# Optimization Policy of Inventory Spare Parts Stocking and Provisioning

Tae-Sik Yun, Jong-Hyuk Park, Eui-Youp Hwang, Sung-Soo Yoo, In-Hwan Kim
*Korea Electric Power Research Institutes 103-16 Mun-ji- Dong Yusong-Gu Daejeon Korea, drsik@kepri.re.kr*
*Korea Hydro & Nuclear Power Corp.167 Sam-Sung-Dong, Gang-Nam-Gu, Seoul Korea*

## 1. Introduction

Spare parts, especially safety related items, being used in Korea Nuclear Power Plants are largely from the United States, Canada, France and the like, meaning the inventory policy, stocking and provision, should be influenced by those countries' nuclear industry situation in a direct or indirect manner. As a result of nuclear industry downturn practices, lots of spare supply corporations have gone broke, which gave immediate signals we have to resolve inventory purchases in need. It is known for that nuclear maintenance spare items are particularly composed of many kinds with small quantities, which makes matters worse to Korea nuclear operation company (KHNP) to purchase them. Hence, Korea nuclear business is trying to change its ex-inventory purchasing paradigm into innovative schemes it did not have to consider in the past. In order to implement a new stocking policy, it should be kept in mind the factors such as not only how much to stock for a smooth operation but also economic point of view. Even though it has done a lot of studies to optimize the inventory stocking level in an academic curiosity, it is not easy to apply the researches in a real world. Since it is so tough job to anticipate when and how large scale even occurs. Hence, it would be thought that the nuclear inventory should be dealt in a different manner from the general manufacturing industry.

## 2. Available model

There are many types of components and items used in a nuclear utility. It could be broken down into critical impact the utility can trip and non-critical in a broad band, inferring that most of the spares are managed in a same method; the minimum level of quantity got just held for general items, while the retaining quantity for critical must take into deliberation to not to impact utility operation and safety.

*2.1 Critical Component Identification Process*

In order to apply the appropriate algorithms, it should be the first step of classifications ones are critical and non-critical. The document of INPO AP913, *Scoping and Identification of Critical Components* is the common method which is also applied in this pilot plant, Ulchin 5&6 nuclear power plant. Among target items in total are 50,047-item, critical 1&2 is 10,310, non-critical 39,738 including minor and no-impact.

To complete categorization each assigned system engineer is required to follow the process as described.

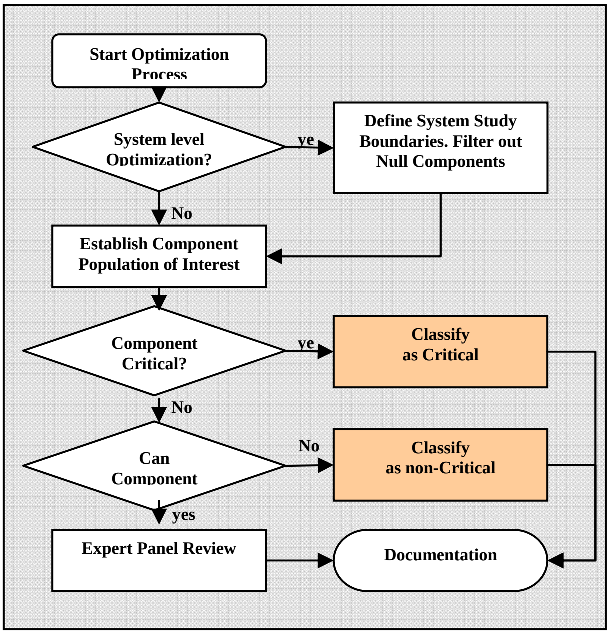



*Figure 1-1Component Categorization Process Diagram*

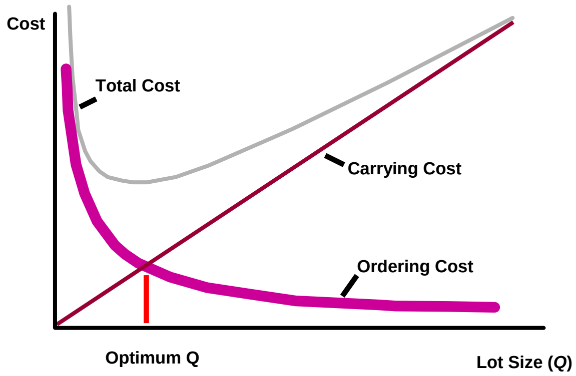
*2.2 Optimization Algorithm*

On the basis of the categorization above, it is expected that EOQ model could be used for non-critical items and ROQ and Binary Decision Model for critical ones.

2.2.1 EOQ Model

So as to determine the optimal number of non-critical items. EOQ(Economic Order Quantity) is broadly used in conditions likewise ;

- Demand rate known and <u>constant</u>
- Delivery is <u>immediate</u>
- Lead time known and <u>constant</u>
- Inventory carrying cost are known and <u>constant</u>
- Ordering, or setup costs are <u>constant</u>
- No backorders are allowed
- Materials never expire (Shelf Life)




*A = annual usage in units*
*S = ordering cost in dollars per order*
*i = annual carrying cost rate as a decimal of a percentage*
*c = unit cost in dollars*
*Q = order quantity in units*

- Annual carrying costs = average inventory cost * cost of carrying one unit for one year = average inventory * unit cost * carrying cost = Q/2 * c * i
- Annual ordering cost = number of orders * cost per order = A/Q * S

It can be optimized that the point of annual carrying cost and annual ordering cost is met. The optimal number is calculated;

$$Qic/2 = AS/Q$$

$$Q^2 = 2AS/ic$$

It can be known, inferred from the conditions above, it is difficult to be applied into the critical items which could impact the plant's trip.

*2.2.2 ROQ Model*

ROQ(Re - Ordering Quantity) is a kind of derivatives of EOQ. As known above, EOQ can not resolve for the case of critical items which must be taken into safety stock. The amount of safety stock depends on three main factors : *the variability of demand, the reliability of supply and the dependability of transport.*

The variability of the demand during lead time is addressed by examining the history of the demand for the item and calculating the Standard Deviation (sigma)

Safety Stock = sigma * safety factor

The maximum level for the critical items must be the quantity equal to the demand during lead time(DDLT) plus the safety stock(SS). The quantity on hand plus the quantity ordered must be sufficient to last until the next shipment is received.

Order Point = DDLT + SS

*2.2.1 BDM Model*

A Binary Decision Model for the stock control is sometime applied for very slow moving items but purchasing cost is high which are designed for heavy production facilities, insufficient demand for statistical estimation, normal EOQ models do not fit, and decision is to stock one or none and the like. Hence specific model is developed in this note for this problem to compare the alternative decisions of keeping a stock of 0 or 1 assuming the process of demand occurrence is Poissinian(parameter λ).

$$F(0) = (F1) \rightarrow T\lambda(c + p) = T_1h + cn + pn_0$$

$$h = \lambda p$$

*F(0) = expected total cost of "0" on hand*
*F(1) = expected total cost of "1" on hand*
*h = holding cost, c = purchasing cost*
*n =demand occurrence*

This means that nil stock policy is not preferable;

$$\text{if } \lambda < h/p.$$

## 3. Conclusion

For the purpose of optimizing the inventory stocking level, many manufacturing companies have tried various theories and got some fruitful results. However those theories using in manufacturing area could not applied into power utility in a perfect manner. Hence, in this paper, three kinds of algorithms are suggested to match the characteristics of inventory items. Non-critical is on EOQ, critical on ROQ, slow moving items on BDM.

As stated above, anticipating and calculating the inventory of a power utility, however, is very tough. In the process of fixing the quantity number, many rounds of discussion and evaluation steps with system engineers are needed. In addition, the one time fixed number must be revised in a regular time basis.

## REFERENCES

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