Establishing Integrated Maintenance System in Stone Industries.

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For years, industrial and other organizations concentrated most of their attention upon product production, generally ignoring the maintenance function, viewing it as a necessary evil. Till now Stone industries maintenance is simply considered as corrective exercise when something shuts done then electrician or fitter or mechanic is called for the problem being fixed up and forgotten again to device and invite more trouble .

However with the corporate culture being adopted by the stones processing industries there has been a gradual attitude change in how general corporate managers view the maintenance function. Today one of the most important factors forcing this change is the realization that maintenance departments have become major cost centers . Today with general operating costs rising at the rate of 10% +/- each year, there is the potential for the realization of significant savings in the maintenance department that deserves serious scrutiny. By implementing certain of the advanced management practices outlined here savings can be very significant.

By integrating the listed programs the Maintenance function , will produce dividends in the immediate, as well as for the long term value enhancement. Through the application of Good Management Practices (GMaP), and with the use of sound technical expertise, cost reductions in the range of 20% to 35% are within the realm of possibility.

There are thirteen basic facets to Best Practices in Maintenance for the stone industries as they will have an impact on the organization when integrated, they are:

1. Philosophical and Theoretical Shifts.
To achieve Best Practices, within the maintenance and production organizations, there must be both a technological and an organizational philosophical shift in the way that departments/ functions conduct their daily business. Unless both the technical and organizational shifts occur at the same time, the cycle of change can not be sustained. The organization will slip back to its old ways, failing to achieve these Best Practices in Maintenance.

2. Understanding Change.
Most people fear changes therefore are resistant to it. It is important that everyone realize the importance of making the necessary changes. Only those willing to make the changes necessary can expect to achieve real success. As the stone industry today are becoming a World Class Organization and competing with other sectors, they must be willing to develop within themselves a highly disciplined and committed plan of action. Once the

plan of action is developed, it must be reviewed and agreed upon by the top management. When approval has been received, maintenance and production function in charge must move boldly and swiftly to make the changes as necessary and implement the plan as rapidly as possible.

3. Teamwork.

All plant operation and support personnel need to be informed of the plan and its affect upon each individual in a timely fashion. They need to participate in the re-engineering processes so they can gain ownership. Personnel who understand and agree with a process are more willing to cooperate with it, and will be less likely to create difficulties later on. Teamwork throughout the organization realignment process is critical to achieve success.

4. Training.

A specific training program must be developed covering all aspects of the proposed changes being made. Training sessions and progress meetings will be necessary to introduce the new ideas. Basic methods must be presented so that personnel will understand them. Training sessions should be limited to one hour each day and cover all aspects of the new plan. Workshops can be used to focus on the current and day-to-day problems as they arise.

Use practical training methods to assist in the development of solutions as problems arise. Training must be ongoing until the newly established standards are fully established, so that they can be maintained.

Plant personnel need to be trained in Problem Solving Skills using a formal methodology. People need this type of training so they can learn how to constructively analyze information. Using a single common approach methodology, everyone involved will bring a common approach or perspective to how they will access performance problems and develop recommendations. Anytime problems arise and the indicators' trend in a negative direction, the company as a whole can pull together quickly using the multilevel, cross-functional team that is equipped to analyze the opportunity.

Once trained in problem-solving methodology, groups may need the support of a qualified facilitator. An individual within the organization (generally a Personnel Trainer) needs to be assigned to receive specialized training to meet those needs. Having a facilitator present is beneficial while the groups are small and new to the process. As time passes, they will naturally be able to work more and more without the aid of the facilitator. The facilitator should be able to provide support in the development of positive group dynamics by honing those skills they learn.

5. Asset Management.

Realign the plant into major plant equipment configurations or asset centers. An asset center can be a group of similar equipment designed to produce a single product, or group of similar process machines like gang saw cutter, polishing machines. Each of the newly established asset centers will constitute the newly devised individual cost centers.

By associating all costs, equipment, personnel and material associated to the operation of the group costs can be assigned. Once established, each cost center must be tracked and monitored for the important trending factors to provide management personnel with accurate and viable information as to where money is being spent.

Establish a unique but specific center identity classification for each asset center. In this manner total operation and maintenance costs, with relevant work orders and their associated costs are charged to the specific cost center. Equipment descriptions, personnel assigned and other specific identification systems are then standardized to facilitate easy data retrieval. With a sound and effective asset management plan, the computerized maintenance tracking system will function at its full potential.

6. Warehouse/Inventory Control.

The re-organization of the warehouse function is one of the more critical function changes. Most existing store rooms are improperly stocked, because the nature of maintenance personnel is to hoard critical individual parts and supplies until it is necessary to overhaul the entire system. It is essential that the parts on hand be adequate to meet the needs of all work in progress and emergencies, so that each maintenance function be fully served: not too many, not too few.

The warehouse must be audited and inventoried in its entirety including the hoarded parts and supplies. Parts and supplies must be tagged and be easily located within the store-room. Once tagged and placed into the store room, the part must be entered into an automated control system by identification number, location and cost center(s) that use the part. Parts and equipment must be cross-referenced by application to multiple cost centers. This will allow maintenance personnel to locate any specific item and/or part each time they make a search.

Create an equipment history analysis, identify dormant or excess stock items. Once identified, excesses are tagged for salvage or scrap keeping your inventory viable. The creation of optimum warehouse inventory levels is essential, on the basis of real time usage that is justifiable. Procedures for spare part receipt, issue, audit, salvage and scrap must be formulated. A written directive to produce a clear understanding by all personnel is essential.

Warehouse and maintenance personnel must be trained in all aspects of data entry relevant to their job duties. Access into or entry into the warehouse must be restricted to only warehouse-men and be strictly enforced.

7. Corrective Maintenance (CM).

With assets and parts identified, corrective and preventive maintenance can be carried out in a more meaningful fashion. Personnel can be assigned to meet the needs of the newly created asset centers. Their costs directly associated to the individual asset center. Work orders must be written directly to the asset number in question so that costs associated

with the work order for parts, materials and labor are effectively accumulated then used for accurate cost analysis, and to enhance performance forecasting.

Everyone associated with production and maintenance should know what is being done, by whom, where, when and why. Develop written procedures for the work order system as a whole, detailed responsibilities are assigned to specific personnel for the completion and reporting of work. The use of operators to do routine maintenance tasks such as lubrication, minor adjustment is essential.

Planning is the critical stage in the work order system. It is the Planner who sets the expected labor, material and time line requirements. The planner must be charged and empowered to make the determination of how much work can be accomplished in a given time period for each asset center to facilitate both production requirements and maintenance needs, and how much production and maintenance backlog there will be. Backlog must be effectively managed so that it does not grow to an unmanageable size. The planner must be answerable to the production manager and the maintenance manager to do his job effectively, and meet both maintenance and production requirements.

8. Preventive Maintenance (PM).

The PM program must also undergo a total re-evaluation to determine its adequacy and effectiveness. Too much unscheduled downtime and frequent equipment breakdowns indicate that PM's are not working as they should. The real objective of the PM Program is to reduce downtime and breakdowns to a level that is acceptable and manageable by the specific departments. The effective PM program must be set to work hand-in-glove with a corrective and a predictive maintenance program if it is to be successful in the reduction of unnecessary equipment down-time.

It is essential that there be good coordination and cooperation between operations and maintenance managers as a standard practice. Use written directives to establish who is in the lead and who is in the lag position in various operating scenarios. It is critical to success to realize that operations not always be allowed the lead. The leads should always relate to equipment reliability and be the dictating factor in establishing lead and lag positions. At the same time, maintenance needs to realize that without the cost center effectively producing products the outcome in all areas is adversely affected.

9. Predictive Maintenance (PdM).

The effective use of good forecasting tools are essential, if it is the desire of managers, to prolong the useful operational life of the given equipment configuration. Through proper application of the many and varied predictive maintenance tools available to maintenance personnel, failure patterns can easily identify and used to effectively predict eventual failure with some degree of accuracy over time. The more common predictive tools available to maintenance departments without great cost are: vibration analysis, lubrication analysis, thermography, and ultrasonics.

All machines give early warning signs predicting their impending failure. The correct application and early uses of those predictive tools will greatly aid in the identification of impending problems before they become catastrophic. With the use of early detection and effective alert mechanisms by the maintenance department, failure pat-terns can be identified providing managers with information necessary for planning. Effective use of failure trending, will over time, indicate an adverse effect in performance for any equipment assigned to the trending analysis and its ultimate effect upon production. When trends are ignored, failures do occur, the lesson to learn is how soon or when to make the necessary repairs. To capture a pending fail-ure just prior to adverse action in performance, rather than just prior to the equipment failure event is the key. Effective failure analysis data becomes a tool to judge the trade off, down time versus loss of productivity due to failure.

PdM must therefore become a routine part of any regular Production and PM program if it is to be effective.

10. Purchasing.

Purchasing also plays an important role in the modern integrated maintenance organization. The use of an automated system to trigger purchase orders that are designed to facilitate stocking levels as they are established is essential. Adequate planning and proper establishment of workable stock levels, (controlled by supply lead-time and usage) can prevent stock-outages and overstocking. This action will be very effective in controlling stock purchasing activi-ties.

The trick here is to have on-hand only the items required for genuine emergencies. By letting a supplier be the main stock point, your in-house stock levels will be only sufficient to meet the needs of a bonafide emergency. One method is to find a supplier who will be willing to guarantee an adequate supply of your stock items on his shelf to meet all the needs of your operation. This can be accomplished by selective purchasing. Selective purchasing can be done by agreeing to purchase all your supplies from a single supplier. To remain competitive, commit to purchase from the supplier on an annual basis, but re-bid purchases on that basis and spot check competitors frequently. A written contract can be very helpful, specifying the need to remain competitive.

The first ten activities were designed to assist managers in regaining control of their maintenance function. As they are put into practice, they can be refined and tuned to meet the individual plant's requirement.

11. Pro-Active Maintenance (PAM).

Pro-active maintenance is a term to identify the enhancement of both the preventive and predictive maintenance technologies. It is absolutely necessary that managers identify and document data gained from both the PM and PdM programs so that they can develop the PAM portion of the equation. The PAM becomes the history that is viable to each cost center.

To make this happen, establish and effectively use a documented history for each cost center. Start charting each center's uptime versus downtime, determine the cause and effect factors as they become apparent. Make changes in the operation and maintenance functions as they affect the overall uptime. Equipment histories must be accurate for them to be useful and effective in the PAM program. The effective PAM program will ultimately lead to a timely and accurate implementation plan of action. The PAM will provide managers a vehicle to effectively create a reduction in total maintenance down time while maximizing equipment production reliability and useful life.

12. Accountability.

Accountability is required and must be built into the system. Individuals and groups assigned need to be specifically challenged so that the drive is in the proper direction. Activities need to be charted along with the development of detailed plans and how they have impact on the key measures. The indicators are then used to highlight the success of the plan and serve to reinforce those actions taken.

Too often personnel perceive accountability in the negative. They are often called to account for poor performance. It is critical that a reward's mechanism be built into the measurement system. With positive results, visible recognition will have positive impact on the key measures. The use of indicators to highlight the success of the plan will serve as a factor for reinforcement.

Overview Indicators:

These indicators are normally valuable for upper management, and are generally broad based. To be more effective, each is broken down into sub-indicators for a true analysis.

The sub-indicators need to be shared with all employees. Some of the viable sub-indicators are:

- Budget Compliance (Actual versus Forecast).
- Plant-wide Overall Equipment Effectiveness (OEE).
- Costs as a Percent of Sales or Operating Costs.
- Maintenance Costs as a Percent of Replacement Asset Value.
- Maintenance Dollars per Unit Produced.
- Percent Absenteeism.
- Safety, Environmental and Regulatory Performance/Compliance.
- Training Hours or Dollars as a Percent of Overall Hours or Dollars Expended.
- Employee Turnover

Organizational Structure Indicators:
Of lesser importance are the organizational structure indicators, however they do reflect ratios of different positions or functions. They do show if the organization is moving

more or less in empowerment. Some of the indicators are:
• Ratio of Salaried Employees to Hourly Employees.
• Ratio of Company Employees to Contractors.
• Ratio of Production Employees to Maintenance Employees.
• Maintenance Employees per First Line Supervisor.
• Maintenance Employees per Planner.
• Maintenance First Line Supervisors per Planner.

Stores/Maintenance Parts Management Indicators.

The use of indicators to reflect the storeroom's ability to provide high availability of parts as required at the optimal cost is essential.
The following indicators can be used:

• Inventory Accuracy and Frequency.
• Percentage of Stockouts.
• Inventory Turnovers,
• Percentage of Inactive Inventory.
• Materials versus Labor Ratio.
• Percentage of Growth of Line Items.
• Percentage of Growth in Number of Suppliers.
• MRO Value as a Percentage of Plant Replacement Values.

Routine Maintenance Indicators.

The following indicators can be used to evaluate the consistency in performance of maintenance activities. To adhere to good maintenance practices as reflected by these indicators, expect positive results financially and in equipment performances. Examples are:

• Work Input Level (By Craft, Priority and Type).
• Backlog Level (By Craft, Priority and Type).
• Standing Work Orders as Percentage of Total Hours.
• Man Hours per Work Order.
• Daily Schedule Completion.
• PM Completion.
• PM Expense as a Percentage of Total Maintenance Expense.
• Work Generated Per PM/PdM Task.
• Percentage of Maintenance Rework.
• Percentage of Overtime and Total Callouts.
• Percentage of Emergency Work.

Equipment Performance Indicators

The Equipment Performance Indicators are the most valuable of all the indicators, as they alone will reflect the "actual value of the plan" and employee activity successes or failures. These measures specifically focus upon reliability, cost of critical equipment or the cost of manufacturing lines.

- Overall Equipment Effectiveness (OEE)
- Equipment Downtime
- Equipment Capacity, Utilization, Running Speed or Performance Efficiency.
- Mean Time Between Failure (MTBF) for Pumps, Motors, Compressors, etc.
- List of Worst Performing Equipment.
- Set-up or Change-over Times.
- Start-up and Shut-Down Times.
- Monthly Costs for Each Type of Equipment (Pumps, Motors, Compressors, etc.)
- Monthly Costs for Each Asset Center.

Summary

The measurement of performance is critical to the organization's plan for success. It has been often said: "What you measure, is what you get." In all reality the use of measurement is much more complex, not being simply what is measured, what is more important is: How it is measured. To achieve success, integrate these measures into the overall company vision and strategy. Create a process to insure the indicators are acted upon in an intelligent and expeditious manner.

With the use of a cross-functional review team charged to review and evaluate the maintenance and the manufacturing reliability indicators should include those in the organization most affected by that action, or those who can have real impact upon the indicators. Teams will consist of a company wide equipment operators, craft personnel, first line supervisors and engineers. Create and use a dialog with a free exchange of ideas, real communication is most important to remove inhibitions. Then move forward to achieve real successes.

13. Reliability Centered Maintenance (RCM).

RCM is the final stage of maintenance realignment program. RCM totally integrates PM, PdM and PAM with accountability in each major manufacturing configuration. The total function of that configuration and how well it is centered in reliability maintenance is the real measure of success. Each of the assigned equipment components' within an asset center can be operated with a higher degree of confidence, resulting in better production forecasting, greater employee satisfaction and higher profit margins.

Once RCM has been accomplished, the result will be a Totally Integrated Maintenance (TIM) approach to problem solving and providing for equipment reliability improvement. PM, Pdm and PAM must be working together with each established facet in place and

fully functional if RCM is to become successful. When TIM is achieved the Maintenance Department will become a RCM Department. Personnel equipped to meet the demands of the World Class Manufacturing Organization.

Long range benefits for the Totally Integrated Maintenance department can be far reaching, included in the benefits are:

1. The overall reduction of equipment emergencies by as much as 75%.
2. Reduction in maintenance purchasing by as much as 25%.
3. Improvement of warehouse activities and warehouse accuracy to as much as 95%.
4. Increasing PM effectiveness by as much as 200%.

Industrial Maintenance Technology (IMT) is fast becoming an advanced science, where and whenever implemented/integrated, the RCM Management Plan will work. The plan does require hard work and dedication. It will be upsetting at first, ultimately it will aid in the establishment of or in the enhancement of a World Class Organization in your plant.

The Use and Abuse of OEE

Overall Equipment Effectiveness (OEE) is fast becoming a widely used measure for manufacturing industry, but it is also one of the more misunderstood and misused measures and causing much confusion.

What is OEE for?

The simple answer is "Improvement". OEE is an improvement measure and is used as part of the improvement cycle. Unfortunately, much is made of the 85% 'World Class Standard' an arbitrary target found in the original TPM literature. Not only is this target out of date (Nissan in Sunderland are running welding lines at 92-93% **OEE**) it gives the wrong message. A customer has no interest in your OEE – that is an internal measure which relates to your efficiency and costs. The customer is far more interested in a measure such as On Time In Full (OTIF) ie did I get my order? Running a manufacturing business on an arbitrary efficiency measure rather than a customer satisfaction measure is a recipe for disaster. The best use of an **OEE** target such as 85% is to recognise that if you are reaching that level and the customer is still not getting his orders on time, then you may have a capacity constraint.

OEE does not tell us if we have a problem, the customer does. What OEE does do is help us analyse the problem and make improvements. This is why Toyota use it as a spot measure on a particular machine where there is a capacity or quality problem. Calculating the **OEE** of anything other than a discrete machine or automated line is pointless; we have far better measures of the efficiency of a factory or department as a whole.

OEE developed out of the need for improvement groups to have a way of measuring and analysing equipment problems as part of their Define, Measure, Analyse, Improve, Control cycle. **OEE** defines the expected performance of a machine, measures it and provides a loss structure for analysis, which leads to improvement. It can then be used as a tracking measure to see if improvement is being sustained ie if control is sufficient.

What does OEE measure?

At its simplist, OEE measures the Availability, Performance and Output Quality of a machine.

A machine is available if it is ready to produce, as opposed to being broken down or having some changes or adjustments made. The definition of availability allows for planned maintenance, when the machine is not meant to be available to production, but makes no allowance for changeovers etc. No machine with changeovers can ever be 100% available. The reason for taking such a hard line is that changeovers are a major loss to both efficiency and flexibility, so the **OEE** analysis focuses attention on it by making no changeover allowances.

Performance efficiency measures the output during available time compared to a standard. Here there can be debate about what the standard output should be. A good rule of thumb is to make the performance calculation based on best known performance. This may be greater or less than design speed. My argument is that if a machine has never reached its design performance it is not helpful to measure against that. On the other hand, if it has consistently out performed the design spec you can have (and I have seen) performance figures of 140%, which can hide poor availability. This is always remembering that one purpose of **OEE** is to help tell you if you have the capacity to meet customer demand.

Output Quality is a First Time Through measure – what percentage of the output was right first time, without any rework. FTT measures are always the best quality measures. The issue in **OEE** is that sometimes the quality feedback is not immediate. In FMCG businesses, a customer complaint can be received three months or more after production. In these cases it is best not to include quality in the **OEE** calculation and use a more customer focused measure for quality – number of complaints etc. If there is no way we

can use the Quality component of **OEE** in a real time improvement cycle, then it is pointless to measure it.

Loss Analysis

The next level of analysis are the seven (or six or eight or sixteen) losses. Within **OEE** we usually talk about seven losses, although TPM loss structures have been known to define 23 losses in all.

Availability losses are primarily Breakdowns and Changeovers. Changeovers can be separated into Tool changes, Material changes and Reduced Yield at start up, but fundamentally these are the same issue. Further analysis reveals breakdowns to have two fundamental types, those due to deterioration because of inadequate maintenance and those due to inherent machine characteristics.

This gives us three basic responses to availability issues – improve changeovers through SMED, improve basic maintenance and improve machine characteristics. Depending on the Pareto analysis of losses we may need to act on one, two or all three of these.

Performance losses are usually separated into speed loss and minor stops – is the machine running slow, or is it stop-starting? The definition of minor stop is also open to debate – originally it was less than ten minutes, then five minutes, then three minutes. The pragmatic approach is to say that if you can measure the amount of time lost for a stop it is a breakdown, not a minor stop. If you can only record the quantity of stops, then they are minor stops.

There is some practical use for the speed/minor stop distinction – if a machine is running slow we can always speed it up, whereas if it is jamming we need to look at the physical mechanism and try to remove the cause of the jams (my favourite example is where we found the root cause was when metal washers were being loaded into a hopper with a metal shovel, which damaged some, which then jammed the feed – the solution was a plastic shovel!).

We can however also make a useful distinction between performance losses due to

deterioration or contamination and those caused by inherent machine characteristics. As with breakdowns this gives us two improvement approaches – better maintenance or equipment re-design.

Improvement

The only reason to measure and analyse anything is to improve it. If we are not going to use the whole improvement cycle there is no point in measuring **OEE**. It tells us nothing we do not already know. At a gross level all **OEE** tells you is how much you made compared to what you wanted to make, and any schedule adherence measure would tell you that already. Averaging **OEE**'s over whole plants or time periods just hides issues – **OEE** is a specific measure for use in specific improvement projects.

The biggest misuse of **OEE** is to use it to compare different processes, plants or machines. **OEE** is not a useful executive KPI. It is not even a very useful operational measure. It is an improvement measure, for people who want to improve their equipment performance.

How to massage your OEE

1) When the machine breaks down, log it to planned maintenance
2) Do changeovers during planned maintenance or at weekends if not 24/7
3) Use an easy performance standard
4) Measure the best machine and quote that figure
5) Set arbitrary targets and achieve them through the above

Using the above strategy you should be able to report decent **OEE**'s and even make some money if pay is **OEE** performance related. What this will not do however is improve your ability to meet customer demand.

How to improve performance

1) Measure against customer demand (OTIF or similar)
2) Measure **OEE** on constraints or problem equipment
3) Set realistic performance standards

4) Analyse losses to identify issues for improvement

5) Use the whole improvement cycle