

## **Enabling the Reliability Centered Maintenance process with IBM Maximo Asset Management.**

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### Introduction

Reliability Centered Maintenance (RCM) is an analytical process used to determine an optimum maintenance strategy for physical assets. It is an advanced maintenance strategy for increasing asset availability by minimizing downtime caused by failures, reducing an asset's total cost of ownership and increasing overall equipment effectiveness (OEE). This white paper describes the RCM process and shows how IBM Maximo® Asset Management supports each step in the RCM process.

RCM uses the concept of Failure Modes, Effects and Criticality Analysis (FMECA) to determine what can go wrong with critical assets. It identifies only the maintenance required to defend against important failures with significant consequences, avoiding expensive, non-productive maintenance tasks that create high costs and consume resources, without raising equipment reliability, performance or safety.

RCM programs have achieved notable successes, first with commercial and military aircraft, and subsequently in many other industrial sectors where cost-effectively achieving high equipment reliability and safety is paramount. However, there have been many cases in which considerable expense and resources were deployed in pursuit of RCM programs with very few tangible benefits.

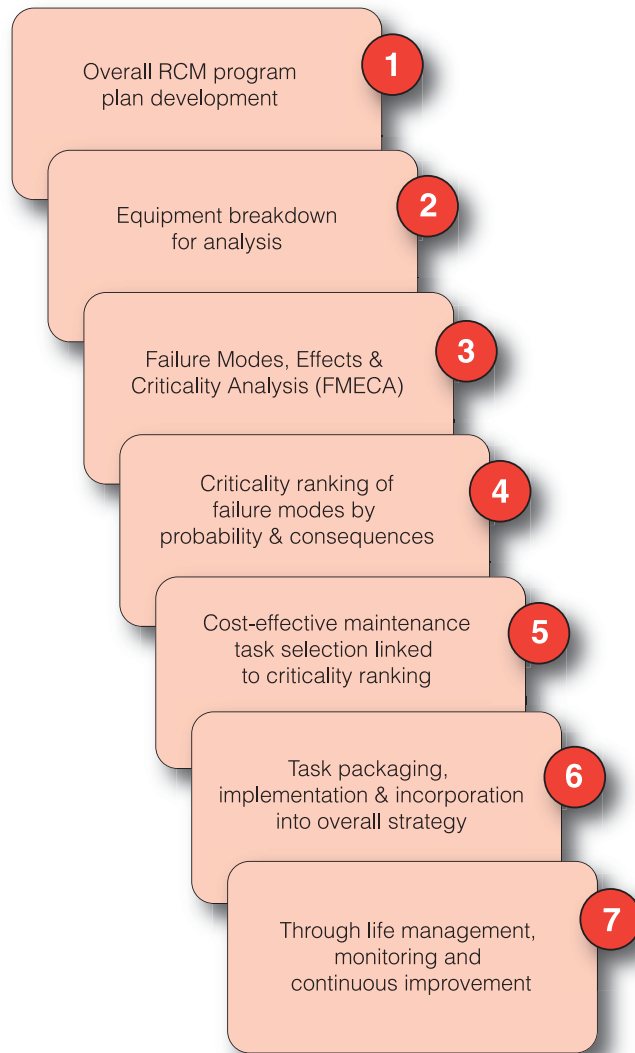
The most common reason for achieving disappointing results from RCM programs seems to be the failure to connect and integrate them fully and completely with overall asset maintenance strategies and supporting information systems. Modern enterprise asset management (EAM) systems can be used to prioritize and target RCM programs, to provide the data required to support the questions generated by the RCM process, and to act on the results of the analysis.

Part of the IBM Tivoli® software portfolio, Maximo Asset Management has been designed specifically with RCM in mind to help support all stages of the RCM process including initial targeting of the RCM program, implementation, monitoring of results through real-time key performance indicator (KPI) dashboards, and permanently embedding RCM as part of continuous performance improvements in asset-intensive industries or businesses.

**The RCM process**

The seven key steps of the RCM process are shown in Figure 1. The following sections describe each step of the RCM process and how Maximo Asset Management supports them.

**Figure 1: Steps in the RCM process**



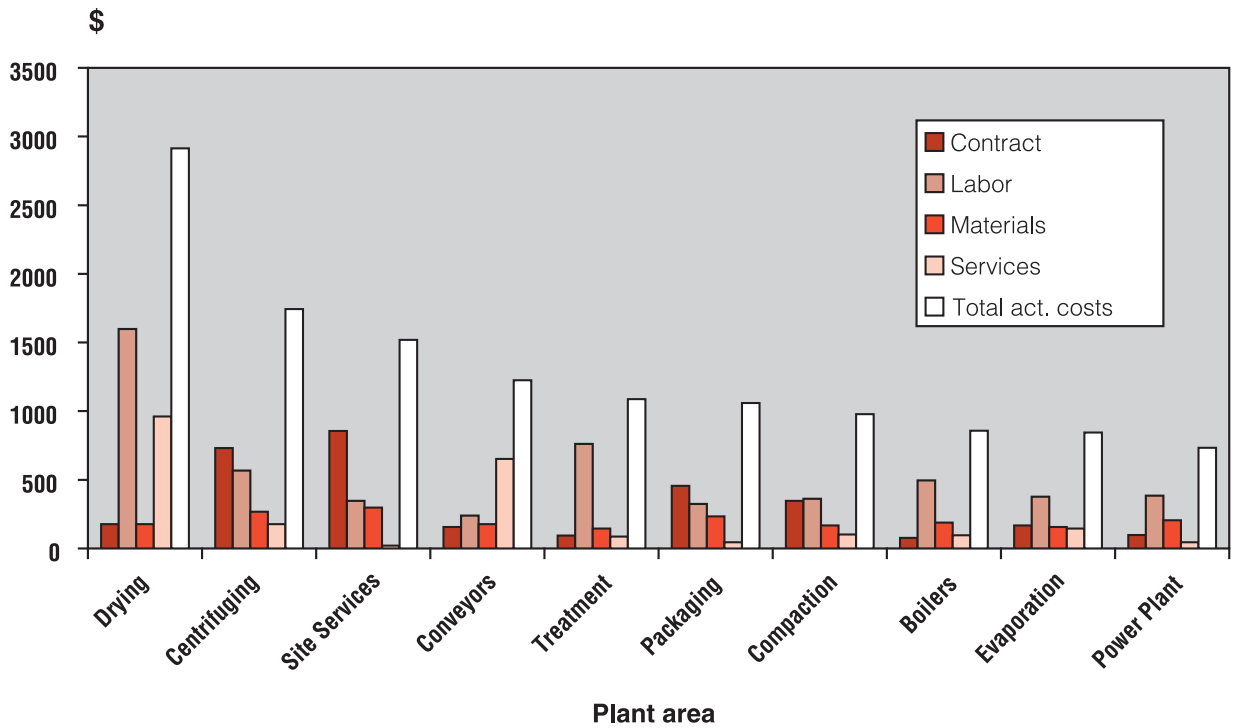
*This figure outlines the seven key steps of the RCM process, from RCM plan development to ongoing monitoring and continuous improvement.*

**Step 1: Overall RCM program plan development**

When planning an RCM program, it is essential to select analysis equipment for the areas in which the greatest benefits can be achieved. Poor targeting commonly causes RCM programs to fail because tangible results were not delivered. It is critical to understand priorities and to focus on the areas that exhibit the greatest problems in terms of cost, reliability, downtime, environmental risk and overall impact on business performance.

The advanced analytics and graphical display capabilities of Maximo Asset Management provide easy access to information required for targeting RCM and benchmarking the “as-is” situation, so that potential benefits delivered by the RCM program can be accurately quantified. Using Maximo Asset Management plant history data together with powerful Maximo Asset Management and Microsoft® Excel® data exchange capabilities, graphical displays such as the one shown in Figure 2 can be produced to help identify priority targets for RCM.

**Figure 2: Top 10 maintenance costs**



*This Maximo Asset Management report provides advanced analytics in a graphical display.*

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**Highlights**

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KPIs such as mean time between failures (MTBF), and mean time to repair (MTTR) can be easily accessed together with all associated cost information, allowing “roll up” to facilitate plant-wide top 10 analysis for initial priority setting, and “drill down” for more detailed analysis and localized targeting.

Other important aspects to plan for at this stage of the program are implementation of the RCM analysis results and the different ways in which the outputs of the RCM program will be sustained, as well as how continuous improvements will be embedded into the existing framework of ongoing plant maintenance strategy and execution.

Maximo Asset Management provides the background information required for these considerations, including details of resources and skills available within the plant maintenance organization together with the history of tasks and routines already being carried out. Maximo Asset Management’s configurable KPIs and management dashboards, which display critical plant performance information in real time, provide a strong foundation for quantifying the results, identifying priority targets for RCM and measuring the benefits delivered by the RCM program after successful implementation. Maximo Asset Management also provides historical data on all assets that can be easily transferred to Microsoft Excel for further analysis or combined with other information systems.

***IBM Maximo Asset Management’s configurable KPIs and management dashboards display critical plant performance in real time.***

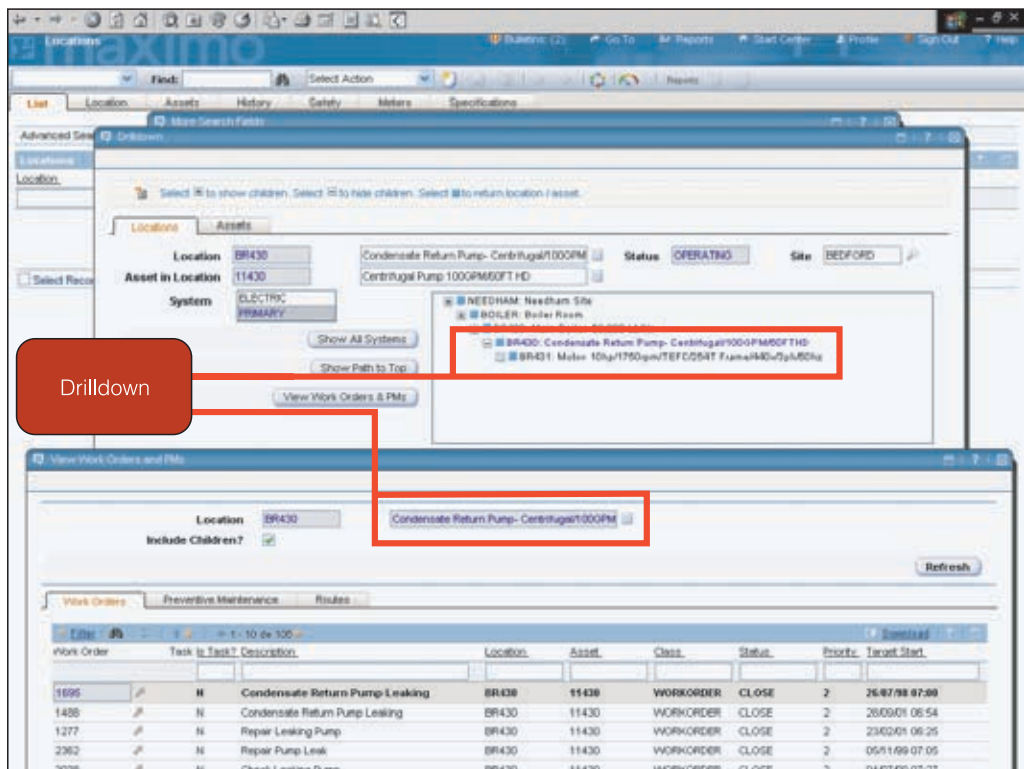
**Step 2: Equipment classification for analysis**

To prepare for detailed RCM analysis, important decisions need to be made regarding the way equipment is classified from main system to subsystem and within unit levels. This must be done in a way that is consistent with the existing maintenance strategy, tasks, routines and levels of unit replacement.

The powerful asset hierarchy navigator and drilldown functionality within Maximo Asset Management (illustrated in Figure 3) helps make this task easier to perform. Furthermore, the simple and intuitive navigational structure provides a useful framework to monitor the RCM program's progress.

Connectivity with specific RCM tools is also important in order to reduce workload and errors resulting from manual data exchange. Maximo Asset Management has capabilities to integrate and share data from these selected proprietary tools for further analysis and graphical display.

**Figure 3: Equipment classification for analysis**



This screen capture shows the drilldown functionality of Maximo Asset Management, as it supports detailed RCM analysis.

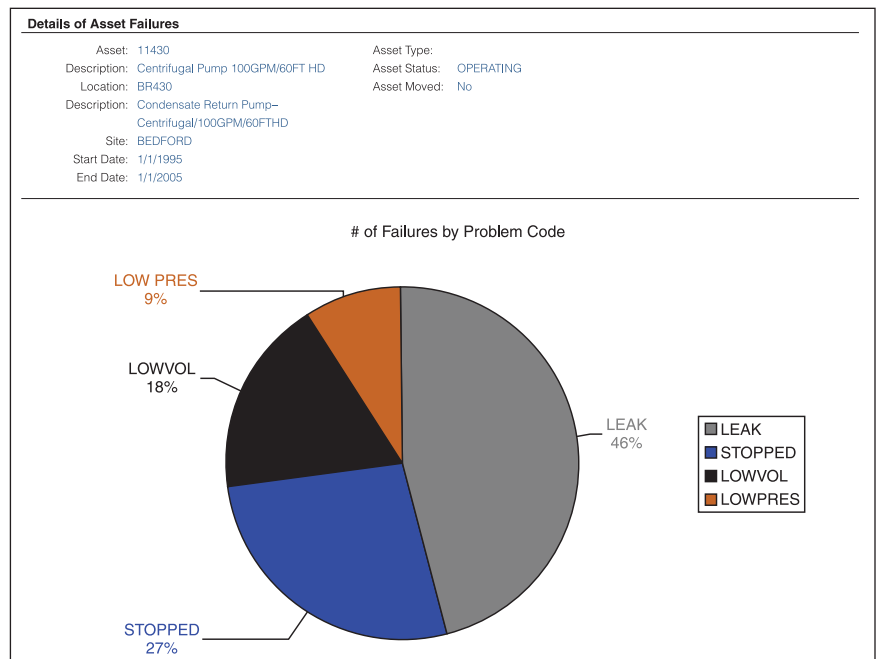
This connectivity can be achieved through the optional IBM Maximo Enterprise Adaptor, which is based on the Service Oriented Architecture (SOA) concept and technology, which optimizes application-to-application integration. The integration provides a more robust, scalable and secure integration infrastructure, leveraging industry best practices such as XML, Web services and portals to standardize interoperability.

**Step 3: Failure Modes, Effects and Criticality Analysis (FMECA)**

FMECA isolates ways in which the equipment can fail and seeks to identify the significance of these failures in terms of their impact on safety, environmental risk, operations and costs. In doing this, FMECA evaluates both probability and consequence of failures, providing the basis for making risk-based decisions to optimize maintenance activities. While engineering judgment is a key element of FMECA, its full potential can only be delivered with strong data support.

Maximo Asset Management is structured specifically to provide data in a format directly relevant to and supportive of the RCM process. Its equipment history is structured to demonstrate all possible failure modes and provides the basis for calculating the severity and impact of these failures in terms of bottom-line costs to the organization, as shown in Figure 4.

**Figure 4: Failure analysis in Maximo Asset Management**



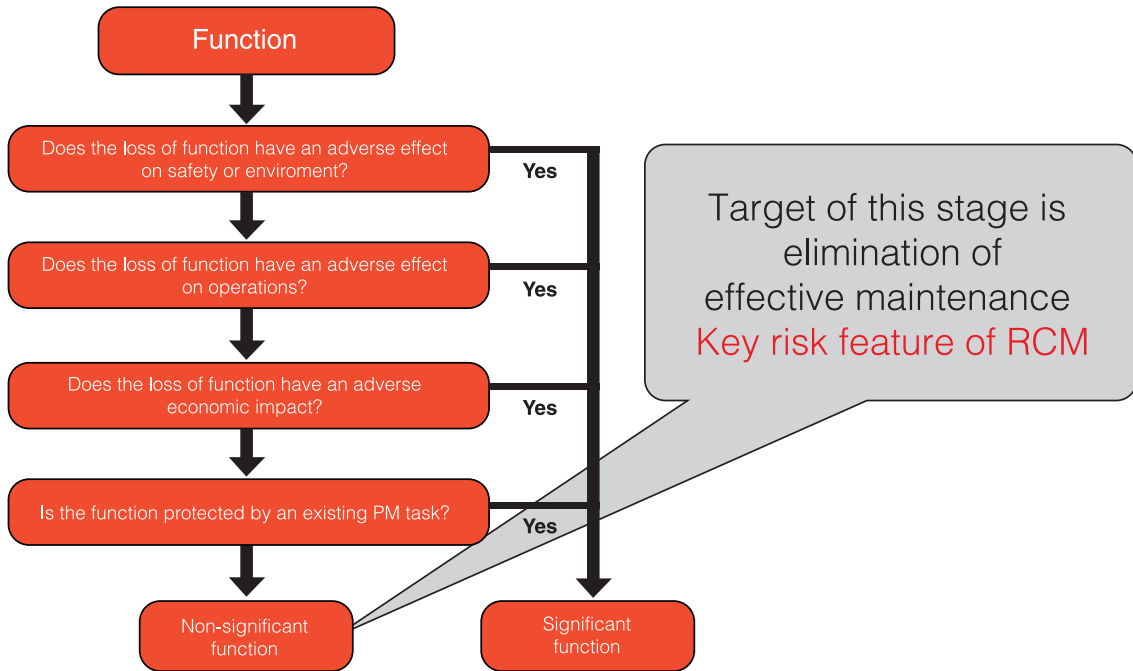
This Maximo Asset Management report uses a graphical display to provide asset failure details.



**Step 4: Criticality ranking of failure modes by probability and consequences**

After utilizing Maximo Asset Management to identify the full range of equipment failures to be considered, Step 4 of the RCM process requires that they be ranked according to their probability and the severity of consequence for the organization. It should then be determined whether the loss of equipment function resulting from each failure is significant or not, and hence whether further consideration of the failure by the RCM process is justified. This is a key stage in determining how effective RCM can be in removing non-productive work activities. The RCM decision tree shown in Figure 5 can be used to help determine an asset's criticality ranking.

**Figure 5: Criticality ranking of failure modes**



This figure provides an RCM decision tree, which can be used to help determine an asset's criticality ranking.

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Traditional RCM is based on the question, “Is the lost function significant?” But the real question is, “How significant is the lost function?” Quantifiable answers are needed in order to determine priorities for action. Judging the significance of individual failures requires understanding the context of the associated equipment within the asset hierarchy and, therefore, the impact of its failure on plant operations as a whole. For example, failure of a single small item of equipment occupying a critical position in the hierarchy may sometimes be more significant than a larger item for which there is standby capacity.

***The asset hierarchy navigator function within Maximo Asset Management facilitates analysis and quantification of asset failures.***

Making these important judgments is greatly facilitated by referring back to the asset hierarchy navigator function within Maximo Asset Management, which was utilized in Step 2 of the RCM process to determine the most appropriate equipment breakdown for analysis. By understanding the significance of individual failures through the use of the asset hierarchy navigator, one can complete the answer to the “How significant” question.

By utilizing the analytical tools and historical data in Maximo Asset Management to provide the necessary analysis and quantification as outlined in Step 2, priorities can be set for subsequent stages of the RCM process.

**Step 5: Cost-effective maintenance task selection linked to criticality ranking**

When RCM was first developed nearly 30 years ago, fairly equal importance was given to all the various maintenance task options that could be chosen. The RCM process suggested listing all the options and then selecting the most cost-effective mix from these options. Since the origin of RCM, Condition Based Maintenance (CBM) has become much more prevalent. In fact, many organizations already have well-developed CBM practices and procedures in operation, delivering substantial cost benefits.

For this reason, there are significant benefits from combining Steps 5 and 6 of the RCM process and utilizing the Maximo Asset Management history functionality to investigate the use of CBM practices. By doing this, CBM practices can be utilized where appropriate to achieve the most cost-effective results. This strategy also takes advantage of the skills, technology and practices already working successfully within the organization.

Maximo Asset Management provides capabilities for integration with CBM practices and direct interfacing with plant-based data acquisition systems and hardware such as programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) systems. Maximo Asset Management also provides capabilities to manage data from multiple meters/counters including volume, pressure, transactions and distances. It is also possible to integrate data from industrial engineering systems and components such as controllers, digital communications, displays, power supplies, barriers, samplers, recorders and isolators. These integrations are based on capabilities provided by Maximo Enterprise Adaptor optimized for application-to-application integration. Provisions for cut-and-paste functionalities to exchange information with external information systems are also available.

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*A successful integration results in changed maintenance practices that incorporate a more focused and effective approach, with less wasted effort.*

#### **Step 6: Task packaging, implementation and incorporation into overall strategy**

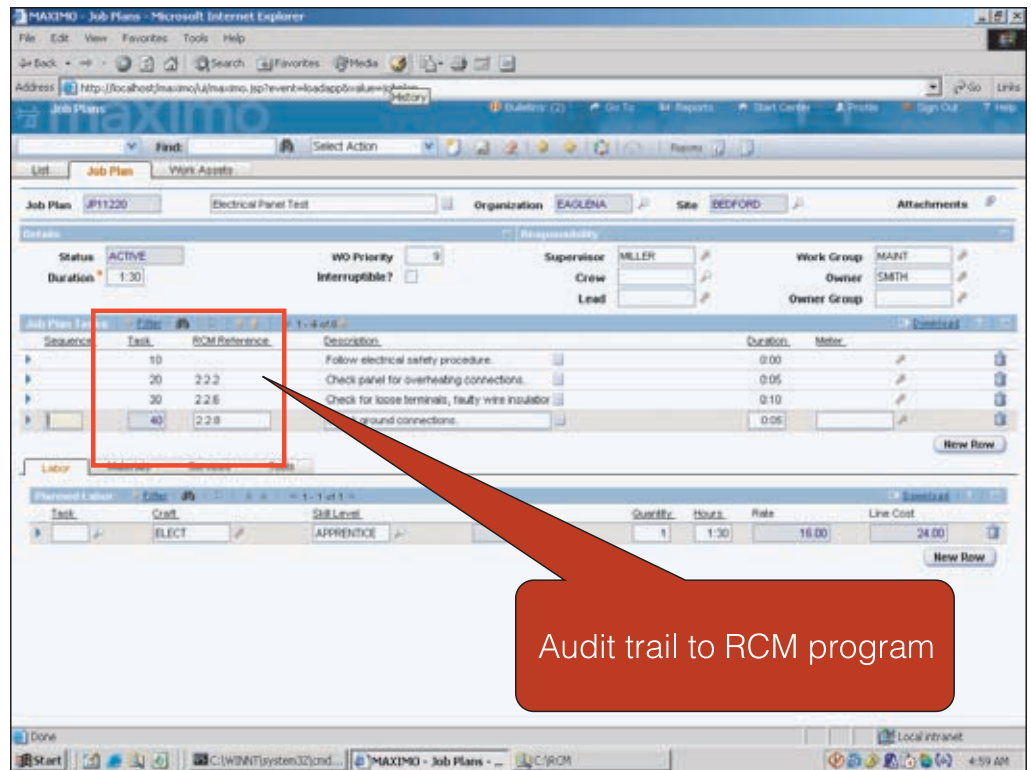
It is important to recognize that – other than the learning and team-working benefits arising from the RCM analysis – the parent organization sponsoring the RCM process achieves no real tangible benefit until the results are implemented as part of the existing asset maintenance approach. A successful integration results in changed maintenance practices that incorporate a more focused and effective approach, with less wasted effort.

This means that individual tasks, determined as a result of the analysis, need to be packaged and integrated within existing maintenance programs. Many otherwise well-run and well-managed RCM programs fail at this stage, when it is discovered that the suggested tasks do not integrate easily with existing work programs and are not easily supported by local skills, resources, knowledge or culture.

These problems are more readily avoided when the RCM process is supported at all stages by the knowledge base, navigational capabilities and analytical tools provided by Maximo Asset Management. New maintenance tasks can be selected with the full knowledge of existing in-house and contract skills and resources tracked by Maximo Asset Management, so that they are supportable within the existing approach and are easily integrated using Maximo Asset Management’s native work packaging, scheduling, planning and management capabilities.

Maximo Asset Management also provides traceability and audit trails linking the packaged and integrated work tasks back to the RCM decision-making processes that created them. This includes RCM references, which are embedded in the system and associated with maintenance tasks selected via RCM, as illustrated in Figure 6.

Figure 6: RCM work packaging



This screen capture shows how Maximo Asset Management provides an audit trail for the RCM program.

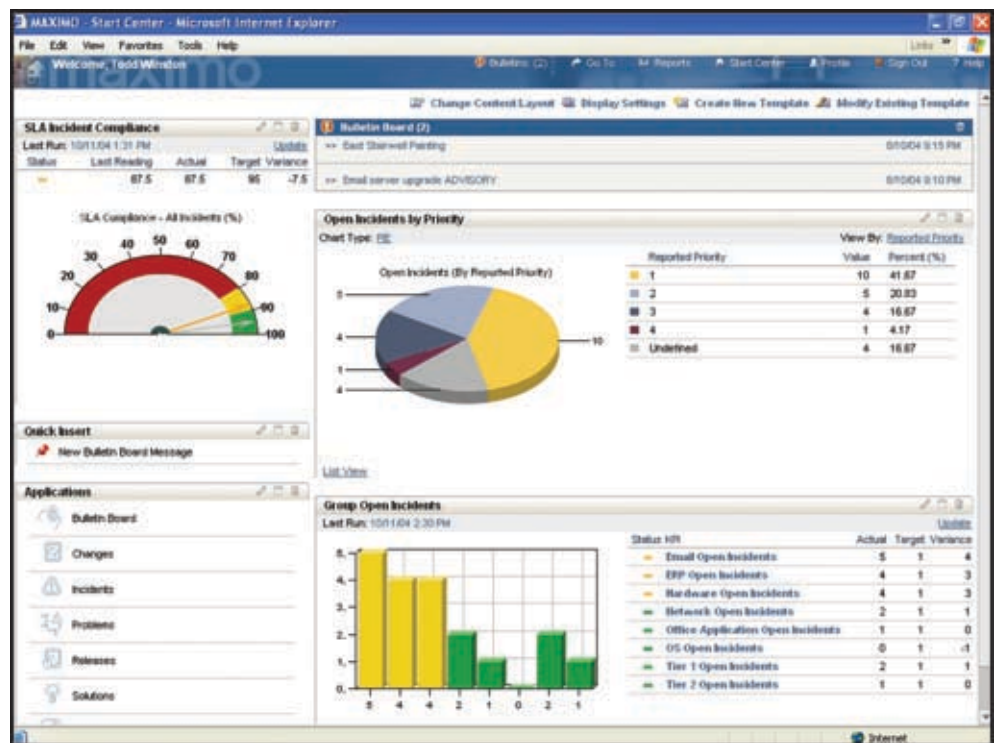
**Step 7: Ongoing monitoring and continuous improvement**

The most important first step in establishing successful on-going monitoring and continuous improvement processes is to understand the “as-is” situation. Utilizing Maximo Asset Management, this can be established in Step 1 of the RCM process by setting out the underlying logic for the areas targeted by the program in terms of their impact on key factors such as security, health and safety, environmental risk, operations and costs. This can help ensure that the best results are achieved in return for the expenditure and resources employed in carrying out the RCM program.

Managing the entire RCM process in close connection and integration with Maximo Asset Management helps ensure not only that the most beneficial plant areas are targeted, but also that the best choices are made among maintenance task options, and that the outputs of the RCM work program become an integral part of plant maintenance strategy and execution.

In addition, the implementation results of the RCM program can be monitored and quantified through the use of Maximo Asset Management in its Work Management, Service Delivery and workflow capabilities utilizing the powerful and user-configurable KPI and dashboard features, as shown in Figure 7. As a result, it becomes part of a continuous maintenance strategy and improved performance.

**Figure 7: Through life management, monitoring and continuous improvement with Maximo Asset Management configurable dashboards and KPIs**



This screen capture shows the user-configurable KPI and dashboard features provided by Maximo Asset Management.

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## Highlights

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***Maximo Asset Management can help improve the reliability of critical assets by addressing service management requirements.***

Maximo Asset Management can also help improve the reliability of each critical asset by managing all necessary steps and processes with regards to the service element and service management requirements linked to these assets. This is done by managing:

- *Service level agreements and performance tracking.*
- *Corrective actions and reporting.*
- *All changes that occur during the entire business process.*

Service level agreements can define and confirm the level of services to be provided to either internal or external customers. Monitoring and managing all corrective actions are also important for compliance reasons (including Sarbanes-Oxley) and in regulated industries (e.g., ISO, FDA).

As mentioned, a service management environment requires that all corrective and preventive actions be managed. This can include incident and problem processes, identifying the source of an incident – or any event that is not part of the standard operation of a service and that could cause an interruption or reduction in the quality of that service.



An incident may be an isolated issue that can be easily resolved. A problem can be an indication of an underlying issue that must be corrected to prevent incidents from recurring. After capturing a change request, the impact of the change needs to be identified. The tasks can then be planned, approved, scheduled and tracked, then implemented and subsequently verified. These business processes provide a consistent approach to handling all reported corrective and preventive actions and help organizations understand the associated risks linked to any change of the business process.

In Maximo Asset Management, the workflow capability is used to manage these processes and to escalate work orders appropriately. The combination of workflow and a knowledge-based system can be set up to track and monitor all incidents and to take the appropriate actions.

Supporting these processes has clear benefits, including the ability to:

- *Respond to and resolve corrective actions as quickly as possible.*
- *Minimize adverse impact on business operations.*
- *Enable root-cause analysis to identify and correct the underlying causes of problems and prevent recurrences.*
- *Formalize documents and automate asset management practices to improve resource utilization and asset reliability.*
- *Provide a structured system and give visibility to the information needed in a service management environment.*

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## Highlights

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### Conclusion

RCM programs have been successful in industries where cost-effectively achieving high equipment reliability and safety is paramount. There are numerous examples where savings of up to 50 percent of direct maintenance costs have been achieved as a result of carefully structured and implemented RCM programs.

For example, take the experience of a company that was preparing to buy additional production equipment in order to meet demand. A 2006 study by MCP Management Consultants of that company found that actual utilization for the current equipment was less than 60 percent and operational equipment effectiveness was less than 55 percent. Using data taken from the plant history held in the asset management system, an RCM analysis identified the main sources of loss and typical failure rates. By eliminating the recurrent failures stops and reducing changeover times, the OEE increased to such an extent that the need for the additional asset investment disappeared, saving the company US\$6 million in unnecessary capital costs.\*

Such savings have been delivered against a background of improving plant performance, raising safety standards, and reducing equipment-related environmental risks.

However, there are also many cases in which RCM programs have failed to produce tangible benefits, despite its expense and use of considerable resources. Most often, this is due to a failure to connect and integrate the program with overall maintenance strategies and supporting information systems.

Used correctly, sophisticated EAM systems can provide a solid foundation on which to build successful RCM programs. They can help set initial priorities for targeting the program, provide the data required to support the questions generated by the RCM process, and also put into practice and execution the results of the analysis. Maximo Asset Management provides essential support at all stages of the RCM process from initial targeting of the RCM program to permanently embedding RCM as an integral component of a continuous performance improvement program in asset-intensive companies.

***Maximo Asset Management provides essential support at all stages of the RCM process.***

**For more information**

To learn more about asset management solutions from IBM, including Maximo Asset Management, please contact your IBM representative or IBM Business Partner, or visit [ibm.com/tivoli](http://ibm.com/tivoli) or [maximo.com](http://maximo.com)

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03-07  
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\* Source: Noel Grinsted, Director, MCP Management Consultants, and experienced Asset Management Strategist.

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