Reliability Excellence in Utilities

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Abstract *— The Reliability Excellence tools and methods are explained through this paper providing an effective understanding on how to apply it in different areas such as: utilities, facilities and manufacturing. Using the Reliability Centered Maintenance as methodology and the Asset Criticality Ranking as foundation, it was identified the top critical assets within the Utilities area. The identification of critical assets is performed between different departments at the same location to get all inputs simultaneously. Based on the Asset Criticality Ranking, the approach to implement the Reliability Excellence is What if Exercises. From the 36 What if exercises performed, 28 were approved and 8 were not approved since there was product impact regarding safeguards suggested. Based on the What if Exercises, 19 Preventive Maintenance Job Plans must be revised to have strong tasks in order to increase Utilities equipment performance. In addition, it's required 2 equipment modifications to replace obsolete parts by new ones minimizing the risk of failure by 67%.*

Key Terms *– Asset Criticality Ranking (ACR), Computerized Maintenance Management System (CMMS), Failure Mode Effects Analysis (FMEA), Predictive Maintenance (PDM), Preventive Maintenance (PM), Root Cause Analysis (RCA), Reliability Centered Maintenance (RCM), Reliability Excellence (Rx), Real-Time Monitoring (RTM), Run-to-Failure (RTF).*

INTRODUCTION

During the latest 30 years the pharmaceutical industry has used different tools or concepts to improve current processes looking for better results with ambitious goals and objectives. In that journey, maintenance topics are prohibited for many companies or this work is considered an expense instead of an investment for manufacturing.

Project description

The company Z located at east of Puerto Rico is a pharmaceutical industry with vast experience manufacturing oral solid dosage products. As part of new product transfer to the site, there are several challenges on how to improve the reliability for utilities equipment. Most of these products require utilities supplies more stable and reliable for working in specific ranges to avoid discard the product if there is a deviation regarding environmental condition parameters or compressed air pressure.

Objectives

The objectives of this project are to prevent major breakdowns and to reduce downtime in the utilities operations. Currently, there is 1 major breakdown/biweekly and equipment downtime 3.8 hours/week. The objective is to reduce major breakdowns 0/biweekly (100% reduction) and equipment downtime 2.6 hours/week (30% reduction).

Project overview

A risk based in Reliability Centered Maintenance initiative is adopted to ensure potential risks are identified and safeguards implemented. Safeguards are those precautions that improve the process and replace the reactive mode into a proactive behavior. Through the RCM tool, the inherent risk in the critical utilities equipment operations and maintenance is analyzed to make sure adequacy/robustness of existing safeguards which can be improved taken in consideration equipment performance trends. Also, examine the maintenance basic conditions, operating standards,

deterioration, design weakness and human error practices and effectiveness to prevent:

- Breakdowns
- Downtime
- Setup or adjustment failures
- Start-up or shutdown losses

LITERATURE REVIEW

The Reliability Excellence it's one of the most powerful tools used in Maintenance to improve productivity and equipment performance identifying waste time or areas of opportunities. How reliable are the equipment's? This is a frequent question made when there is product transfer or project expansion regarding to manufacturing.

Reliability Engineering for Maintenance

The Reliability Excellence (Rx) is a set of capabilities which involves as first step the innovation mindset and as foundation the sustainability of the operation. Once the Rx is integrated to maintenance it's known as Reliability Centered Maintenance (RCM). If an RCM program is pursued by an organization it is because there are needs to have good equipment performance and stable operations without deviations or major breakdowns which at the end of the day will affect the supply chain**.**

RCM is a systematic approach to determine the maintenance requirements of plant and equipment in its operating [1]. It is used to optimize preventive maintenance (PM) strategies. The developed PM programs minimize equipment failures and provide industrial plants with effective equipment [2]. Engineering studies have demonstrated the importance to establish as organization what systems will be used for tracking the equipment history. The data storage systems are known as Computerized Maintenance Management System (CMMS). These systems are validated most of the times, since the information stored is used during regulatory inspections, release product and to make trend analysis for improving the equipment performance. As part of the equipment historical data assessment are implemented several actions based on RCM concepts such as: asset condition, root cause analysis. FMEA's, predictive maintenance (PDM), training requirements, among others. Based on the research, there are new software's developed specifically for PM and PDM programs in where the client has flags instantly if there is an issue or problem regarding equipment. Definitively this approach is a benefit to take actions immediately to mitigate downtime in manufacturing or utilities areas.

The RCM topic could be complex within an operation mind, but pretty simple to explain in numbers if there is data available and accurate. RCM philosophy employs preventive maintenance, predictive maintenance (PDM), Real-Time Monitoring (RTM), Run-to-Failure (RTF) and proactive maintenance techniques is an integrated manner to increase the probability that a machine or component will function in the required manner over its design life cycle with a minimum of maintenance [3,4]. From the research, the above mentioned concepts show up critical information to develop charts, trends and financial analysis that supports the operation.

In addition, the methodology for analyzing the information gathered is an important key to make sure is captured essential data in order to create boundaries and robust initiatives. Assessing the information in the research it is suggested follow several stages for completing a good RCM process. The RCM steps are as follows [5]:

- Step1: system selection and data collection
- Step2: system boundary definition
- Step3: system description and functional block
- Step4: system function functional failures
- Step5: failure mode effect analysis
- Step6: logic tree diagram
- Step7: task selection

Asset Condition Management

This stage is critical the assets improvement depending on how the RCM framework is designed

to ensure the Maintenance area is changing from reactive to proactive approach.

At the moment to identify business needs, the equipment historical trends provide a clear background that support the strategies and initiatives to be implemented based on predictive maintenance. Non-destructive and Non-invasive tests such as: thermography, ultrasound, machinery lubrication, vibration analysis, among others. These are the common technologies used to determine business needs when a critical situation is identified based on tests. Using this approach is prevented equipment downtime and major breakdowns.

In the develop of an organization based on asset condition management the operators or mechanics are the main resource to identify business needs since they are closely working with the equipment and have the knowledge on how the equipment behavior is. Preventive actions can be taken once the operators and mechanics report the equipment situations in an expedite manner. Also, it is important to develop an Assets Master List in where the High Management has the knowledge which equipment area reaching the useful life, major offenders regarding maintenance budget expenses, among others.

Work Execution Management

This is the responsible element in having all components regarding compliance, documentation, communication and systems in a reliable condition to be audited anytime without deviations. The data integrity in Maintenance is the most important piece within Pharmaceutical industries is the documentation and procedures compliance. Maintenance isn't exempt of this, by that reason the data integrity in works related to Maintenance are subject to inspections by Health Agencies. The documentation is stored in the Computerized Maintenance Management System (CMMS). Once the technicians are executing the works, the documentation must be contemporaneous with the works executed to be in compliance avoiding back dating or transcribing data. This information is as important as Batch Records and could be utilized for product investigations or identification of equipment issues.

The organization always must be looking for options in reliable automatic systems to implement automated processes in order to reduce manpower situations. However, these systems must be easier to manage and should have all elements required to be robust programs such as: audit trails, user levels, among others. In addition, reliable systems in where the assets performance supports to increase company outcomes.

Leadership for Reliability

Important role in the Organization for supporting Reliability Excellence initiatives and strategies in order to assign budget, headcount and training resources to achieve business goals.

The integration of the High Level Management in Maintenance projects is the key to make sure all elements are present if a cultural change will be implemented. In the RCM initiatives it is important get the support from the High Level Management since there are several items that needs approval. To promote RCM strategies the Project Manager or Owner shall to prepare an assessment in where is it presented the current condition and future stage with clear objectives and goals keeping in mind the benefits for the organization. It's more a financial discussion, but taking consideration company outcomes with mindset in safety and compliance.

As part of the RCM implementation, it is important to develop a Workforce Training Matrix to identify areas of opportunities and strengths areas. Once the analysis is complete, the knowledge acquired with some resources within the RCM project will be shared with other colleagues to ensure everyone is trained. Having the personnel trained it is reduced the manpower investigations.

DATA ANALYSIS

It was performed an assets evaluation based on the ACR. About 65 Utilities assets were assessed using the ACR tool. To determine the Asset

Criticality Ranking score were used the following criteria's:

- Equipment Availability – How many hours is it required to operate?
- Cost of Operation – What is the effect in the cost of operation?
- Quality – What is the effect on product/output quality?
- Environmental and Safety – How will the safety of the people be affected?
- Operational Failure History – How frequent does a failure occur?
- Mode of Operation – How ill operational throughput be effected (run time, efficiency, etc.)?

The scoring of each asset was determined between all site departments to avoid surprises at the end of the ranking list. As part of the assessments completed in the ACR analysis, it was distributed the downtime by top offenders based on the Utility service (Figure 1). The information gathered in the process shows the HVAC utility as the top offender with 49% downtime in a full year

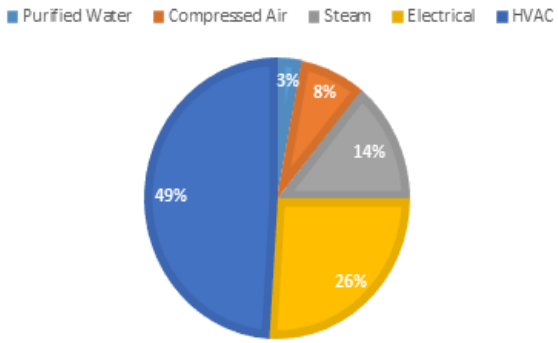

Figure 1
Downtime Distribution

Taking as foundation the ACR tool were completed 36 What if Exercises to identify the top three assets to implement the recommendations and safeguards. The shop floor personnel was integrated to the assessments to evaluate recommendations and assets safeguards before implementing to make sure are feasible.

RESULTS

The recommendations and safeguards from the 36 What if Exercises (Figure 2), 28 were approved by all representatives and 8 were not approved since there was product impact regarding safeguards suggested. However, for those 8 What if Exercises not approved, it was identified other options to mitigate equipment downtime or major breakdowns.

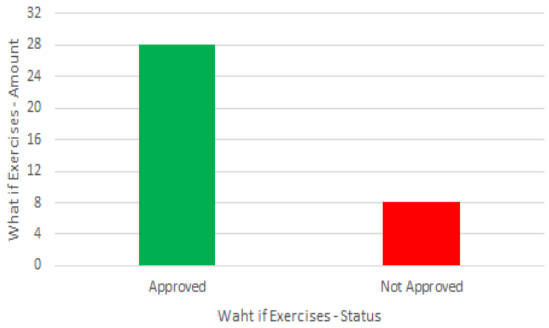

Figure 2
What if Exercises –Tracking Tool

In the What if Exercises were identified 19 Preventive Maintenance Job Plans that must be revised to have strong tasks in order to increase Utilities equipment performance. In addition, it is required 2 equipment modifications to replace obsolete parts by new ones minimizing the risk of failure by 67%.

CONCLUSIONS

After finalizing the implementation stage of the safeguards and recommendations, it is evidenced through the What if Exercises and RCM tool the equipment downtime and major breakdown will be reduced in alignment to the project objectives. Based on the actions identified, there is no expectation in having major breakdown biweekly and equipment downtime reduction by 30% in order to support product transfer keeping Utilities operations reliable and in control. The implications in the project will be the sustainability of the actions implemented. Taking in consideration that point, it will be created a periodic review of the

data gathered to evaluate the effectiveness of the safeguards.

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