SPARE PARTS PLANNING FOR NEW METALLURGICAL PLANT START-UPS—WHY YOU NEED A SPARE PARTS INVENTORY MODEL

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ABSTRACT

Standard practice for newly constructed metallurgical plants is for equipment suppliers to recommend sufficient spare parts for the first two years of plant operation. However, this approach is inadequate, as it does not consider several factors, including:

- Is it necessary to reorder the part after it is used?
- If the part is reordered, how many should be ordered?
- Will the part be used routinely or is it an insurance item?
- Given this approach, how can the total investment in parts inventory be minimized?
- How likely is it that the part will be available in the future when it is needed?
- What will be the effect on production if the part is not in stock when it is needed and must be ordered at that time from the supplier?
- How long will it take to get the part once it is ordered?

All of these questions are critical and are not adequately answered if the equipment suppliers simply deliver an estimated two-year supply of parts.

INTRODUCTION

All too often, operations preparing for a new plant start-up limit spare parts inventory requirements to equipment suppliers' suggested spares—usually the recommended first two years' spares. The end result is a collection of disparate printouts in various formats. In most cases, the engineering company simply orders the spares, which are thrown into a lay-down yard or into a shipping container. Is this useful for the plant owner/operator? The simple answer is no; it is not very useful.

What the plant operators really need are data that can be uploaded into their purchasing and warehouse inventory control system. For each part, these data include:

- The *reorder point* (*ROP*), or the stock level at which a replenishment order is placed.
- The *economic order quantity* (*EOQ*), or the order quantity that will minimize the sum of inventory carrying costs and ordering costs.

Of course, these values are not determined directly. They are computed based on answers to the following questions:

- Is the spare an insurance item, such as a mill pinion, or is it likely to be used in routine operation, such as a bearing or pump impeller?
- If it is a part anticipated to be used in routine operation, what is the estimated annual usage?
- What is the cost of the part?
- What is the estimated lead time to procure the part?
- Given the criticality of the part, what quantity should be assigned as safety stock?

With the answers to these questions, along with values for the cost of carrying inventory and preparing purchase orders, the key parameters—**ROP** and **EOQ**—can be automatically determined by an inventory model.

Developing a spare parts inventory model, requires input from engineers and plant operations specialists with years of experience in the operation and maintenance of similar metallurgical process plants. This experience can be put to use in determining the necessary insurance and routine spares, as well as estimated usage rates and recommended safety stock requirements.

The parts data come from a variety of sources, including:

- Equipment supplier-provided data.
- Engineering company spare parts list (supplier spare part data compiled by the project engineering company).
- Data from supplier documentation in an owner's or specialist consultant's files.

METHODOLOGY

Each equipment supplier is contacted by e-mail or telephone, and a recommended spare parts list is confirmed. The supplier-provided spare parts recommendations are then scrutinized by experienced personnel. Part type and usage rates are determined by these personnel based on plant experience. The parts analysis team must capture or establish the following data for each part:

Part Number

The manufacturers' part number is entered in this field.

Part Type and Description

Using a consistent naming convention, the most descriptive terms are entered for the part in the part type and part description fields. In many cases the supplier provides poor part descriptions. Experienced owner or consultant personnel can improve upon these descriptions where necessary.

Part Weight

The equipment supplier-provided weight is used.

Part Manufacturer

When made available by the supplier, the part manufacturer is entered into the spare parts inventory model database. If the supplier does not provide the manufacturer, the supplier is entered in the manufacturer field.

Part Supplier

The name entered in this field is the supplier who has been issued the original purchase order for the equipment.

Unit of Measure

Normally the unit of measure is *each*. In some cases, such as conveyor belting and wire rope, the unit of measure could be *feet, yards,* or *meters.*

Spare Type

The spare type is either *insurance* or *routine*. An insurance spare represents a part that may never be needed, but must be kept in inventory in case it is needed. Normally insurance spares are expensive, critical, and have long lead times if one is to be ordered. If an insurance spare is not available, extensive production losses result. Where the spare type is defined as *insurance*, the ROP is automatically set at zero with a reorder quantity of one.

Routine spares are estimated to be needed in the course of operation. For routine spares, the normal EOQ and ROP algorithms are used.

Lead Time

The lead time is based on estimates of the following:

- The time required for the inventory control system to generate a *reorder advice* notice and the purchasing department to place the order.
- The time estimated by the supplier to fill the order and initiate shipment.
- The time required to deliver the part to site and restock the warehouse.

Price

The total price for the part is entered into the database. If applicable, factors can be added for customs duties and shipping costs.

Component

A component name is added to this field when it is applicable.

Issue Quantity and Annual Usage

The values must be carefully assessed based on equipment use, plant environment, and the experience of the personnel making the analysis.

Equipment

A linking table in a database is necessary for identifying each equipment item number on which the part is used. For example, there could be several pumps of the same design, each with a distinct equipment number, that use the part in question.

Safety Stock

Safety stock represents a buffer quantity of a part kept in stock. This buffer is designed to account for uncertainty in the lead time and parts usage. In an ideal world, the exact parts usage rate in a specific period of time—say one month—would be known. In the same ideal world, the exact lead time to obtain the part would be known. In that case the reorder point would equal *lead-time usage (LTU)*. For example, if a quantity of one particular part was used each month and the lead time was two months, the reorder quantity would equal two, since two parts would be used during the two months it took to order the part and get it into stock.

Safety stock values are typically based on a multiple of LTU depending on the criticality of the part. For example, consider the following example rules for establishing safety stock:

- For a critical spare that would result in lost production, set:

  Safety Stock = 6 x LTU.

- For a spare where there is a spare item of equipment such that there is no immediate production loss, but the primary equipment is shut down, set:

  Safety Stock = 4 x LTU.

- For a spare where there is no serious production loss, set:

  Safety Stock = 2 x LTU.

The higher the safety stock value, the lower the probability of a stock-out for the part. However, the higher the safety stock, the higher the inventory investment.

Other Factors

Other factors necessary to consider before calculating EOQ include:

Cost of Carrying Inventory Expressed as a Decimal

This cost includes:

- The cost of money tied up in inventory or the opportunity cost.
- The cost of the warehouse and other storage space.
- The cost of handling.
- The cost of obsolescence and deterioration.

All of these costs can be expressed as a percentage or decimal based on the cost of borrowing money to cover them. This cost largely depends on the prevailing interest rate. For purposes of this paper, we can assume that it is **15 percent**, or **0.15**.

Cost to Place a Purchase Order for the Part

This cost includes:

- The undepreciated cost of the purchasing department office structure divided by the number of part orders per year.
- The annual cost of purchasing department personnel salaries and benefits divided by the number of part orders per year.

This estimate does not have to be particularly precise. For purposes of calculation, we assume that it is $100.00. Of course the ordering cost does not generally depend on the cost of the part ordered.

COMPUTATION OF ROP AND EOQ

Use the following equations for ROP and EOQ:

(1) Reorder Point (ROP) = LTU + Safety Stock

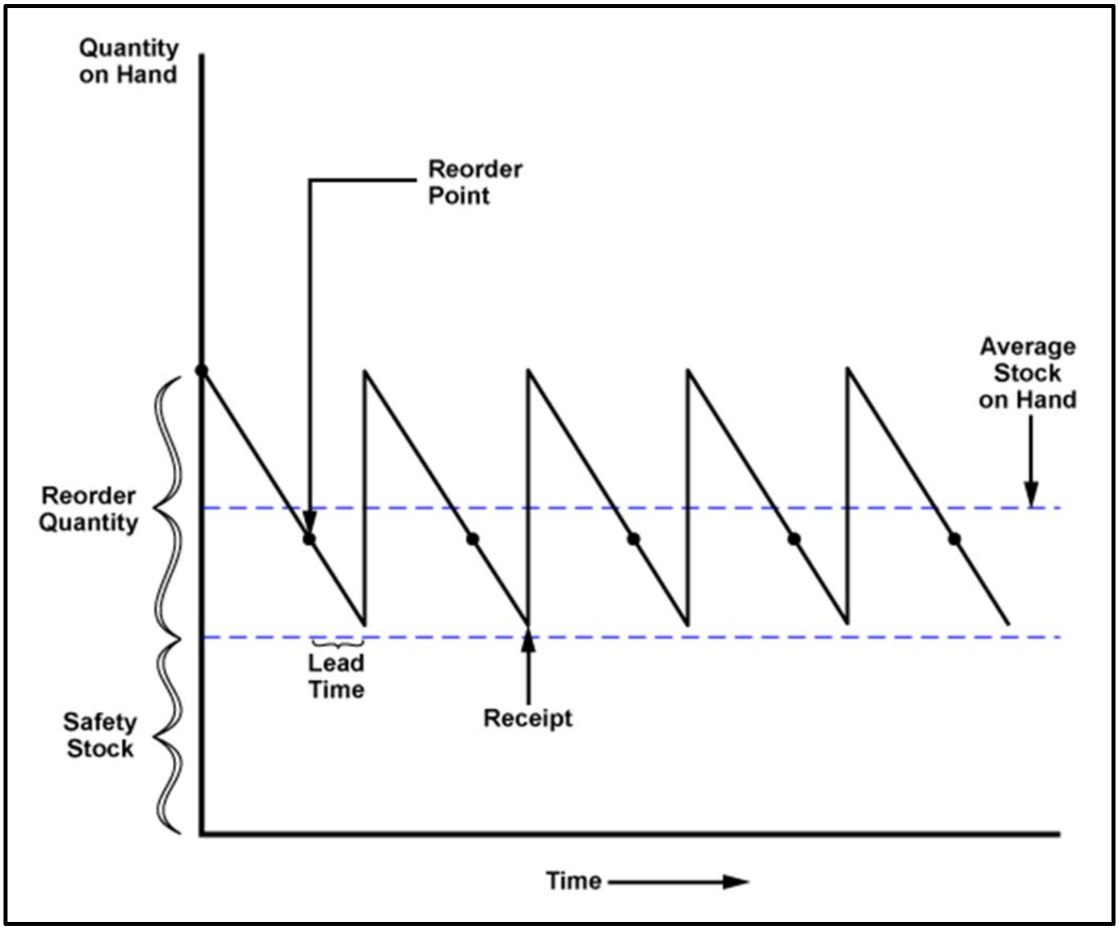

Figure 1. Quantity on Hand Based on Using ROP = LTU + Safety Stock

$$\textbf{(2) Economic Order Quantity (EOQ)} = \frac{[2BA/I]^{1/2}}{\text{Part Unit Cost}}$$

Where:

B = Cost to place a purchase order.
A = Annual usage cost = annual usage x cost of part.
I = Cost of carrying inventory expressed as a decimal.
Q = Quantity.

The advantage of the EOQ approach is that it minimizes the sum of the ordering cost and the inventory carrying cost.

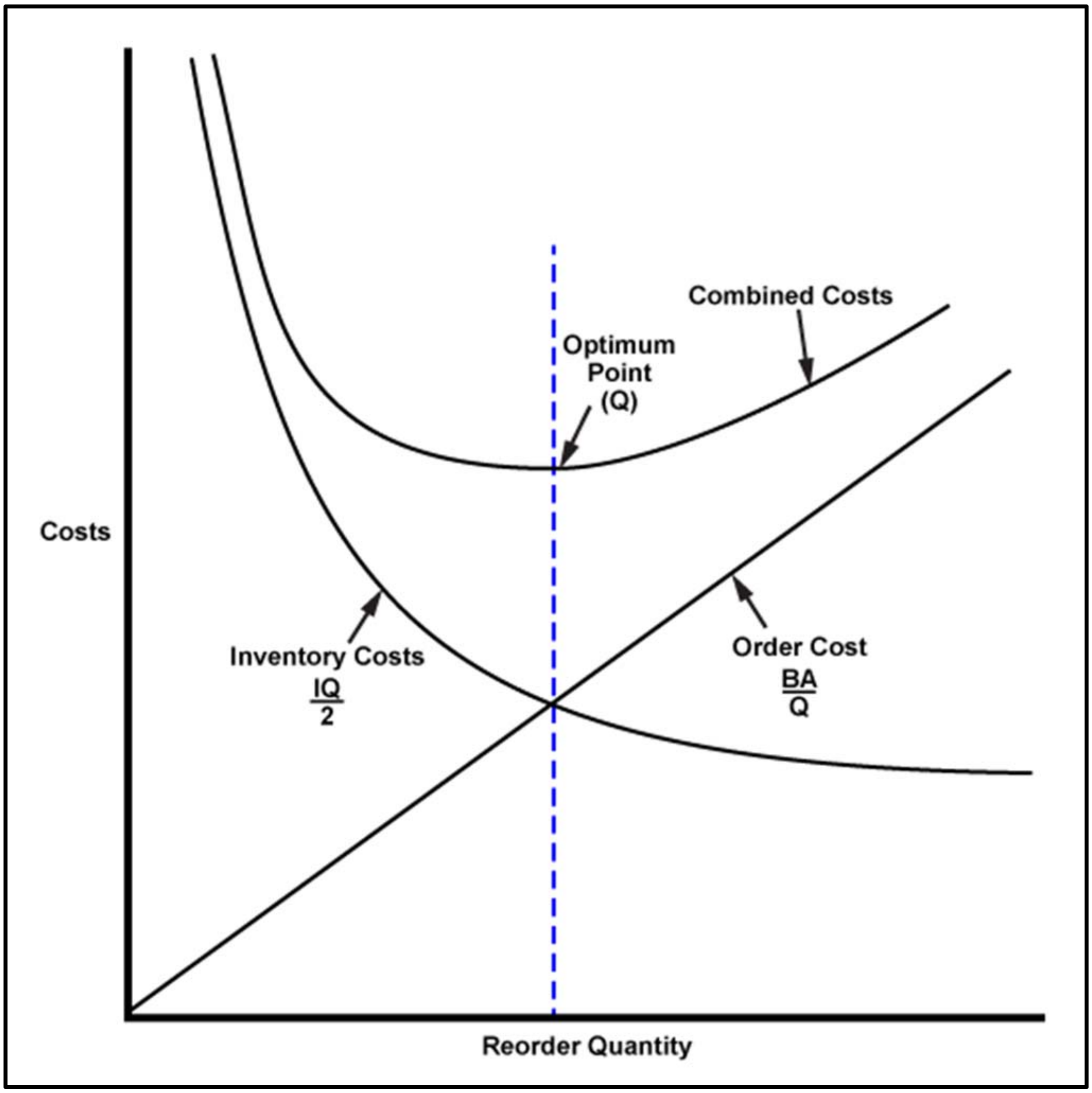

Figure 2. Minimum Inventory Cost Curve

WHAT NEXT?

The data base information collected, established, and calculated are then uploaded into the computerized inventory management system. Once this process is completed, plant operators and maintenance personnel have an inventory of spare parts and a system of reordering to ensure that parts are available when needed.

To recap, the essential factors that ensure a good inventory of spare parts on hand are:

- Making a formal contact via telephone or e-mail to obtain the suppliers' spare parts recommendations, including ordering data.
- Experienced personnel analyzing the use of each part as follows:
    - Is it *routine* or *insurance*?
    - For routine spares, what are the estimated *usage rates* and *safety stock* requirements?
    - What is the estimated *lead time*?

During actual plant operation, the part usage values can be adjusted based on experience and the ROP and EOQ values recalculated.

SAMPLE SPARE PARTS PRINTOUT

Refer to the following page for a sample printout from a typical inventory model.