RELIABILITY BASED MAINTENANCE IN THE INDUSTRIAL / MANUFACTURING SECTOR (S)

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KEY WORDS
Preventive Maintenance, Predictive Maintenance, Proactive Maintenance, Root Cause Failure Analysis.

ABSTRACT
Reliability Based Maintenance (RBM) programs are commonplace in the Aviation, Power Generation and Chemical / Petrochemical industries. In these sectors, Equipment Failure is not an option. The Industrial / Manufacturing sector(s) have not fully embraced the RBM concept and for the most part routinely suffer loss of production output and the subsequent loss of revenue associated with equipment failures. Two of the Key Elements to the successful implementation of the RBM process in the Industrial / manufacturing sector(s) is the establishment of Reliability and Maintainability Specification and a viable Machinery / Equipment Lubrication and General Preventive Maintenance Program. This Paper will outline procedures for establishing an RBM Program. Methods to evaluate the results will be outlined as well.

INTRODUCTION
RBM programs are structured to completely eliminate equipment failures whenever practicable. Copious amounts of lost revenues are realized when Equipment Failures are considered a “Way of Life” and machinery is routinely operated to failure. The basic concept of RBM is to combine the efforts of the Preventive Maintenance, Condition Monitoring, Predictive Maintenance and Proactive Maintenance processes to ensure equipment reliability. The success or failure of an RBM program is dependant upon relative ease of lubrication, general maintenance of the machinery and provisions for utilization of the Lubricant and Machine Condition Monitoring technologies. These features are most cost effectively Engineered (“Built In”) to the Design of the Machinery. A Machinery and Equipment Reliability & Maintainability Standard (Specification) will mandate specific requirements of the machine builders / suppliers to provide manufacturing and maintenance with equipment that can be easily lubricated, maintained and monitored. These requirements will generate some initial Up-Front Costs in the price of the Equipment. However, the Life cycle cost(s) of operating and maintaining the equipment will be dramatically reduced.

MAINTENANCE PROCESSES

PREVENTIVE MAINTENANCE
Preventive Maintenance is based on following the Original Equipment Manufacturer (OEM) Recommended Routine Maintenance / Lubrication Schedule. The Equipment would be routinely serviced and operated to Failure.

PREDICTIVE MAINTENANCE
Predictive Maintenance utilizes Lubricant and Machine Condition Monitoring Technologies i.e.; Oil Analysis, Vibration Analysis, Ultrasound, Laser Alignment etc. to detect anomalies in the machinery. Maintenance personnel are able to predict with some certainty an impending Equipment Failure.

PROACTIVE MAINTENANCE
Proactive Maintenance utilizes Equipment History and Data accumulated through the use of the Predictive Technologies to schedule Repair / Overhaul prior to failure. With proactive maintenance manufacturing should suffer no loss of machinery service during normal production runs.
GETTING STARTED
RBM should begin at time of equipment procurement. It is far less expensive to provide provisions for the application of the Predictive Technologies during the Equipment Build process.

RELIABILITY & MAINTAINABILITY SPECIFICATION.
The Specification must include provisions for the application of the predictive technologies i.e.; Oil Sampling Ports, Guarding clearances for Vibration Analysis, Infrared and Ultrasound detection. The Reliability and Maintainability Specification should incorporate your Basic Lubrication, Lubricant, Vibration Analysis, Laser Alignment and Precision Balancing, Airborne Ultrasound, Hydraulic, and Pneumatic specifications as well. The Reliability & Maintainability Specification should include provisions for taking baseline readings prior to acceptance of Machinery and Equipment to ensure that the equipment complies with your specification(s). Another set of baseline readings should be taken once the machinery is in operation at full capacity. These baseline readings will be used to trend machine and lubricant condition(s).

IMPLEMENTATION STRATEGIES
Conduct a “Needs Analysis” prior to any attempt to Procure Lubricant and Machine Condition Monitoring Equipment and Training. You must evaluate each technology on its own merit. You will be charged to explain how it will be of value to your operations in protecting the manufacturing equipment assets and improving equipment availability. Prepare a Business Case to justify Capital Cost. Rely on Equipment Failure Histories and be sure to reference Programs from “Best of Class Companies (Documented cost avoidances). Include estimated time for return on investment.

ESTABLISH A CORE RMB GROUP
The efforts of the Proactive and Predictive Maintenance Groups should be directed and dispatched from a single source. You will find that it will be easier to coordinate your maintenance effort and eliminate redundant tasking. The RBM Group will exchange information / data gathered from utilization of the Condition monitoring Technologies. The RBM group will then evaluate the data and determine if it will be necessary to dispatch another technology group to verify the presents or absence of any anomalies in a specific machine or system. The combined expertise of the RBM Core Group can then be dedicated to formalizing an action plan to schedule repair or replacement.

ESTABLISH CONDITION MONITORING ROUTES
When setting up routes, include Manufacturing / Production in your decision making process. Prioritize your Equipment based upon the overall impact of loss or reduction of output. Maintenance and Manufacturing downtime reports can help you prioritize your routes and or schedules by identifying bottlenecks in the manufacturing process or throughput issues.

AWARENESS AND DOCUMENTATION
The success or Failure of your Process will determined in part by how well the results of your effort are Documented and Communicated. Manufacturing must understand that the RBM Group is productive and an asset to the organization and certainly not viewed as just another “Cost / Burden” associated with operating a business. Distribute the results of your work to Manufacturing and Maintenance regardless of the absence of any anomalies. Develop a Standardized Form for Documenting Anomalies. Include the Equipment affected, a description of the anomaly, who detected the anomaly, which Technology or combination of Technologies was utilized to detect and or verify the anomaly, when the anomaly was detected and a comprehensive action / corrective plan. Establish a Formal procedure to communicate your findings and schedule corrective action(s). Scheduling repairs prior to failure may seem difficult at times. However, you will likely find it much easier that explaining to manufacturing how or why a piece of Equipment has failed during operation / production. Be certain that your Evaluation / Analysis of the Equipment is correct. You must earn Manufacturing’s confidence and respect. Develop a Standardized form for documenting Cost Avoidances. This is your “Bread and Butter” Be realistic in your accounting.

EVALUATION
The primary goal of the RBM Process is to eliminate Equipment / Machinery failures and in so doing, increase the profitability of the company. If you are concentrating your efforts monitoring and maintaining the proper Equipment at the correct intervals, your expectations will be realized. In those cases where the objectives of the RBM Process are not met, an evaluation of the process is in order. The evaluation will quite likely reveal that either you have failed to properly prioritize your machinery taking into consideration the impact of the loss of availability or you are not doing an effective job of analyzing the data you have gathered from the Condition Monitoring Technologies.

ROOT CAUSE FAILURE ANALYSIS (RCFA)
Redundant equipment Failures are not a “Way of Life”. Root Cause of these failures must be ascertained and corrective actions taken to eliminate them. The RCFA process when properly employed is an invaluable tool to establishing true cause of an equipment failure. Through process of elimination, you completely rule out any and all conditions that can be determined to be effects rather that the cause. You will systematically eliminate any Component, Physical Intervention and Management issues that cannot be directly attributed as the root of the failure. Always bear in mind that theory behind RCFA is to ascertain and correct “Root Cause” and not an exercise to find fault or lay blame.

CASE HISTORIES
1. Triple Reduction Gearbox Failures
2. Bearing Failures, 4500 GPM Split Housing Double Suction Pump.