

## Topic Report Maintenance and Materials Management Programs

by  
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Recently, I reviewed the application of the Computerized Maintenance and Materials Management System (MMMS) and the process of obtaining spare parts and materials in support of operations and maintenance at a plant in its first year of operation. The conditions I observed were so common that I have rewritten my trip report in the form of a general topic report for distribution to our clients.

Clearly, this Plant Manager was concerned about these areas, as demonstrated by his request for my review. My own observation supported that concern. The management and administrative processes by which replacement parts were being acquired for routine maintenance was, indeed, dysfunctional. The MMMS program, in its then-present state of implementation, was not being used to provide a fraction of its capabilities. In each case, however, relatively minor corrections should result in substantial improvement. Throughout my review, I saw nothing I had not seen before, many times, in different plants using several different maintenance management software packages.

Before reading the remainder of the report, remember that this plant was in its first few months of commercial operation. Just a few months ago, the O&M Team was caught up in one of the most common and disempowering circumstances possible, that of being involved in a plant startup over which they had little control. During that period of near helplessness, nearly all management teams find it difficult to function as problem-solving, forward thinking leadership groups. Because of this, and because few plant management teams include persons with a broad administrative background, effective control systems are unlikely to be

implemented when they should be, before they're really needed.

### Perspectives:

**MMMS-** These are any of a number of common relational databases programs to combine maintenance work order, machinery history and spare parts inventory. They are analogous to having an electronic file cabinet in which all of the maintenance records are kept and cross-tabbed. They are generally written in a version of d-Base, Paradox, FoxPro or similar database programs. Since they are "compiled" into machine code, it is difficult for anyone but the software supplier to customize it, and that is expensive. It should be noted that **the people at the software supplier probably know next to nothing at all about power plants** or the equipment in them. The features that come "out of the box" will do what is needed, but satisfactory results in the application of the MMMS depends almost entirely upon having one person, that knows the program very well, taking "ownership" to maintain data integrity and train others in its use.

**The most important part of initial setup of these programs is entering the Master Equipment List and the parts associated with each piece of equipment** on it, in a consistent and accurate manner. Learning the "bells and whistles" of the program is of little value unless the plant specific data is properly entered. I know of **no successful implementation of this or any other similar software by people unable or unwilling to learn the underlying database program** and to **develop a clear and cogent vision of how the data should fit together** to support a cohesive maintenance and materials management information system to

accomplish these important functions:

**Parts Cross Reference-** Probably the most valuable capability of these programs is that of relating part numbers to the Master Equipment List. The program, when properly implemented, list the nomenclature, part numbers and quantities on hand for the parts associated with that particular equipment. When someone is looking for a part, they don't start with a part number, they start with the equipment that needs it. At a bare minimum, **each part purchased for inventory before it is actually needed for use must be entered and associated with the equipment it fits.** In the best MMMS implementations, each part listed in the manufacturer's manuals is listed and associated at the time of the initial data load, even if the intended stocking level is zero. Subsequently, if parts are only issued against a work order, and the work orders are properly closed, this association of parts to equipment will take place automatically. At some time, usually a year or so into commercial operation, a manual search for duplicate parts should be undertaken, as part of an inventory optimization plan. Several categories, such as bearings and electric motors, often have common parts of the same generic specification, even though they may have different manufacturer's part numbers.

**Equipment Maintenance History-**Every work order issued should be related to a specific piece of equipment. **If every part is issued to a work order and every work order is properly closed out, these programs will keep an excellent record** of what has gone wrong with each piece of equipment on the Master Equipment List, what parts were used, what they cost and how much labor was used for repairs and for preventive maintenance. This data is, of course, invaluable in justifying plant improvement projects as problem equipment is identified. It is also just good management to have objective information upon which to make budget decisions and to adjust maintenance and operating practices.

**Corrective Work Order Management-**With a properly implemented program in a plant such as this, hard copies of work orders are unnecessary. Corrective work orders can be opened and prioritized by the person noticing the requirement, usually an Operator, at a terminal in the Control Room. Everything else that has to be done to approve, prioritize, review parts availability, define status, report the work accomplished and close the work order can be done at terminals either in the maintenance shops or supervisor's offices. This is not rocket science, "duo digit" typists can accomplish everything needed. It is done every day in just this manner in power plants and other facilities of similar complexity. It does, however, take training, commitment and consistent high expectations of people to attain the full use of these programs. One good program administrator, careful application of the levels of security and clear assignment of responsibilities for following up of each type of work order status code are imperative.

should be reconciled with what is actually on hand.

**Preventive Maintenance-**The recommended preventive maintenance actions from the manufacturer's manuals and their frequencies should be reviewed and entered as recurrent work orders at the time of the initial data load. Commonly, the manufacturers will specify actions or frequencies that are not cost-effective. This necessitates **some judgement on the part of the person setting up the PM program.** It is also necessary to review PM actions monthly, for the first year, adding those that experience dictates and reducing the frequency of those which result in no corrective adjustments and are simply cluttering up the system with meaningless work orders.

**Spare Parts Valuation-** Properly implemented, the program will provide a real-time **valuation of spare parts in inventory and of the commitments made in outstanding purchase orders.** These are important values for project accounting purposes. Once yearly, the inventory

**Parts Procurement**-In general, I've found that there are three broad processes which drive the purchase of replacement parts at power projects. Each of them is handled somewhat differently if management efficiency and effective cost management are to be attained:

**"Insurance Spares"**- These usually include items from the manufacturer's recommended spare parts lists which have long lead times and potentially serious impact on plant operations if they are not available. The important characteristic of these parts is that they are generally chosen because of the consequences of not having them, rather than because they are likely to be needed. Most are purchased in the hope that they won't be used before the first major overhaul of the equipment, if at all. Because long lead times are uncommon in high turnover parts, this category **rarely includes many items of use in normal maintenance.** Owners and operators alike are frequently dismayed to find that they have spent millions in parts only to find that the inventory on hand is **nearly irrelevant to day to day operation.**

These parts are normally purchased from construction funds directly from the major equipment suppliers, usually well before the plant goes into operation. The value of these parts is high, necessitating some sort of relative value and consequence analysis to balance capital cost against the project risk management philosophy. Because there is little immediacy, the value is high, and the project capital structure and risk philosophy is involved, the approval process for these purchases usually includes a great deal of involvement and discussion with the Owners. Frequently, the **precedents set** during the procurement approval of these parts **adversely affects the more immediate and financially less significant process of purchasing parts for routine use.**

**Immediate-Use Replacement Parts**-These are parts, **not in inventory**, that are purchased in

response to an emergent maintenance requirement. If the "Insurance Spares" have been well selected, there should be few critical items with long lead time in this category. It is likely, however, that there will initially be a large number of "crisis items" that require emergency purchasing and heavy expediting. In the first few months after startup, it is normal for nearly all of the replacement parts to fit into this category. If minimum inventory carrying costs are important, it is actually better to start with little or no stock until a need is actually demonstrated. This means that **the first purchase of nearly all parts should be for immediate use.**

Practically, **purchase approval for most of these parts is irrelevant**, since there is **little choice but to buy them.** More often than not, speed is more important than price. Good business practices regarding the selection of vendors, terms of purchase, formality of communication and effective administrative followup should be part of the procurement procedures which dictate the process. Once these are properly in place, Owner and Management **approval can be limited to an after-the-fact review to see that the procedures are appropriate and properly followed.** Normally, this takes place at the time of approval for payment of the invoice.

Conventionally, the purchase of these parts is an integral part of the maintenance planning process. Since **proper planning of the work involves determining the parts that will be needed**, the person performing this function should be able to properly identify the source, nomenclature and part numbers necessary for purchasing any not in stock. For the first few months, when a large number of parts is purchased for immediate use, this process will require the involvement of everyone performing or directing maintenance. Later, when most of the commonly used parts come from inventory, **I would expect one person to be able to keep**

**up with the maintenance planning activities in most independent power plants.** This person might be a dedicated Maintenance Planner, more often it is a maintenance supervisor or someone with overall responsibility for the MMMS. To be effective, this person must be very well acquainted with the plant equipment. **The use of "buyers" or warehouse personnel, who have little knowledge of the equipment to buy parts the first time, is generally counterproductive.**

**Inventory Stock Parts**-Each time a part not in stock is purchased, a deliberate decision should be made to determine whether or not to purchase additional quantities for inventory. If the first, or subsequent, use reveals the need to keep the parts on hand, **a separate requisition should be processed to place one or more in inventory.** This requisition should be prepared and justified by analysis of consequences of delay, expediting costs, expected frequency of use and un-expedited lead times, for unhurried consideration in the same manner as the "Insurance Spares". Part of the equation determining the advisability of including a part in inventory should be the significant, but intangible, consequences of creating unnecessary inefficiency internal to the plant organization as a result of not having the part available. **It often takes 3 or 4 phone calls to special order a part but it only takes a moment to fax in a routine reorder,** if there is a price change the vendor will call you. In addition, a work order held up for parts takes several times more coordination and administrative "loop closing" than one that can be opened and immediately released to the "Do" list.

Since inventory carrying costs can be substantial, I would expect the **Owner's Representative to take an active role** in considering and approving maximum and reorder points for inventory stock parts. **Reordering at previously approved stockout**

**points, however, should require no advance approval** for purchase. Rather, the review of stock parts replacement expenses should be part of the general budget review process, with this segment justified by the Maintenance Manager.

I generally suggest an annual review of parts turnover, a month or so before the overall budget review, so that the results of that review can be incorporated in the annual budget. **The parts turnover review should be a formal process** in which high turnover parts are considered indicators of a problem potentially requiring a change in plant equipment, operating procedures or maintenance practices. Other parts, with low turnover or very short lead times, may be candidates for reducing stocking levels or making arrangements for vendors to stock them with assurances of quick delivery.

**Purchase of inventory stock parts is effectively accomplished by administrative or warehouse personnel.** In the approach I've outlined, the source, nomenclature, specifications and part numbers will have been determined during their first purchase for immediate use. That information, along with any more data, should have been entered into Mainsaver at the time the original purchase order and receiving report were entered. By input of the approved max and reorder point, the MMMS will automatically generate a purchase order. **These should be subjected to a very short approval process, if any, then faxed directly to the approved vendors from the warehouse.**

Throughout the above discussion, I have been describing the procurement process for replacement parts for permanent plant equipment. In particular, the items described above all have individual part numbers that can be related directly to one or more specific items on the MMMS Master Equipment List. In addition, there are a number of other types of materials which are purchased routinely in

plants of this nature:

**Bin Stock**-These materials are such items as nuts, bolts, flexitallic gaskets, boiler chemicals, laboratory reagents etc. They are not usually specific to any particular piece of plant equipment and their use is not charged to a specific work order, unless on a distributed basis. These are usually restocked by a vendor that periodically comes around to restock bins that he has provided, or by the end user, such as the plant chemist phoning in the order. Occasionally, the vendor actually owns the original stock and only charges for replacing quantities used. These are **generally bought under a "blanket" purchase order approved as part of the annual budget.** Individual receiving reports are filled out at the time of restocking to reflect the quantities actually used and replaced.

Management control takes place at the time of approval of the requests for payment of past deliveries. Periodically, it is necessary to review and focus attention on controlling the cost of bin stock, since its ready availability and simple replenishment process encourages casual use. Even so, the convenience of bin stock promotes enough efficiency to counter this negative aspect.

Practically, **bin stock is most effective if it is maintained in the shop in which it will be used** most often, rather than in the warehouse.

**Consumables**-These include such items as office supplies, gloves, earplugs, hard hats, electrician's tape, flashlights, batteries, coffee supplies etc. They generally are assigned stock numbers and are issued to individuals or shops in "box lots". These are usually set up for automatic reorder, just like a replacement part. Sometimes these are bought under a "blanket" order issued to a local wholesale house. Cost can be controlled by reviewing the quantities issued to whom. **Controlling cost by individually processing purchase orders adds**

**an enormous administrative workload that is counterproductive.**

**"One-Off" Materials**-Initially, there will be a large number of one-time purchases of materials, not related to permanent plant equipment such as tools, office machines, analytical equipment, personal preference items, etc. These items should be justified and approved as part of the overall budgeting process, by department. Some plants have an "authorized buyer" in each department and in the office to make these purchases directly, with the warehouse involved only in receiving the materials and notifying the buyer of its arrival. In these cases the purchase order is never entered into MMMS.

#### **Frequent Observations:**

In many plants, the process by which parts are purchased is inordinately complicated, has too many people involved and too few responsible for attaining the imperative result of getting parts ordered and on the way to the plant in a timely manner. I've counted as many as 10 steps, including three levels of approval, in the process of ordering parts for emergent work on plant equipment. Frequently, no one person knows all of the steps that have evolved into the process.

In some plants, nonproductive positions grow out of the confusion. In one plant, that had a Maintenance Planner, I was unable to discern any value being added to the procurement, MMMS implementation, or to maintenance work by that person. In about an hour, this person described what he did with his day. In general, it consisted of passing work orders back and forth. Little of what was said relieved the warehouse person of any of the crushing load of buying parts, or of researching technical data to make the craftpersons work go better or

improving the data in the MMMS. I was left with the impression that the **vector sum of his activities is somewhat less than zero.** In other

words, if he stopped doing all that he said he was actually doing, I believe the process would have been marginally improved.

Most plants process between **200 and 300 purchase orders per month**. This level of activity is about what I would expect to see continue for the life of the plant. Essentially every one of these, in many plants, is a special order with virtually none of this activity in the form of programmed reorders for stock replenishment. Each of these special orders takes at least a half-hour to look up, call for quotes and delivery, initiate the purchase order, obtain approval and place the order. **If the warehouse person does it all, he will have no time in an eight hour day to get anything else done**. Clearly, this person will fail if he must do all of the purchasing of immediate use parts, or even if he must process all of the purchase orders for them.

There is **often no routine process in place to review special order parts for incorporation into inventory as automatically reordered stock**. Without this, the current state of falling ever farther behind in supporting maintenance with parts will continue. Parts are consistently issued, not to work orders, but to individual employees. **This practice effectively renders all of the MMMS's Machinery History and parts cross-referencing functions useless**.

There is often a computer network upon which the MMMS runs, but it frequently does not include the control room, where most work orders will originate, nor the shops where they will be closed. **This forces a "hard copy" system and eliminates much of the value of the program as a work order management program**.

The initial loading of the Master Equipment List is often the place where the ultimate failure of the system is established. This is an intensive process, generally best accomplished by creating the database outside the MMMS, in a spreadsheet, then loading it in a single batch. The interfaces of most MMMS programs are well suited to making one entry at a time but are

too slow and provide too much of a "tunnel vision" view to set up the database originally. Whether done manually by the plant staff or by simply loading the EPC contractor's tag number database electronically, the important thing is to do the editing early in plant life. It is much more difficult to accomplish after there is history attached to the MEL data.

## **Recommendations**

**Raise the Expectations of Performance-** At every level of my reviews, I hear how inefficient processes have been created to counter the expectations that someone wouldn't enter data correctly, wouldn't make a good decision, wouldn't know how to do something right or some such similar potential transgression. I've learned that people measure up to what is expected of them. If the expectation is that they are not going to be competent to work effectively, or that they can't be trusted to make good decisions, they'll certainly measure up! Conversely, if standards of performance are set high and if management makes a determined commitment to remove obstacles to meeting the standards, people have usually met or exceeded my highest expectations. Those that can not, or will not, should be candidates for applying their talents elsewhere.

Setting high expectations applies to the management team even more than to the troops. These few are expected to not only set high standards, but to remove any obstacles to attaining them. In my plant visits, I usually meet several "articulate historians" that tell me of the events and decisions that led up to the current state of affairs. I heard how the Master Equipment List was downloaded by others, how the "Data Entry Person" was redeployed by others, how the spare parts funds were limited and further reduced by the contractor's markup, how the plant isn't really accepted yet, how there really isn't an operating budget yet... the

list goes on. What I rarely hear is very many people saying "it's my problem, here's what I'm going to do next to solve it". If you think about it, failure isn't an option. Yet, I hear people wherever I go tell me why they are failing and why it isn't their fault.

**Flow Chart the Process-**In situations like this, I commonly find that many of the complexities of the process such as this are easier to address if the management team will get together and diagram the steps and decisions involved. It becomes much easier to see the "loop backs" and stumbling blocks in the system when you draw out the steps involved. I advocate that the Owner's Representative, Plant Manager, and each of the Department Managers get in one room with a blackboard and have a Shift Operator, Maintenance Journeyman, the Maintenance Planner and Warehouseman describe, while someone draws, the various steps involved in the life of a corrective work order. Then do the same thing, with the process of special order part. Be careful not to let the atmosphere be judgmental of people, just describe steps that are now being done. Once the current practices are clear, it will be best to dismiss all but the Owner's Representative, Plant Manager and Department Managers to see what you can agree to do to simplify the processes. First of all, I think you'll be surprised at the complexity and inefficiency of the process that has evolved. Second, I predict that you'll be able to cut out about half of the steps in both processes if you'll look at them with the intent of achieving efficiency.

**Eliminate Work Order "Approvals"-** No approval of a work order is really required, if people are trained to initiate one, not by requesting a particular action, but by giving a factual description of a problem. This subtle change in emphasis means that all work orders are legitimate, since even one in which the problem described is invalid, is evidence of something that needs fixed, if only by training

of the writer. Obviously, some work orders are written that are really requests for plant modifications. When this occurs, I've found it effective for the Supervisor, instead of "disapproving", to change the corrective action requested back to the writer, for his or her own action to submit a plant modification request to the Plant Engineer. When the person has done that, they should close their own work order with the corrective action they themselves have taken.

Immediate and constructive feedback sessions when someone fills in a form improperly, orders the wrong part or is imprecise in writing requisitions or work orders will, over time, establish the right expectations and solve a problem much more effectively, and permanently, than adding another approval process or inserting some stridebreaking check step into the process that never goes away, even if the problem does.

**Simplify Procurement Approvals-**Set up management consensus procedures such that forward motion doesn't depend on signatures above a department manager. The notion that the Warehouse Person or Maintenance Planner should be **walking parts requisitions and purchase orders through a labyrinthine and hierarchical approval process, in a management group that consistently demonstrates that they don't trust one another's judgement**, is a bankrupt approach to leadership. Managers should be constrained by procedural limits defining whose verbal approval they must get before they affix their signature, but any Department Manager's signature should be all that is required.

**Managers should demand high quality documents, before they sign.** I hear a lot about requisitions that take hours of work to decipher the nomenclature and parts data to convert it into something that could be purchased. Professionalism is an attitude issue that starts at

the management level. If you'll sign anything, that's what you'll get. Worse, when the same document, included in the package of information that justifies payment, reveals that what was done was done unprofessionally, or wasn't what was agreed to in the conversations that enabled it, the fabric of trust necessary for supportive and cohesive management is jeopardized.

Repair parts for out of service equipment need supervisory or management involvement and communication of the action to be taken to get the equipment back in service. This should be the context in which the conversations take place. Budgets should be approved, then the departments should be answerable to their performance to them. Inventory stocking levels should be approved and reordering should be automatic. In none of these cases should a multi-level advance approval sequence be required.

**Keep the Priorities Straight-** Frequently, the controlling stricture for acquisition of parts to keep the plant running is the Warehouse Person. It shouldn't be that way, but it is. I've watched them spend an hour making phone calls and getting a check for the exact amount to buy coffee at Price Club or Sam's. Laudable as it may be to save a few dollars on coffee by buying it at a discount, it is a sad commentary on this management team that this is representative of the priorities to which the plant is subjected at this point.

**Complete the Network-**MMMS terminals in the control room and each of the maintenance shops will make it possible for many work orders to be opened by the operators and closed by the shops with no one else involved. I advocate that the **Maintenance Planner, if there is one, be taken completely out of the loop for any work order for which parts are available and which can be accomplished by one craft.** It should be the Craftsmen or

Foreman in the shops that refer a work order for planning, when it does not meet those criteria or requires an outage or vendor support.



**Designate a Maintenance Planner** -This person should be the System Administrator for the MMMS, Plan Outages and Purchase most parts and vendor services for immediate use. Initially, parts procurement might overwhelm this person, necessitating support by a temporary clerk to assist in MMMS Data entry and with purchasing records. Whomever is assigned this critical job must be computer competent, know plant equipment well enough to be effective in ordering parts and, most of all, be responsible enough to take the effectiveness of the maintenance management program as his personal challenge.

**Issue Parts Only Against Work Orders**-It's not clear to me why the practice of issuing parts to individuals or shops instead of work orders gets started, but it often does. I suspect that it has something to do with having too many steps before the warehouse issues the work order number. By the time that bit of irrationality has been accomplished, somebody useful has probably already gone to the warehouse, gotten the part needed and finished the work. Whatever the reason, it should stop. Until it does MMMS is going to be an expensive embarrassment.

**Properly Close Out Work Orders**-Once again, the practice of not closing work orders is one that gets started for reasons obscure to me. Unfortunately, parts inventory drawdown and automatic cross referencing in most MMMS only take place when work orders are closed. By not doing it, these useful features of the program are defeated.

**Assign a Part Number to all Parts**

**Purchased**- Even if a part is purchased for immediate use and is not expected to be placed into inventory, it should be entered as a stock item and issued against a work order. Its nomenclature, part numbers, the equipment it fits, the source of supply, price and all the information necessary to reorder will then be

available, even if the stocking level is zero. In addition, its use will be automatically entered into the equipment history when the work order is closed.

**Bring Back Unused Parts**-The reason the MMMS doesn't change the inventory records or enter parts consumption into equipment history records until the work order is closed is to allow the return of unused parts. Keeping parts that are drawn from the warehouse, but unused, is tantamount to throwing them away. It's only a matter of time until they're gathering dust in some obscure corner of the plant and forgotten. When they're needed again, it's altogether too likely that another will be purchased unnecessarily.

That's not the course of action I recommend, however. This work does not lend itself to delegation to data entry personnel, it takes a Maintenance Engineer with enough commitment and patience to dig through the data. The work is not keystroke limited, although it might be effective for a technical person to fill in entry forms and a clerk to actually enter them. Practically, **it's much more important that this data load be done well than it is that it be done quickly.**

**Complete the MMMS Data Load**- It's not by accident that this is the last of my recommendations. **The problems I see as critical are not the result of lack of data, but of ineffective system management.** Practically, if the Master Equipment List is entered well, and all parts purchased are entered into the program and only issued against work orders, which were then properly closed, most MMMS databases will effectively generate themselves.