of spare part item is

Plant

↳

Parent group /family group

↳

Sub-group
↳ Item

E.g.: Petrochemical / Petroleum downstream Complex
in which having a several number of plants like Ethylene, Ethylene Glycol, and Polypropylenes Plants.

1) Codification Example

Mechanical Seal of a centrifugal pump are codified based
on individual plant basis. Code for Ethylene plant: E, Parent code-P, Code for Centrifugal Pumps-1, Code for Equipment: 01and hence Item Code for mechanical seal- EP10110.Similarly Code for Ethylene Glycol plant: G
Code for mechanical seal: GP10210.
Both seals are same and stocked in two codes and definitely minimum stock level is one seal per plant basis. Approx. average cost of complete cartage mechanical seal of size 2.875'' is USD 8000/-(John Crane makes).This cost can be reduced if we codify as companywide and could require only a seal to stock.
Revised and proposed codification structure is as below
Company code

↳ Manufacturer code (E.g: John Crane: interchageabilty code)
↳ Subgroup (E.g Type)
↳ Item

2) Codification Example

Code for company: C, Manufacturer code: J, Subgroup Code for Centrifugal pump: P1, Code for equipment: 01, hence Code for mechanical seal: CJP10110. Item under the code will be stocked minimum only one as among all interchangeable mechanical seals.

II. LITERATURE REVIEW

Growth of cost reduction techniques in Spare parts stock control Management are

A. Spare Parts Classification Review[5]

This is the approach in which items are classified based on ABC analysis. However, other criteria simultaneously may also play a significant role in classifying stock keeping units such as lead time & rate of consumption, etc

B. Based on the EOQ analysis[6] & [7]

From the original work by Harris (1913) on Economic Order Quantity (EOQ), different inventory models have been developed; including the following classic models:

1) Continuous Review (R, Q) [8]

In this model the inventory is continuously monitored and, when the level reached the order point "R" a lot size of "Q" (economic order quantity) is placed;

2) Periodic Review (T, S) [8]

In this case, orders are placed in fixed interval of time "T", in an amount to replace the inventory position to the maximum Inventory level "S" and;

C Base Stock (B) [8]

Here, at each withdrawal from inventory, an order of the same amount is made for replacing the baseline, keeping the inventory position (inventory on hand plus open orders) constant and equal to "B".

D Criticality Analysis [9]

A systematic technique is used here to evaluate spare part
Criticality based on structuring the evaluation process into a three-level hierarchy. At level 1, we define failure Consequences of spare parts, i.e. the most reasonable
Consequences resulting from spare part failure or
Malfunction; what could happen if the spare part is not
available in stock, how it will affect the major concerns of
the organization? The definition of failure of consequences
is based on the level of loss in terms of production and
Plant safety and down time loss.

1) Decision To Stock Or Not To Stock[10]

In This approach to reduce spare parts inventory levels, a critical revision of the need is carried out by modeling to decide upon to maintain or not .

2) For Off Shore Spare Parts Management[11]

Maintenance personnel from individual plant would like to have their own stock of spare parts for the equipment which is having interchangeability for almost all spare parts with the equipment in the other plant. They believe more stock in the warehouse, the safer it is. Actually, it is not a good decision to have too many spare parts in the warehouse.

3) E-SPIR base Spare Parts Stock Control [12]

A guide for Electronic Spare Parts Interchangeability Record in which Manufacturers list all of recommended identical spare parts for different Tagged equipments indicating the installed quantity of spare part in each equipment as well as total identical installed quantity of individual spare part.. The very fundamental identification of the identical spare parts from E-SPIR document is having same manufactures part number.

III. WORKING FRAMEWORK

The proposed approach for cost reduction constitutes in following stage process for companywide spare parts stock control management [12]. An appropriate framework is developed in following steps

A. Company Wide Manufactures Standardization During Project Stage

Prime items: Pumps, Motors, Control valves, Sub assemblies like Mechanical seal, Couplings, PSV's, parts and valves etc. General items like Pressure Gauges, Line valves, Electrical Junction box, Circuit Breakers etc.

B. Procurement Strategy

During the procurement of equipment at project stage an instruction to bidders is prescribed that they should provide E-SPIR (Electronic-Spare parts interchangeability record (in the prescribed format) with recommendations of stocking quantity. [13].

C. Stock Level Formulation[13]

SPIR recommended stock level quantity are based on the Manufacturer however further review is required for stock levels which is based on functional requirement of equipment.

E.g.: A centrifugal pump which is used for the service of water and other pump whose service is hydrocarbon. The pump used for Hydrocarbon service will be treated as more critical than pump for water service. Spare Parts stock level needed a consideration for service criticality along with past history of maintenance.

Stock levels practice using in the industry practice are [9].

1. MRP Type V

Stock levels are set up for the spares / other consumables. Automatic purchase order will be initiated at Min stock level.

2. *MRP Type ND*

No stock is set up for this category of equipment since failure probability is low for the parts, however the information is ready to use in E system or CMMS system. Purchase order initiated in case of fail of spare parts.

3. *MRP Type: PD*

Stock in this category not to kept, however warehouse has on-hand stock which were ordered during project stage. The total stock is the quantity of spare parts on-hand. If the total stock falls the lower the Min set, the purchase order will be initiated automatically. The levels for stock quantity as Max/ Min value is based on the criticality, Mean Time To Failure, total installed quantity of equipment lead time and cost of spare etc.

4. Companywide Spares Stocking Analysis Based on Above Framework as well as Following Assumptions

a) Standardize Manufacturer optimum one or two nos. like mechanical seal all from John crane Make
b) Pumps Coupling are Rexford Make
c) Pressure safety valves from Cross by or one more.
d) Some Spares are repairable
e) All spares are located on main warehouse.
f) Items (Spare Parts) are from same Manufacturer and having interchangeability with respect to Type and Size
   a. Interchangeability of parts are based on the OEM's item part number, means items are interchangeable, if part number is same.
   b. Spares stocking levels Min / Max are based on the criticality ratings and MRP type selection.

E. Conceptual Frame Work- Spare Parts Stocking- Mechanical Seal & Parts – Companywide policy

TABLE II

Plant			**Spare parts for Mechanical Seal**							
Stock Level ↓		Ins. Qty.	Mating ring		Primary Ring		Soft parts- Mating ring		Soft parts Seal Head	
Min	Max	→								
Ethylene		Z1								
EG		Z2								
U & O		Z3								
Total		Z4	Y1	Y2	Y1	Y2	Y3	Y4	Y3	Y4

1. Mechanical Seal and parts are interchangeable not only w.r.to the individual plant but also with other plants.

2. The stocking quantity Min. / Max. for Mechanical seals and its parts (Hard & soft both) Could be rationalized and based on total installed quantity of all units

IV. Analysis of Stock Levels

It is understood that stock levels under plant wise are higher than the companywide stocking policy.
Hence, Total Installed Quantity
Z4 =Z1+Z2+Z3 (remain same) in both stocking policy

A. *Comparison of Stock Level Plant Wise and Companywide*

1. Mating Ring stock level X1 >Y1, X2> Y2
2. Primary Ring stock level X1>Y1, X2>Y2
3. Soft parts mating ring X3>Y3, X4>Y4
4. Soft parts Seal head X3>Y3, X4>Y4

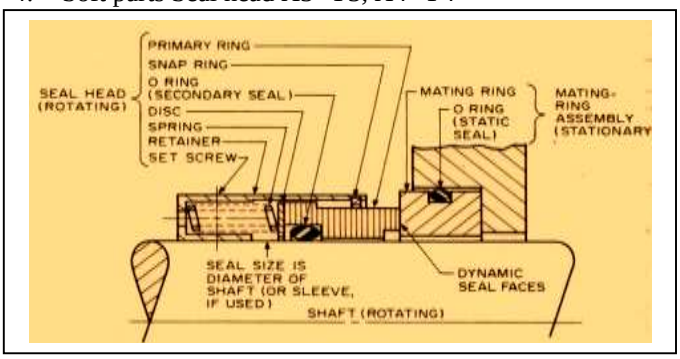

Fig. I Sectional View of Mechanical Seal on Shaft Mechanical Seal

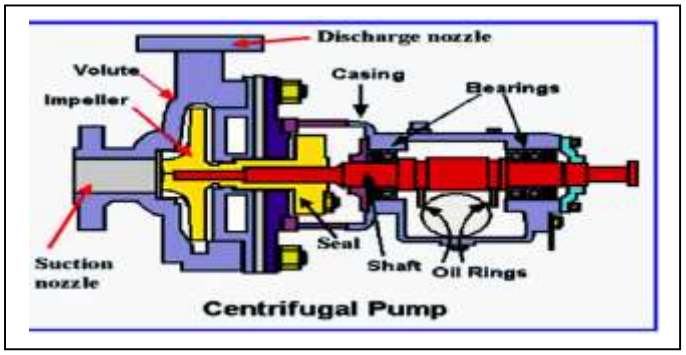

Fig. II Schematic Diagram of Centrifugal pump with

D. *Conceptual Frame Work- Spare Parts Stocking- Mechanical Seal & Parts – Plant Wise Policy*

TABLE I

Plant			**Spare parts for Mechanical Seal**							
Stock Level ↓		Ins. Qty.	Mating ring		Primary Ring		Soft parts- Mating ring		Soft parts Seal Head	
Min	Max	→								
Ethylene		Z1	A1	B1	A1	B1	A2	B2	A2	B2
EG		Z2	A3	B3	A3	B3	A4	B4	A4	B4
U & O		Z3	A5	B5	A5	B5	A6	B6	A6	B6
Total		Z4	X1	X2	X1	X2	X3	X4	X3	X4

Currently many organizations Spare Parts Stock levels policy is based on plant level, keeping interchangeability among parts within the plant level.

B. *Case Study of SABIC Petrochemical plant in KSA*

This includes plants Ethylene, Ethylene Glycol, Utility & offsite in the same campus. M/s John Crane approved Manufacturer for Mechanical seal since project stage. Spare Parts stock levels are set on plant basis policy using E- SPIR for parts interchangeability for Mechanical Seal as well as other Spare Parts for equipment. Min / Max levels of Spare parts are based on the

1. Criticality of equipment & MRP Type
2. Maintenance frequency of equipment – once a year
3. Cost of item & Lead time for replenishment

V. Conclusion

This study, present an approach for cost reduction by using companywide policy for stock control management of spare parts. According to our study, we can derive the following general conclusions:

1. Companywide Spare parts stocking policy reduce the stock levels for identical spare parts among all installed quantity for same manufacturer.
2. The companywide standardization for manufacturer during project stage is one prime steps in this approach.
3. Manufacturer standardization for general items like pipeline valves, pressure gauges, PSV's, electrical circuit breakers, relays, control valves, filter elements etc. also leads to reduction in variety and stock level.
4. Stoking levels for identical parts could be rationalized and reduced as companywide installed quantities are higher, since all equipment does not fail within same period and asking for identical spare parts.
5. It may calls for high demands of identical spare parts during scheduled shutdown of plants companywide, then extra quantities could be estimated and planned orders could be made.
6. ERP packages as SAP R/3 Materials management module is item based codification tool. Hence E- SPIR interchangeability should be prepared prior to the data entry for spare parts item in SAP R/3.
7. Duplication of item code reduces in the company wide stocking policy for identical spare part.
8. It has been practically experienced for companywide stocking policy provides tremendous cost saving to one of the SABIC affiliate of Saudi Arabia.
9. Below is the Interchangeability study companywide which was carried out by research Scholar during working with SABIC affiliate. Huge data and cost saving however could not be share.

Companywide -Interchangeabilty : Mech. Seal					Date: 12-08-04
PUMP TAG #	**item code for Mech. Seal**	**Service**	**Qt'y**	**Criticality**	**Mechanical Seal Interchangeable with Pump Nos (Review analysis)**
P-1145	560824	Quench Water Return Pump	1	2	Interchangeable with P-1148 , P-1205 A/B, P-1760 A/B
P-1148	560824	Residue Drum Recycle Pump	1	2	Interchangeable with P-1145, P-1205 A/B, P-1760 A/B
P-1202A,B	560825	Weak Caustic Pump	2	2	Interchangeable with P1203 , P-1204 A/B, P-1217 A/B
P-1203	560825	Strong Caustic Pump	1	2	Interchangeable with P1202A/B, P-1204 A/B, P-1217 A/B
P-1204A,B	560825	Spent Caustic Pump	2	2	Interchangeable with P1202A/B, P-1203 , P-1217 A/B
P-1205A,B	560824	Water Wash Pump	2	2	Interchangeable with P-1145 , P-1148 ,P1760 A/B
Notes 1) This is for few mechanical seal (Courtesy - by SABIC Affiliate)					
2) Criticallity 2 - consequnces of loss very less hence stock levels rationally reduced					
3) Study for interchageabilty carried out by SABIC team based on manufacturer's data					

Table: 3 Companywide Interchangeability-Mech.Seals (shown few items)

VI. Future Scope

1) Mathematical modeling for rationalized stock levels could be developed
2) Benchmarking of companywide interchangeability of spare parts could be further analyzed in Industry perspective.

Acknowledgement

It is worth acknowledging the sharing of a script of interchangeability data and working as inventory controller with SABIC affiliate.

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