



Inspectioneering Journal

ASSET INTEGRITY INTELLIGENCE

FEATURED ARTICLE

A ROADMAP TO SPARE PARTS OPTIMIZATION

BRAD MOORE, *Senior Project Manager at Pinnacle Advanced Reliability Technologies*

VOLUME 21, ISSUE 5

SEPTEMBER | OCTOBER 2015

A ROADMAP TO SPARE PARTS OPTIMIZATION

BY: BRAD MOORE, Senior Project Manager at Pinnacle Advanced Reliability Technologies

INTRODUCTION

Operators in all industries are trying to increase equipment availability – the probability that an asset (or system) will be operational (either running or able to be run) at any given time. Yet oftentimes, critical process equipment is not available due to planned or unplanned maintenance. To increase equipment availability, steps must be taken to reduce downtime.

One way to reduce downtime in a refining or petrochemical facility is to ensure that spare parts are organized and available in the event repairs are needed. The activities included in spare parts optimization include the following:

- Identifying the potential challenges or roadblocks,
- Spare parts identification and association with the appropriate equipment,
- Determining the appropriate stocking decision methods (quantitative or qualitative), and
- Setting minimum stock quantities.

A standard calculation generally used by equipment operators or managers throughout the process industries is Mean Time to Repair (MTTR). The formula for MTTR is listed below.

$$\text{MTTR} = \frac{\text{TOTAL MAINTENANCE TIME}}{\text{NUMBER OF REPAIRS}}$$

One of the factors that can affect MTTR is the availability of spare parts needed to complete a maintenance activity. A top priority for facility management is keeping costs low while maintaining optimal uptime. However, accomplishing this goal can be challenging when equipment breaks down unexpectedly. Even the replacement of a minor part on a piece of equipment can turn into a major incident if the appropriate spare part is not readily available.

The intent of this article is to discuss various methods used to identify spare parts and recommend stocking quantities to help minimize the MTTR, while maintaining a focus on cost optimization of the inventory. We will consider the issue of incorporating spare parts for a new capital project into an existing inventory system. This scenario could be the installation of a new unit at a refinery or a new offshore production platform that shares a warehouse with several other platforms.

PROJECT CHALLENGES

Incorporating these new parts can uncover issues with current spare parts organization and management. It can also reveal inefficient processes leading to inaccessible and poorly identified spare parts inventory.

During a recent project, a facility faced several challenges, including the duplication of spare parts that were recommended for various equipment units, the inability to locate spare parts for new equipment in the existing inventory, and the inability to confirm whether multiple inventories of a similar part were actually the same part. These inefficiencies led to unnecessary delays and in the end, lost profits.

FOUR-STEP DEVELOPMENT

To reach their spare parts optimization goals and eliminate existing inefficiencies, a considerable amount of spare parts development work was required. The development work included four steps.

First, a process was developed to comprehensively identify all of the spare parts needed for each new piece of equipment included in the capital project. Second, an audit of the existing inventory system was performed to determine if the part was already in stock, and if not, a process was developed to incorporate the new parts into the existing inventory system. Third, a link between the equipment hierarchy and the spare parts inventory was developed. Finally, we re-evaluated the recommended stocking quantity for each part to ensure confidence the part would be available when needed in the future.

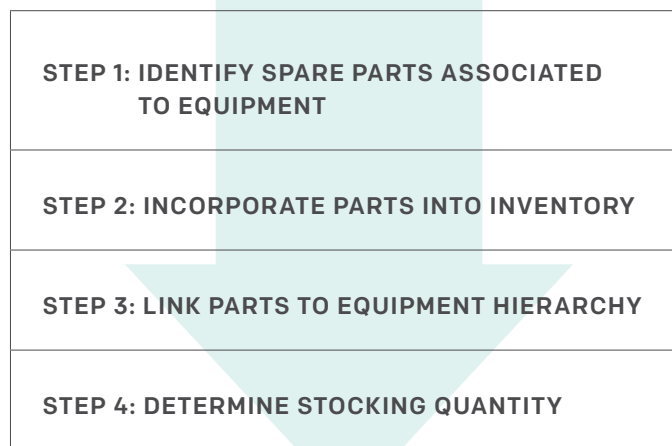


Figure 1. Spare part optimization process.

SPARE PARTS IDENTIFICATION

For new capital projects, the spare parts needed for new equipment are typically identified in the Equipment Installation, Operation, and Maintenance (IOM) manuals or in Illustrated Parts Lists (IPL) supplied by the equipment vendors. In most cases, the formats of the documentation in which the spare parts are presented are inconsistent from one vendor to the next. The first step in the spare parts optimization process was to gather all spare parts information into a common format so that the data could be manipulated as necessary during the development process. This was accomplished using a spreadsheet with the

following fields:

- Item description
- Manufacturer part number
- Vendor part number
- Manufacturer/vendor recommended stocking quantity
- Unit of measure
- Number of parts needed per repair
- Equipment that can use this part
- Item cost
- Item lead time
- Shelf life or preservation issues

Once the parts were identified, an initial stocking decision was required. The stocking decision was based on certain risk factors, and included asking: “Does this part even need to be stocked at all?” This initial “stock/no stock” decision can be made using one of two primary methods — quantitative or qualitative.

QUANTITATIVE VERSUS QUALITATIVE METHODS

The quantitative method drives the decision based primarily on financial impact. Alternatively, the qualitative method drives the decision based on safety, health and environmental considerations, as well as convenience.

The quantitative method compares the cost of keeping a part in stock against the financial impact that occurs if the part is not available when needed. Essentially, if the annualized cost of stocking the part is less than the annualized cost of not stocking the part, then the part should be kept in inventory.

Two major issues should be considered when evaluating the financial impact of stocking a part. The first is the actual cost of the part (net present value versus depreciation). The second is the holding-cost factor, which is typically 20 to 30 percent of the cost of the part per year. This is because keeping a part in stock can produce significant costs including available space, time (life-cycle of the part), and inventory management. Typical costs may include storage space, insurance, salaries, handling, and the loss, deterioration, or obsolescence of the part.

To calculate the cost impact if the part is not stocked, four issues should be considered. These are: the lead time to acquire the part, the lost-profit opportunity (such as production losses) due to equipment downtime waiting for the part, the expediting costs, and the annualized demand for the part (i.e., the equipment failure rate). Lost-profit opportunity can result from an off-specification product, a throughput rate reduction, or the continuation of a facility shutdown until the repairs can be completed. The duration of the lost opportunity event can be directly affected by a part's lead time before acquisition.

If the equipment that uses the part does not have a direct or quantifiable financial impact, the decision to stock a part will rely on the qualitative method. To qualitatively determine if a part should be stocked, the following issues should be considered:

- Does the equipment have an impact on facility safety, health, or environmental performance?

- Must the facility be shut down to allow for repairs to this equipment?
- Would the duration of equipment unavailability, comparable to the lead time of the part acquisition, be intolerable?
- Finally, should the part be stocked for convenience due to high demand?

If the answer to any of these questions is “yes,” then a facility manager may be justified in keeping a part in stock.

Sometimes it will not be justified to keep certain parts in stock using either the quantitative or qualitative evaluation methods. In many cases, these are parts with short lead times (e.g., one day for belts) or they are used by equipment that does not require a rapid repair due to the lack of significant consequences for the duration of the part lead time (e.g., pumps with an installed spare). Other parts might not be stocked due to the remote likelihood of component failure (e.g., pump case, electrical enclosure) or because an effective predictive maintenance program could detect incipient failures with enough time to procure the parts before equipment functional failure occurs. These non-stocked parts essentially have a stocking quantity of zero. The manager must decide if these non-stocked parts will still be managed in the inventory system, making them easy to locate when the parts actually need to be ordered.

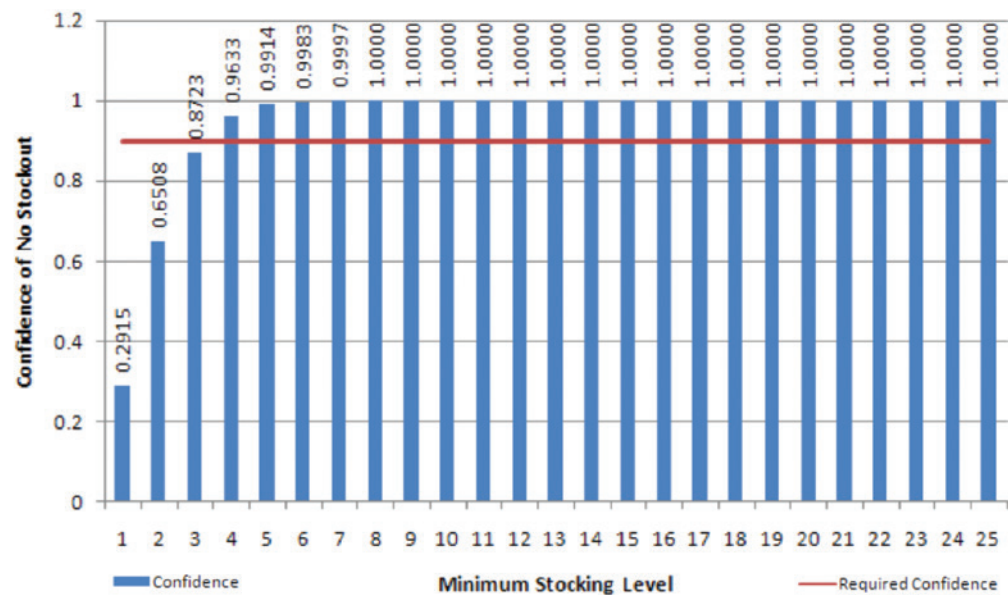
The input required to complete quantitative and qualitative analyses is typically gathered by performing a failure modes-and-effects and criticality analysis (FMECA) of the equipment. This analysis identifies the financial, safety, and environmental impacts that an equipment failure might induce. The resulting criticality of the equipment typically relates closely to the initial stock/no stock decision.

SPARE PART INVENTORY IDENTIFICATION

After the initial stock/no stock decision has been made for each part, the existing inventory system should be searched to determine if the part is already being held in stock. This review can reveal a number of issues with a facility's current inventory system. First, identical parts might be included in the inventory, but itemized under multiple inventory item numbers (i.e. duplication of the part in inventory). Second, item descriptions may not be standardized making it difficult to confirm whether a part in inventory matches the new part to be stocked. Third, the inventory might include obsolete parts and/or invalid or missing manufacturer/vendor part numbers. Finally, the system might contain incomplete information that is required to order the appropriate part.

A comprehensive inventory system data clean-up effort might be required to address these issues. Existing spare parts optimization must begin with this data-cleansing work. During this optimization, managers should identify different inventory item numbers that have the same manufacturer part number and update item description fields to keep a standard format for similar parts. Also, managers should conduct research to validate that the correct information is available to order the part. Additionally, managers

Figure 2. This graphic shows the increasing confidence that a part will be available when needed as the minimum stocking quantity increases. For this example, the confidence level threshold is set at 90 percent and the minimum stocking quantity would be set at four, since this is the number required for a confidence level of no stock-out greater than 90 percent.



might need to perform a physical inventory audit to ensure that the quantities of the parts are correct in the inventory system and to verify if different inventory item numbers are identical or are unique parts.

Some of the new parts for the capital project will already be included in the current inventory and will be identified during the review previously described. The other parts to be stocked that are not currently in the inventory system must be assigned a new inventory item number and properly documented.

At this point, all parts associated with the capital project should have an inventory item number. A link must be created between the equipment and the inventory item numbers for the equipment parts. This link can reside in the inventory system or in the Computerized Maintenance Management System (CMMS). This link creates a list of parts that are used by each piece of equipment, which is needed to identify the correct parts needed for planned or unanticipated repairs.

MINIMUM STOCK QUANTITIES

For each of the cost-justified parts, a minimum stocking quantity can be calculated. Assuming a normal distribution (random failure rate) of demand for this part, the data needed to complete the calculation includes the estimated lead time to receive parts once they are identified and ordered, and the number of parts required to complete the repair per demand. Typically, a single part is needed to complete the repair, but there are several scenarios in which many parts might be required for the repair (e.g., replacement of all filter elements in the housing).

Also, managers should determine the number of equipment units that can use this part (e.g., four identical pumps that use the same seal assembly) and the estimated MTBF (mean time between failures) for this equipment to calculate an overall annualized demand rate for the part. Some parts are needed for pre-planned maintenance activities and managers might need to account for this demand on the part in the minimum stocking quantity calculation.

Finally, the manager should determine the minimum acceptable probability that each part is available in stock when needed. This probability, or confidence level, is based on the equipment criticality and level of failure consequence. This confidence level is equal to 100 percent minus the percentage of stock-out the facility operator will accept for a demand on this part. For example, a confidence level of 98 percent indicates that up to a two percent stock-out rate for that part is acceptable. Common confidence levels are 98 percent for critical equipment and 80 percent for non-critical equipment.

All of these factors are used to determine the minimum stocking quantity for each part. This quantity is the number of parts that should be kept in inventory to reach the target confidence level. When inventory falls below the minimum stocking quantity, additional parts should be ordered to return the inventory quantity to the minimum stocking quantity or higher. While awaiting delivery of the parts, there might be additional demands for the part. Stock-out occurs when there is demand for a part that is not in stock before the ordered parts have arrived and have been incorporated into the inventory. The manager must set this probability of stock-out at a threshold acceptable to the company.

CONCLUSION

In all industrial organizations, including refineries and petrochemical plants, the optimization of spare parts activities, including the management of inventories, ordering processes and risk analyses, is always important. This process becomes even more critical during periods of economic stress. Facility and plant managers should review and optimize their current spare parts procedures and inventory documentation systems to ensure that plant turnarounds or unscheduled downtimes are not extended due to poor spare parts management. ■

For more information on this subject or the author, please email us at inquiries@inspectioneering.com.



BRAD MOORE

Brad Moore is a Senior Project Manager at Pinnacle Advanced Reliability Technologies, directing asset management implementation projects for Fortune 500 companies in the oil & gas, petrochemical, and power industries. These projects include the development of asset hierarchies, Reliability Centered Maintenance (RCM) studies, Proactive Maintenance (PM) programs, including Operator Driven Reliability (ODR) activities, pre-planned repair procedures, and spare parts optimization. Mr. Moore received his Bachelor of Mechanical Engineering from Georgia Institute of Technology, and over his career has held positions as a reliability engineer and project manager.

The Future of RELIABILITY

PinnacleART is your SME for comprehensive reliability
asset management and integrity services.



Engineering Services

- Audits, Analyses & Assessments
- Damage Mechanism Support
- Fitness for Service
- Integrity Operating Windows
- Program Evergreening
- Risk-Based Inspection
- Reliability Centered Maintenance
- Software Implementation – IDMS, RBI, CMMS, EAM
- Spare Parts Optimization



Inspection Services

- Inspection Drawings
- Inspection Planning
- On-Stream and Visual Inspections
- Positive Material Identification
- QA/QC Vendor Surveillance
- Tank Inspections – MFE Floor Scans
- Turnaround Inspections



Training

- API 571 & 580
- Program Maintenance
- Software – IDMS, RBI, CMMS, EAM