ABS Group

Marine and Offshore Solutions

SPARES MANAGEMENT

OVERCOMING OVERSTOCKING IN THE MARINE AND OFFSHORE INDUSTRIES

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Abstract

This paper examines the causes and effects of inventory overstocking, how to determine if your inventory is overstocked and how to optimize and maintain adequate part levels.

Problem

The methods used to determine spare parts and stocking strategies in the marine and offshore industries are often less than scientific in their approach. Incorrect stocking strategies are commonly exacerbated by poor inventory lifecycle controls, which lead to gross overstocking. Identifying a methodology to optimize spare part stocking strategies utilizing engineering and data is critical to recognize significant cost savings. Implementing quality metrics and processes results in the continued refinement of these strategies to maximize savings while avoiding stock shortages.

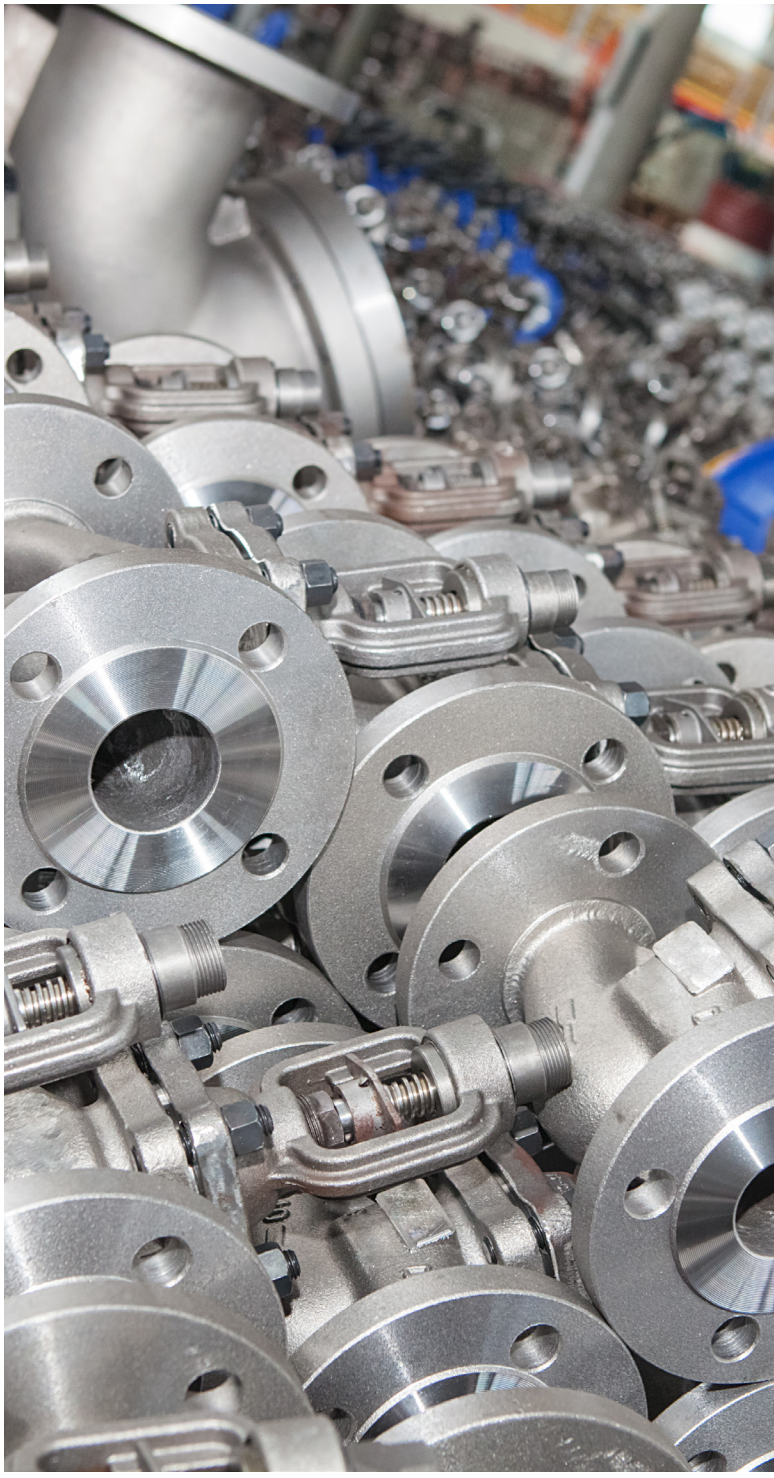
Many of us have either seen, performed or been the recipient of spare part selection as part of a newbuild project or when a new piece of equipment was purchased. Spares management is typically handled in one of several ways (or some combination thereof).

The "Turnkey"

The first option is to simply ask the shipyard or equipment supplier to provide spare parts included in the overall price. We all understand it. They are rolling the price of the initial spare parts loadout into the capital project. It also saves cost in manpower because no one from the organization must decide what parts to buy. But what parts are being supplied? Are they really the parts that will be needed? When do we reorder and how many do we reorder? Another problem that arises with this method is the parts are provided with no information, i.e. purchase price, which leads to difficulties in understanding inventory value and total cost of maintenance. It can take years, to recover from one of these implementations from a maintenance and reliability perspective.

The "Fixed Amount"

Here, instead of having the parts supplied by the shipyard or manufacturer, a budget is set and the person who is responsible for maintenance on the equipment is tasked with determining what spare parts can be purchased within the allowed budget.



Where did the magic number come from? Usually from similar projects or as a percentage of the total project price. This goes wrong in a couple of ways. They either start with equipment A, list all the Original Equipment Manufacturer (OEM) recommended spares and quantities, give it to the buyer to source and continue until they are suddenly out of money with half of the equipment still left to buy parts for. Or they apply their experience with similar equipment from the past leading to a better estimation, but not necessarily reflecting the needs of the current equipment.

The "We Can't Afford a Breakdown"

Under this scenario, the purchaser buys everything the OEM recommends and then doubles it. Then they also buy the parts they do not recommend. We can't have a breakdown, so we are going to have at least one of everything! Many of you have seen it, and you know it is not helpful. It may work out initially if the warehouse has the capacity and it is all labeled and stored properly, but inevitably the most common parts run out. Trying to reorder parts usually gets a response of, "You can't need more parts; we bought a ton!" Attempting to buy everything is one of the worst stocking strategies!

The "We'll Buy it When We Need it"

What can we say? This is clearly going to result in breakdowns and unplanned off-hire time. Upfront costs will be incredibly low; however, the costs of failures will be exponential!

Other Causes of Overstocking

Initial set-up of inventory can have a variety of issues, but what drives part overstocking over time? The first is the same thinking as "We Can't Afford a Breakdown" initial stocking. If it might fail, has failed or we think it might fail, then we better have at least two or three on the shelf. The first one will not work, and the second one will get damaged during installation! The second is simple obsolescence. Either the part has an expiration date, the manufacturer changed the part, or an entire piece of equipment was disposed of and all of the parts for it were left in the stock. The third way is one of my favorites: duplication. The same part exists multiple times in the computerized maintenance management system (CMMS) inventory and each one is stocked.

The Cost of Inventory

So, what do best practices from other industries tell us about the cost of inventory? First, the cost of holding an item in inventory is 15%[1] to 30%[2] of the cost of the item per year. These costs come from insurance, taxes, shrinkage, utilities, space and labor costs. The second impact comes from opportunity costs. Essentially, this is how much the company is gaining or losing based on the financial decision made. Opportunity cost is calculated by subtracting the percentage return on the option chosen from the percentage return that was not chosen. For the case of inventory, the return is 0% on excess inventory. For argument's sake, we will use the cost of capital (which can be considered the minimum return a company must earn on its money in order to satisfy debt and equity investors). According to the NYU Stern School of Business, the cost of capital for the marine industry as of August 2020 is 9.37%. For the offshore industry (Oil/Gas Production and Exploration), this number is 7.14%.[3] For simplicity's sake, we shall say that the total cost of holding parts above necessary levels is 22% (lowest holding cost of 15% plus the lowest cost of capital of 7%).

1 From "Making Common Sense Common Practice": Models for Operational Excellence Fourth Edition, by Ron Moore, 2013
2 From "Maintenance and Reliability Best Practices" Second Edition, by Ramesh Gulati, 2013
3 http://people.stern.nyu.edu/adamodar/New_Home_Page/datafile/wacc.htm

Inventory Turns

Having established how much our extra inventory costs us from a percentage perspective, how do we know the quantity of extra inventory we have in the first place? Let's look again to the manufacturing industry and adapt some of their findings to our industry. Manufacturing uses a key performance indicator known as inventory turns to help them understand their Maintenance, Repair and Overhaul (MRO) stock movement. This is a simple calculation which compares the dollar value of inventory issued over a year period against the average total value of inventory over that same period.

$$Inventory\ Turns = \frac{\text{Dollar value of MRO inventory issued over a one year period}}{\text{Average dollar value of all MRO inventory over the same period}}$$

In manufacturing, best in class facilities will see this number be between 2 and 3. This would mean that for every $100,000 in average inventory value for a year, the facility issued $200,000 to $300,000 worth of parts for MRO. I have performed this analysis with numerous clients in the marine and offshore industry and the average I have found is approximately 0.3. Yes, that is correct, three-tenths. Before we get too concerned about how far away that is from a 2 or 3, we need to consider the circumstances and adapt our goal. Manufacturing plants are obviously shore-based and fixed in place. This gives them a lot of advantages over us. Short delivery times and ease of access to required parts means that they can run much leaner than at sea. At this time, no studies have been conducted that demonstrate a best in class for inventory turns for the marine and offshore industries. As an initial goal, inventory turns of 1 should be an achievable, reasonable and value-added target.

Strategic Stocking Plan

The typical answer is to fix things when they break. Although this can't really be argued against, a better reason is to preserve the functions which allow us to perform the operations that make money in a safe, efficient and environmentally conscious manner. It may sound like the same thing, but it is really a matter of perspective and timing. Break/fix is like waiting to change your car's oil and oil filter until your engine overheats or seizes, but you have all the parts to rebuild your engine once it catastrophically fails. An optimized maintenance and spares strategy results in having an understanding that the oil and oil filter are critical to your engine running properly, which is a crucial function for your car's operation. You stock the necessary items to perform the required maintenance at the appropriate time. Simply put, in order to stock the right parts, you must understand how your equipment can fail, why it would happen and how you are going to prevent or mitigate the failure.

Strategically Stocking the Right Parts

Armed with this knowledge you can identify the bills of materials needed to perform preventive or planned corrective maintenance activities and their likely periodicity of replacement. Understanding how the equipment fails will also help you determine the

optimal maintenance strategy. This could be condition directed, life renewal, failure finding or run to failure. A review of the strategy and the criticality of the equipment to your business will determine whether the part should be stocked or not. If the part should be stocked, there are now three numbers you want to know as represented in Figure 1. At what point should I order more of the part? How many of them should I order? How much safety stock do I need?

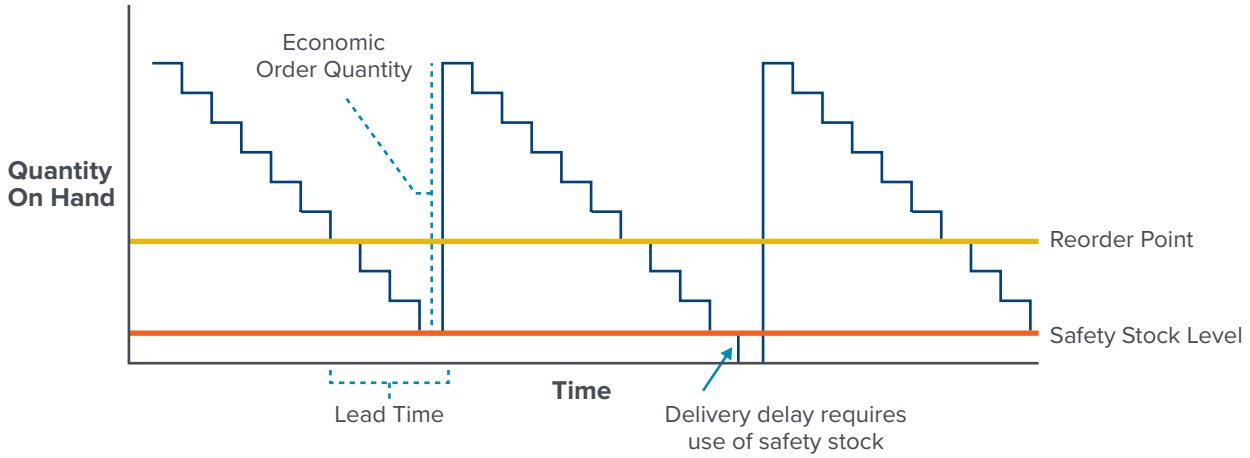


Figure 1 – Stocking Example

Figure 1 is an idealistic representation of how stocking works. Reality is rarely so orderly; however, it is much easier to convey the concept in these simple terms.

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TYPICAL INVENTORIES HAVE BEEN FOUND TO CONTAIN 40% MORE INVENTORY THAN REQUIRED WHICH IS MADE UP OF OBSOLETE, SURPLUS AND DUPLICATED PARTS.

How Many to Order

The easiest of these to address is "how many to order", commonly called **Economic Order Quantity**. The concept is to reduce the total cost of inventory by keeping carrying costs and ordering costs as low as possible as demonstrated in Figure 2 below:

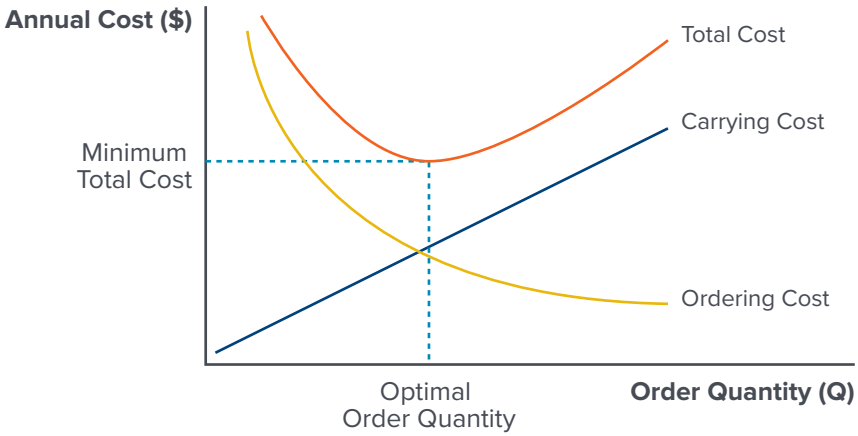

Figure 2 – Economic Order Quantity Visualization

Economic Order Quantity is determined using the following equation:

$$EOQ = \sqrt{\frac{2C_p r}{C_h}}$$

Where:

Cp – Average cost of ordering the part (administration, shipping costs, etc.)

r – The yearly demand for the item

Ch – The expected yearly cost of holding the item in inventory (22% of part value in our case)

When to Reorder

The point at which to initiate the purchase of more parts, the **Reorder Point**, is a little trickier. It involves the probability of having the part available when it is required. For MRO spares we recommend critical spares to have a 99% probability of being available and a 97% probability for all other stocked parts. Figure 3 demonstrates how the probability affects the reorder point. The equation for reorder point is:

$$P = \sum_{i=0}^{s} \frac{(n\lambda t)^i e^{-n\lambda t}}{i!}$$

Where:

P – Probability that the part will be available when required

n – The number of active components of a similar type (i.e. how many places is the specific part in use)

λ – Annual planned usage rate of the part

t – Procurement lead time in days

s – Reorder point

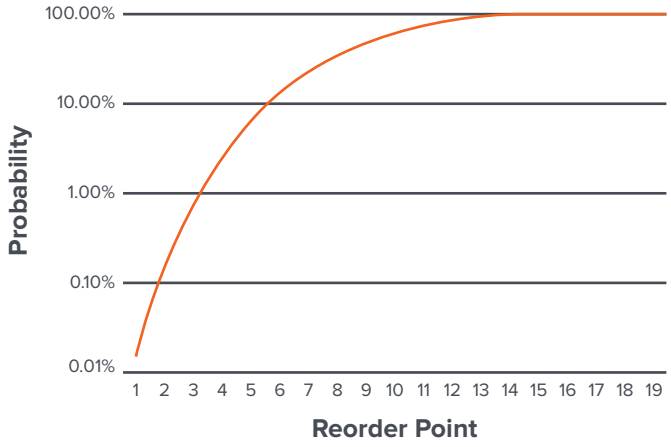

Figure 3 – Probability vs Reorder Point Curve

Safety Stock

The last number to figure out is the amount of **Safety Stock** to carry. This is purely about the management of uncertainty. The more uncertain you are about usage rates or lead times, the more likely you need more safety stock. It is very easy to use uncertainty as an excuse for carrying more inventory than required, so care must be taken to address this. One way to address this is to use the following equation with all values being in days:

$$Safety\ Stock = (max\ usage * max\ lead\ time) - (Avg\ usage * Avg\ lead\ time\ )$$

So, if your maximum annual usage is 15, maximum lead time is 2 months, average usage is 12 and average lead time is 1 month, then your safety stock would be 2.

Dealing with Other Causes of Overstocking

As previously noted, there are four main drivers beyond stocking strategy determination which result in overstock. The first, expiration dates, should be handled within the CMMS. Any MRO inventory which can carry an expiration date should be flagged as perishable and periodically verified. Changes in parts by the manufacturer

should be managed through bulletins issued by the manufacturer. As a back-up, buyers are alerted by the manufacturer when obsolete parts are ordered. This information needs to be captured and the system updated when it occurs as it generally indicates a failure in bulletin management. Parts being left in inventory should be addressed as a part of the management of change process. Parts connected to the equipment being disposed of should be checked to make sure they are not used in other operational equipment and then disposed of accordingly. Potential for duplication of parts in the CMMS is greatly reduced when part make and model numbers are entered and a gatekeeper manages the entry of parts into the system.

Using Reports to Drive Inventory Stocking

Once inventory turns are established as a KPI, this is a simple and easily visible way to gauge the state of your inventory. When inventory turns are not at the desired level, usage reports should be run to determine slow moving stock. Slow moving stock may indicate erroneous assumptions during the stocking strategy determination. Assumptions should be carefully reviewed before being changed. Updating the assumptions will then result in updated reorder points and economic order quantities which can now be updated in the CMMS.

POTENTIAL FOR DUPLICATION OF PARTS IN THE CMMS IS GREATLY REDUCED WHEN PART MAKE AND MODEL NUMBERS ARE ENTERED AND A GATEKEEPER MANAGES THE ENTRY OF PARTS INTO THE SYSTEM.

Optimization Cost Reduction Opportunity

So, what would improving our inventory turns to 1 give us? Working on an incremental inventory value of $100,000, and an inventory turns ratio of 0.3, we would need to reduce the value of inventory being held by $70,000. We now apply the 22% total cost of holding parts to this number and find that we can **save $15,400 per year** in holding costs per $100,000 of inventory carried. This can then be extrapolated to the actual value of your inventory to calculate your total savings. Another way to look at potential savings is shown in Figure 4 below. Typical inventories have been found to contain 40% more inventory than required which is made up of obsolete, surplus and duplicated parts. Identifying and eliminating these parts from inventory can result in significant savings.

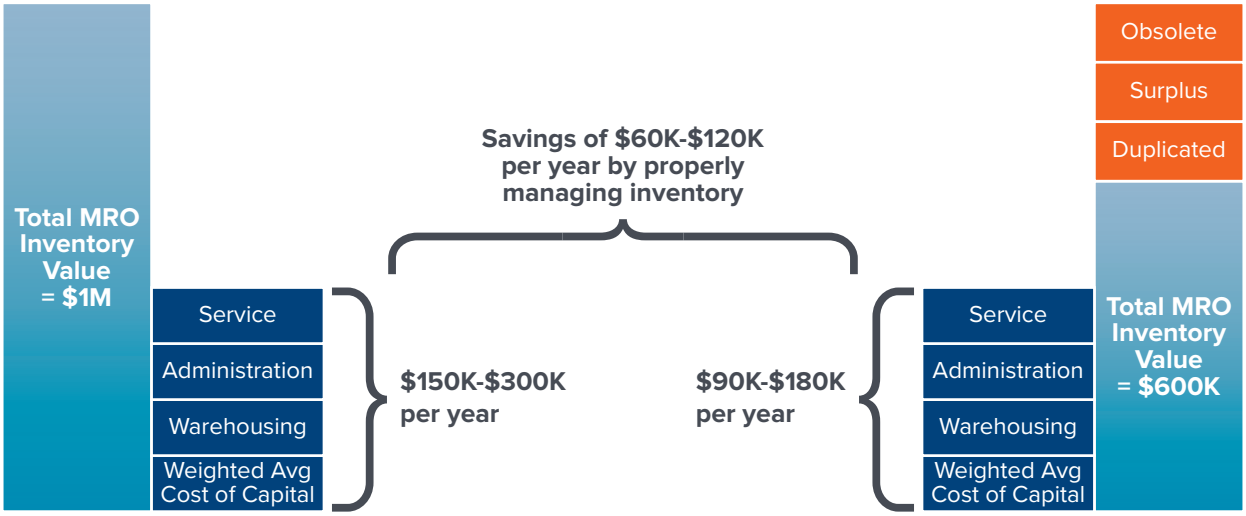

Figure 4 – Cost Savings from Inventory Optimization

Conclusion

There is clearly a tremendous opportunity for cost savings locked within our MRO inventories. The exact extent will vary based on the numerous factors identified within this paper and how your organization has managed them. Utilizing the information presented in combination with your organization's data, you can now develop a business case to demonstrate the return on investment possible through a project to optimize your inventory levels. Highlighting other benefits such as increased confidence of having the right part available when required and the resulting reduced off-hire time can also be helpful. I trust this paper has provided some valuable insights into MRO inventory management and helps spur you and your organization into a new realm for continuous improvement! At ABS Group, we are always here to assist you with your maintenance, reliability and inventory management needs as you progress through your journey to world-class performance levels.

Mark West, Director of Reliability, ABS Group

Mark West is the Director of Reliability at ABS Group. Prior to joining ABS Group, Mark held technical and leadership positions at Seadrill, Johnson Controls and Kaiser Aluminum.

As a veteran of the U.S. Navy and with over 20 years of experience in the oil and gas and manufacturing industries, Mark has a rich history of maintenance and reliability activities. Mark has a B.S. in Computer Information Systems and is a recognized Certified Reliability Leader, Certified Maintenance and Reliability Practitioner.

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