Materials Management

Maintenance and Repair

Maintenance Materials Management

- Generally in the US, the stores investments as percent of estimated replacement value is 1.2% to 1.9%.

- Cost of maintenance materials varies from 2/3 to 1.5 times the direct store management labor cost.

- Typical findings in Stores/Purchasing functions
  - Excessive stock-outs 7% - 10% not uncommon
  - Low turnover
  - Excessive late deliveries
  - Lead times not kept up-to-date
  - Absence of effective materials standards
  - Inadequate off-shift coverage and security
Elements of a Materials Management System

• A team to drive continuous improvement in materials management. The team should include representatives from maintenance, stores, procurement, design, business services, construction and integrated suppliers.

• Standard descriptions of equipment, parts and supply items.

• Effective management of maintenance material working capital.

• Operational rebuilding programs for items such as motors, transformers, controllers, printed circuit boards, and seals.

Elements of a Materials Management System

• Measurement of material management results. These metrics should be a measurement of functional performance and should compliment the business metrics. Examples are:
  – Total stores investment (as a % of plant replacement value)
  – Service level ( % of items supplied when requested)
  – Percentage of stock-outs and backorders
  – Utilization of materials database
  – Utilization of prearranged purchase agreements
  – Inventory turnover and inventory accuracy
Elements of a Materials Management System

- Alternative materials procurement program (sourcing by other than the original equipment manufacturer)
- Utilization of preferred/prearranged sourcing
- Partnerships with suppliers aimed at improving material quality and performance while reducing inventory and costs
- Good materials planning partnerships
- A standardization program to minimize the different types of materials and equipment
- Complete bills of materials for site equipment to identify replacement parts
- A comprehensive up-to-date maintenance store catalog

What is Maintenance Stores?

- In most plants, all items not consumed directly or indirectly in production are included under the heading of maintenance stores
- Maintenance stores can be classified into five groups:
  - General Hardware and Supplies (bolts, small tools, belts, pipe, valves, etc.)
  - Materials (paint, lubricants, cement, refractories, etc.)
  - Spare Parts (bearings, gears, specific components, etc.)
  - Spare Equipment (complete assemblies and machines)
  - Special Items (fillers, lubricant, catalyst, steel banding, etc. used in production; and also items stored on temporary basis, eg., construction surpluses or pilot plant equipment)
Types of Maintenance Spares

- **Bin stock items --- free issue**: Materials that have little individual value with high volume usage (e.g., small bolts, nuts, washers). They are placed in an open issue area. The best way to maintain free issue is the two-bin method.

- **Bin stock ---- controlled issue**: Similar to the free issue items, except that their access is limited. The stores clerk will check the items out, while not requiring a requisition or W.O. number for the item.

- **Critical or insurance spares**: Items that do not have much usage but, owing to order, manufacture, and delivery times, must be kept in stock in case they are needed.

- **Rebuildable spares**: Includes items like pumps, motors, gearcases, or other items that the repair cost (material and labor) is less than the cost to rebuild it.

- **Consumables**: Items that are taken from the stores and used up or thrown away after a time period. These items might include flashlight batteries, soaps, oils, or greases. Their usage is tracked and charged to a W. O. number or accounting code.

- **Tools and equipment**: Certain tools and equipment are issued like inventory items with the difference that the tools are brought back when the job is finished. This tool tracking system should only be used to track expensive tools.
A-B-C Analysis for Spares Classification

- “A” items are: 20% of the stock items
  - 80% of the inventory cost
  - High dollar, “insurance”-type items that must be in stock.
  - Strict inventory policies on the use and movement of these items are required

- “B” items are: 30% of the stock items
  - 15% of the inventory cost
  - Should also be controlled with a strict tracking method.

- “C” items are: 50% of the stock items
  - 5% of the inventory cost
  - The monetary return will not justify the necessary labor to process the paperwork as with items “A” or “B”.

Functions of the Maintenance Store

- Administration:
  - Providing information to the planner or supervisor
  - Doing all the calculations associated with stock keeping (min, max, EOQ, safety stock)
  - Maintaining the parts numbering system
  - Creating and maintaining a store catalog
  - Preparing reports for management
  - Tracking parts to and from re-builders
  - Accounting for all the parts received, used, and left on hand
Functions of the Maintenance Store

• Receiving
  – Unloading trucks
  – Counting parts
  – Inspecting parts for compliance with specifications
  – Facilitating quality efforts
  – Checking for correct part numbers
  – Verifying PO exists and detailing match packing slips
  – Providing proof of receipt to accounting to pay vendors

• Storage
  – Putting away parts
  – Rotating stock
  – Counting parts (physical inventory)

Functions of the Maintenance Store

• Maintenance Support:
  – Reserving (putting aside) parts for jobs
  – Building kits with parts, supplies and possibly tools for common jobs
  – Pulling parts for jobs off shelves and preparing them for transportation (pick-up)
  – Locate parts
  – Helping with research into infrequently used parts
  – Identifying unknown, broken parts
Stores Catalog

- Reference file or list of principal items carried

- A properly developed and maintained stores catalog is essential to achieve minimum cost levels

- The catalog’s value is enhanced if each item is clearly described and further qualified by such features as the maker’s reference number, equivalent items, bin number, unit of issue, unit cost, etc.

- Revisions should be made at fixed intervals (generally several times a year)

Methods for Ordering Spare Parts

- **Individual Orders**: Are for parts that are only ordered as they are needed

- **Permanent Stock Methods**: Permanent stock is material kept on hand continuously, and permanent stock methods restock automatically whenever designated quantities for such parts drop behind a certain inventory level.
  - Fixed-quantity order method
  - Fixed-period order method
  - Fixed-number order method
**Permanent Stock Methods**

- **Order-point method**: This fixed-quantity method is the most common method of ordering. Suitable for small spare parts with a fairly stable rate of consumption. A fixed quantity of stock is ordered when the inventory has dropped to a preset level (the reorder point $P$), with the aim of taking delivery when $m$ is reached.

Source: Productivity Press
Permanent Stock Methods

- **Double-bin method**: Also called the double-box or double-shelf method, the order point and the quantity are the same. Two containers, each holding the order quantity (the order point), are prepared for each part, and an order is issued when one container becomes empty. Suitable for bolts, nuts and other low-cost parts stocked in large quantities.

- **Package method**: Parts are kept in packages (paper, packages, boxes, or bundles) holding a quantity equivalent to the order point. An order is issued as soon as a new package is opened, using the order form attached to the package.

Administration is simplified since no record of parts issued is kept under either of these two methods. However, they do not permit a continuous check on the number of parts left in stock.

Permanent Stock Methods

- **Batch issue method**: The person requesting the parts receives a batch to store at the shop floor where they will be used. Another batch is requested when the parts are used up. Batches contain a standard number of parts. This is a suitable method for reducing the administrative costs of handling cheap, frequently used parts such as bolts and nuts.
Permanent Stock Methods

- **Fixed-quantity ordering method**: The maximum inventory quantity is set to as small a value as possible, and an order is issued each time a part is used. Thus, a fixed number of parts is always kept in stock. This method is suitable for expensive, infrequently required parts such as shafts or other high-priced metal parts.

![Diagram of fixed-quantity ordering method]

- **Fixed-interval ordering method**: The ordering interval is set to a fixed period such as once a year or once every six months. The amount to be ordered varies as necessary. This is used for parts whose frequency of use remains fairly constant, such as tools.

![Diagram of fixed-interval ordering method]
Methods based on Special Contracts with Suppliers

- **Partial-delivery method based on unit-price contract**: The unit price of the parts is determined from the average quantity used over the order period. A watch is kept on the stock level, and the parts are delivered in small batches. Used for parts with a fixed rate of consumption.

- **Deposit System**: The warehouse is in effect loaned to the supplier, who retains possession of the materials deposited in it. Only the materials used are paid for, which is an effective method for parts with a constant rate of consumption and specifications that rarely change.

- Because it is so convenient (deposit system), however, the inventory levels tend to increase and storage can become a problem. It is also difficult to switch to another supplier.

Characteristics for Selecting Permanent Stock

- Parts that must be available in the event of a breakdown unless backup machinery or equipment is available.

- Parts that must be purchased 3 or 4 times a year. (Those that must be purchased 2-3 times a year can be planned for and should not be treated as permanent stock.

- Parts that are likely to fail between maintenance periods. These should be treated as permanent stock in readiness for breakdowns.

- Replacement parts salvaged for emergency repairs, such as compressor cylinder valves.

- Parts with delivery times longer than the planned service intervals
Determining Stock Levels

- For purchasing purposes, maintenance stores fall into three broad categories:
  - Routine items
  - Spare parts and components
  - Complete machines or equipment

- Each category requires a separate consideration before deciding on the best policy to be adopted.

- Every item has to be separately studied before the most suitable maximum/minimum stock levels can be established in each case.

Factors to consider in determining stock levels

- Usage
- Delivery time
- Price
- Discounts
- Package units
- Impact of non-availability (criticality)
- Order processing cost
- Cost of owning or carrying
Establishing suitable order sizes and frequencies

- For daily control of permanent stock, two standards are needed: the order point (when to order) and the order quantity (how much to order).

- Using the same method to control all the permanent stock often leads to overstocking.

- Therefore, spare parts should be ordered in the following three ways depending on how the parts are consumed:
  - Fixed quantity
  - Fixed number
  - Salvaged parts

Fixed Quantity

- A fixed quantity is ordered when the order point is reached. The amount to order is based on the Economic Order Quantity (EOQ)

1. Calculation of Order Point:
   - Average consumption rate \(U\) = 60/month
   - Delivery time \(D\) = 1.5 months
   - Safety stock = 50
   - If order quantity \(E\) = 155, then
   - Order point \(P\) = \(U \times D + m = (60 \times 1.5) + 50 = 140\)
   - Average stock level = \(E/2 + m = 155/2 + 50 = 128\)
   - Maximum stock level + \(E + m = 155 + 50 = 205\)
   - Minimum stock level = 50

Stock level

- Average consumption rate \(U\)
- Order point \(P\)
- Order quantity \(E\)
- Safety stock \(m\)
- Delivery time \(D\)
- Time
Fixed Quantity

- **Economic Order Quantity (EOQ)**: An optimum balance between the carrying costs of storage and the ordering and handling charges.

2. Calculation of Order Quantity

Average consumption rate \((U) = 60/\text{month}\)

Unit purchase price \((P) = 25\)

Procurement costs \((C_p) = 25\) per unit

Carrying cost % per time period \((C_c) = 0.5\%\)

\[
EOQ = \sqrt{\frac{2 \times U \times C_p}{P \times C_c}} = \sqrt{\frac{2 \times 60 \times 25}{25 \times 0.005}}
\]

\(EOQ = 155\)

Procurement Costs vs. Carrying Costs

- **Procurement costs** are a set of costs which vary directly with the number of orders and inversely with the amount of investment.

- **Carrying costs** are a set of costs which vary directly with inventory investment and inversely with the number of orders.

- A decrease in one cost causes an increase in the other.

- Total inventory cost is at minimum when costs of procurement equals the carrying costs.
Costs of inventory

- Procurement or Order Processing Costs
  - Replenishment studies
  - Purchase action
  - Receiving stock
  - Inspecting stock when received
  - Paying for stock (accounts payable)
  - Expediting and follow up
  - Placing in inventory from receiving area
  - Restocking costs

- Carrying or Possession Costs
  - Interest on capital
  - Insurance on inventory
  - Inventory taxes
  - Obsolescence
  - Deterioration
  - Loss, theft damage
  - Inventory taking
  - Heat, light, refrigeration
  - Record keeping
  - Depreciation

Fixed Quantity

- Annual carrying charges from static capital, plus stores handling and overhead costs generally range between 25% - 35% of the cost of the item stocked and can readily be calculated.

- Order processing costs can easily be determined and are usually in the $5 - $10 range, per order.

- Empirical maximum-minimum method whereby reorder quantities and time between orders are determined on the basis of historical plant usage and vendor delivery times. Used for small low cost items which are consumed at regular rates (screws, packing rings, etc.)
Establishing suitable order sizes and frequencies

• **Fixed Number**: When parts are used, the number used is ordered immediately, thus keeping a fixed number on stock. Since this method results in frequent ordering, it is only suitable for expensive, infrequently used items.

• **Salvaged parts**: These parts are repaired, stored, and reused. If the item is expensive, try to increase the turnaround efficiency. Issues to discuss regarding salvaged parts:
  
  – How many parts, both new and salvaged, should be readily available?
  – At what inventory level (new parts = salvaged parts) should an order be issued?
  – What quantity should be ordered?

These are calculated by either the fixed-quantity or fixed number method.

Spare Equipment

• Particularly in large plants, potential savings lies in spare equipment.

• All reserve and duplicate equipment available in each production unit or cost center (including capitalized spares) should be examined and their frequencies established.

• Effort should be made to transfer spare equipment to the safe custody of maintenance stores (unless human safety or production emergencies demand instant readiness on site).

• A spare equipment analysis will ensure proper control of these high cost items and help reduce both production and standby charges.

• Stock turnover ratio of spare parts and equipment must be constantly checked.
Physical Check

- Advisable on critical and high cost items as a means of ascertaining the precise number in stock and to ensure that no corrosion, spoilage or tampering has taken place.

- Proper facilities include a good building suitably located within the plant, adequate bins, racks and other accessories.

- Staff that is physically and mentally suited for the job.

Who controls maintenance stores?

- In a survey conducted, only 50% of the organizations polled allowed maintenance any control over their inventory.

- This result is alarming, since maintenance is responsible for the repair materials budget.

- The minimum controls that maintenance should have over their own inventories are:
  - Item issue quantity
  - Return policy for unused materials
  - Storage of rebuilt items
  - Order points and quantities
  - What components to stock and where to stock them
Methods Used to Control and Reduce Inventory

- Review all stock periodically
  - To adjust order quantities and safety stocks
  - To locate obsolete items for removal

- Control new items ordered for stocking to make sure that only essential items are ordered.

- Order and receive replacement stock rapidly and accurately.

- Audit the operations of the storeroom with a physical inventory.

- Standardize supplies or suppliers.

- Get suppliers to carry back-up stocks

Methods Used to Control and Reduce Inventory

- Reduce spoilage

- Evaluate shop fabrication of spare parts versus buying from suppliers

- Standardize plant equipment

- Use automatic reordering from computer printouts

- Use blanket orders on high usage items

- Set a speedy, in-plant delivery system

- Reduce or eliminate obsolete parts

- Develop spare parts interchangeability list
**Features of a Good Maintenance Inventory System**

- Tracks balances for all items including issues, reserves, and returns
- Maintains parts listings for equipment
- Tracks repair cost and movement history
- Cross references spares to substitutes
- Has the ability to reserve items for jobs
- Has the ability to notify a requestor when items are received for a job

**Features of a Good Maintenance Inventory System**

- Has the ability to notify when the item reorder is needed and track the order to receipt
- Has the ability to track requisitions, purchase orders, and special order receipts
- Has the ability to produce performance reports such as inventory accuracy, turnover, and stock outs