How to Achieve Rapid Results in Developing Asset Reliability Programs

Ivara White Paper

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Equipment Reliability Strategy

Most maintenance professionals would agree that applying a structured Reliability Strategy Development methodology can be taxing on an organization's resources in today's business environment. Which begs the question – "What else is available to rapidly develop or validate reliability programs for my asset base without jeopardizing the safety, environment, quality and production integrity of my plant"?

"RCM sounds like an ideal approach to defining the *right work* for maintaining assets. But to rapidly improve plant performance, we need an approach that balances the resource intensiveness of RCM, with other Reliability Strategy Development methodologies that can be quickly applied across the plant. With this balanced approach, we can turn up plant performance by quickly getting to the *right work*."

The Theory Behind Reliability Strategy Development

Reliability Strategy Development is the foundation of any maintenance process. Identifying the right work at the right time (i.e. an asset's base program) will mobilize organizations to achieve the desired performance from their assets and their facilities.

Reliability Strategy Development methodologies use consistent methods to design maintenance activities – identifying and controlling failure modes that affect the equipment's ability to provide the intended function at the required performance level and ensure that:

- Most maintenance work is proactive (executed prior to the failure event).
- Predictive maintenance technologies are utilized effectively.
- Operational tasks are an integral part of the Asset Reliability Program.
- Acceptance criteria, levels of severity and corrective actions are predefined for all condition and state monitoring tasks.
- Maintenance task intervals are defined based on technically valid principals establishing the 'right time'.
- Root cause failure analysis is applied to address significant failures.

Reliability Strategy Development, as a methodology, produces technically-based reliability programs. Activities are evaluated to judge if they are technically feasible and worth doing based on the consequences of failure.

Reliability Strategy Development Methodologies

Different methodologies are available to define or refine the reliability program for equipment. These typically include the application of:

- Reliability-centred Maintenance (RCM2™)
- Maintenance Task Analyses (MTA)
- Predictive maintenance needs assessments
- Preventive maintenance optimization and failure analysis techniques

Each of these approaches use RCM 'thinking' but some are much less rigorous in approach, thereby exposing organizations to an increased risk of equipment failure when applied. Maintenance Managers and Facilitators need to be educated on the appropriate selection of these reliability program development approaches.

There are many other similar approaches available in the market place that combine elements of the above that can be applied in pursuit of reliability program development efficiency.

Organizations ultimately employ the solution with the lowest resource intensity capable of delivering the highest equipment reliability performance to meet the business goals of the company. Critical to success of implementing reliability-based Asset Reliability Programs is the selection of targeted assets based on consequence and risk to the business as well as the selection of the appropriate Reliability Strategy Development methodologies.

Selecting the Right Combination of Reliability Strategy Development Methodologies

There are two camps when it comes to embarking on a Reliability Strategy Development initiative. One camp would apply the same methodology across all assets using the same application or methodology, the other camp typically uses one application for the critical assets only. Conceptually speaking both approaches are correct. All assets that contribute to the business goals and effectively have “business” consequences should be proactively reviewed for the purpose of reliability. However, based on the results of Asset Risk Prioritization and the current operating context, the selection of the most appropriate methodologies will yield the optimum results. As the adage goes - You need not kill a fly with a sledge hammer.

Asset Risk Prioritization

Before your organization decides what assets are candidates for reliability program review or refinement via a Reliability Strategy Development methodology, stop and ask yourself – Which assets impact my business the most and in what order?

Asset Prioritization is an essential part of the up-front strategic planning required to ensure the success of reliability improvement projects. It is the key to expediting the return on investment of a reliability focused maintenance solution such as an RCM analysis on an asset.

An Asset Prioritization process ensures that your reliability improvement projects are always focused on the assets of highest risk. The definition of high-risk assets, if not formalized, may vary across the organization since the people involved may have used a non-technical basis to assess risk.

Often people say, "All of our assets are critical to our business". However, those opinions are often raised without consensus, and confuse “criticality” with “risk.” The goal is first to achieve consensus on the degree of risk for assets and to create the momentum required to advance the implementation of reliability improvement strategies such as Reliability Strategy Development.

The objective of an Asset Prioritization process is to identify those assets that are most likely to negatively impact business performance because they both matter most when they fail and/or because they are failing too often. Potential consequences of asset functional failure are assessed based on criteria such as safety, environmental integrity, quality, output, customer service, operating costs (or other agreed-upon core business criteria).

Frequency of failure and therefore corrective maintenance work order frequency is multiplied by the consequence score to determine a Relative Risk number.

CONSEQUENCE X FREQUENCY

= RELATIVE RISK

The resulting Relative Risk rating is used to identify and prioritize candidates for Reliability Strategy Development methodologies such as RCM.

This process ensures Production and Maintenance Managers continuously focus on achieving business results rather than reacting to asset failure.

Benefits of Reliability Strategy Development Methodologies

Once asset priorities have been established and before choosing one or more proactive Reliability Strategy Development methodologies, it is important to understand the benefits of each method:

Reliability-Centered Maintenance

Reliability-centered Maintenance (RCM2) is the most highly structured Reliability Strategy Development methodology. RCM2 can go beyond reliability program development by including failure modes addressing causes of human error and design deficiencies. When

these are included RCM2 produces the following outcomes:

- Maintenance programs evaluated on technical feasibility and economic worthiness.
- Recommendations addressing changes to standard operating practices.
- Operational and maintenance training/procedural recommendations.
- Physical redesign recommendations.
- Consolidated and validated information for use in training programs.

The RCM2 process requires answers to the following seven questions:

1. What are the functions of the asset in its present operating context?
2. In what ways can it fail?
3. What causes it to fail?
4. What happens when it fails?
5. Does it matter if it fails?
6. What can be done to predict or prevent the failure?
7. What can be done if you can't predict or prevent the failure?

What will RCM2 do for you?

An Asset Reliability Program is designed by selecting maintenance tasks directed to mitigate failure causes or failure modes. Tasks are defined to detect, predict or prevent failure and provide a proactive management policy to take action to minimize or eliminate the failure consequence.

In defining the reliability program, each task needs to be rationalized against the cause of failure it is meant to address. If a task does not address a known cause of failure, it should be excluded from the reliability program.

The RCM2 process includes a detailed failure mode and effect analysis. All failure modes, considered reasonably likely to occur, are identified. This ensures the failure management strategy is comprehensive, addressing all reasonably likely causes of failure. Recommendations must be made to deal with each cause of failure. Failure effect descriptions provide sufficient information to evaluate the consequences of failure. The RCM2 decision logic provides criteria for determining if a task can technically manage the failure consequence and also provide criteria for establishing whether the task is economically feasible.

Sometimes, the default decision in RCM2 could be a conscious decision to allow the equipment to run-to-failure because the failure consequences are tolerable and preventing the failure may not be technically feasible or worth doing. Also, human error causes and design deficiencies can account for a surprisingly high number of failure modes in an RCM2 analyses. Other default decisions covered by question 7 provide the ability to define recommendations to modify operating procedures, train maintainers and operators, and to redesign the equipment. The technical basis for each recommendation is provided. All reasonably likely failure modes are addressed by recommending the best failure management strategy whether it is proactive maintenance or not.

In RCM2, failure is defined as the inability to meet a performance standard. Functional failures are defined for each performance standard that can be breached.

Physical assets exist in the first place because we want them to perform specific 'functions' at or above a minimum level of performance. Most assets have more than one function with related performance standards. To ensure that all 'functional failures' are considered and all failure causes are identified the reliability program development strategy must start by considering all the functions and performance levels required by the owner/user.

Each step in the RCM2 process is logical and necessary. A properly applied RCM2 analysis minimizes the risk that significant causes of failure are overlooked. All reasonably likely causes of failure are considered and addressed by recommending the optimum failure management strategy.

One of these outcomes is a technically based Asset Reliability Program designed to deliver the targeted performance requirements of the owner/user. This is by definition, the base work for the asset being analyzed. Existing routine tasks not validated by RCM2 are the non-value added component of work and should be eliminated. The complete

identification of the base work will also result in the minimum deviation work.

Maintenance Task Analysis

Ivara Maintenance Task Analysis (MTA) is an extremely cost effective and practical way to develop reliability programs for equipment. With MTA, you can build and implement basic reliability programs for all plant assets in the shortest timeframe possible.

Starting in the area that will have the highest impact, this accelerated FMEA analysis can then be expanded to other systems and areas - creating and implementing the programs system by system, thereby achieving rapid results.

The MTA Process

Maintenance Task Analysis is a facilitated process used to develop an Asset Reliability Program quickly, with low resource intensity. Although less structured than RCM2, MTA makes better use of people's expertise and experience, both operations and maintenance personnel. MTA delivers the basic reliability program quickly.

The MTA process defines the program for and implements the proactive tasks recommended by multiple reliable sources of knowledge about the equipment – the input of skilled trades, operators and equipment specialists. This approach is effective in reducing preventable failures and managing the consequences of the failure.

Maintenance Task Analysis can:

- Validate existing asset reliability programs
- Create new reliability programs
- Address previously unidentified causes of failure (failure modes)
- Optimize existing programs by inactivating tasks that do not address known causes of failure

MTA is both fast and efficient to implement, keeping costs and resource pressures minimal. MTA focuses on recognized best practices and utilizes condition and state monitoring rather than time-based maintenance.

Reliability programs built using MTA ensure that it is the health of the equipment that dictates when to take action rather than basing the task frequency on a calendar. Calendar or time-based maintenance presumes that assets break down at fixed intervals, which is not the case, so they are usually highly reactive in nature.

MTA provides a better understanding of the required proactive maintenance tasks and task intervals. In using MTA to create new Asset Reliability Programs, equipment templates on similar assets are used to jump start the process. Then subject matter experts are interviewed to identify recognized reliability practices. Participants evaluate current maintenance tasks, remove unnecessary tasks, identify additional tasks, identify optimal task intervals, and define the appropriate condition and state indicators to monitor. Lastly, vendor-recommended reliability programs are reviewed.

MTA Templates

MTA software allows for the development of a library of equipment templates. MTA templates are used to speed creation of reliability programs on similar assets. In all cases, these templates are carefully reviewed to ensure that the recommended tasks are applicable and effective in the operating context of the equipment being reviewed. MTA templates provide a pre-defined, ready-to-use starting point for the analysis.

MTA Captures Intellectual Knowledge

Today, companies face a significant challenge in trying to retain the enormous amount of knowledge that will soon be lost as experienced maintenance workers retire. During their twenty to forty years on the job, these workers collect a wealth of knowledge, but this information is almost never documented or transferred to others. This expertise includes asset prioritization, asset condition and performance targets, inspection

knowledge and general know-how pertaining to the maintenance of critical assets. All of this knowledge will be lost if companies do not systematically collect the information as the employee performs his/her job.

Maintenance Task Analysis tools capture the equipment expertise of the people who know the equipment best. The maintenance task analysis facilitator interviews subject matter experts to identify best practices and turns that knowledge into useful information that is easily accessible within the tool.

MTA as a Long Term Strategy

Maintenance Task Analysis delivers rapid results by enabling companies to quickly create and implement basic, technically-sound reliability programs. Many companies have successfully followed up the MTA process with RCM on the highest risk assets, while continuing to use MTA to get full coverage across the plant. Using MTA as a long-term strategy, assets can be revisited to continuously improve the reliability programs. The focus on the people issues ensures that maintenance and operations can sustain the reliability improvement.

Predictive Maintenance (PdM) Needs Assessment

In recent years, tremendous advances have been made in the area of condition monitoring and predictive maintenance. When properly applied, PdM allows you to leave the equipment on-line until its condition deteriorates to the point that failure is imminent. The useful life of equipment is maximized. Personnel conversant with these technologies are able to quickly identify opportunities to apply their trade with other equipment and systems.

Predictive Maintenance Needs Assessment combines predictive maintenance expertise and process expertise to make recommendations for the application of condition monitoring techniques. This includes, but is not limited to, the application of vibration monitoring, thermography, lubrication serviceability and wear and contamination testing, traditional non-destructive testing techniques and electrical equipment monitoring techniques. The objective is to realize the benefits of applying PdM technology in the shortest time with minimum resource intensity.

The Predictive Maintenance Needs Assessment attempts to define the predictive maintenance component of base work. This could include displacing some intrusive maintenance tasks.

Root Cause Analysis

Different approaches are available to investigate the cause of failures and identify what should be done to prevent them from re-occurring. Like RCM2, failure analysis methodologies seek to identify the failure modes responsible for equipment failure. Failure analysis is conducted in reaction to a specific failure (i.e. after the fact). It seeks to identify the cause of that failure and what should be done to prevent the specific failure cause in the future. Often the focus of failure analysis is on the component(s) that have failed and, depending on the methodology, may not identify the root cause.

Apollo's root cause analysis methodology is proven to prevent problem recurrence and ensure continuous improvement. Unlike other root cause analysis methods which are based on a predefined hierarchy of causes, Apollo's RCA encourages input from all stakeholders -- top to bottom – resulting in effective solutions that everyone can agree on every time.

Apollo's RCA provides a disciplined approach to avoid the recurrence of unexpected failures which might still have occurred after a Failure Mode analysis had been implemented to accelerate resolution of chronic problems and provide a systematic approach for continuous improvement.

How to Select the Right Reliability Strategy Development Methodology

To select the right Reliability Strategy Development methodology for an asset, consider its operating context to determine the next best course of action.

The Ivara Reliability Strategy Selector provides a structured decision logic to determine the best fit.

The process starts with prioritizing assets according to risk. Once this has been done, you need to determine if there has been any existing obvious / known causes of failure? If not, then you review the design of the equipment to ensure that it handles the necessary performance requirements. If it does, then determine if the consequence of failure is tolerable for that asset? If the answer is no, then apply RCM2.

If the answer is yes, that the consequence of failure is tolerable, then you need to determine if the equipment performance and relative risk are satisfactory? Performance considerations include operating costs, maintenance costs, throughput, quality, environmental compliance, safety, etc. Relative Risk (consequence of failure x probability) is derived from the Asset Prioritization analysis. For new assets you may wish to assume the relative risk is not tolerable.

If performance and relative risk are not satisfactory, then you need to apply RCM2 – unless there are schedule time constraints, in which case apply MTA.

If performance and relative risk is satisfactory, then you will ask whether or not the knowledge of this equipment's reliability program is adequate? Equipment knowledge includes design, operational and maintenance knowledge, and must be documented in the form of standard operating practices and maintenance procedures. In many companies today, the average age of the workforce is 50 or higher, so loss of knowledge with impending retirements is an issue that needs to be addressed.

If the knowledge is satisfactory, do nothing but continue with the current program. However, if the knowledge level is not satisfactory, then apply MTA.

Root Cause Analysis (ie. Post failure) can be used at any time to prevent recurring failures and to refine the existing reliability program.

In Pursuit of Rapid Results

Within most organizations assets will be found at various levels of performance with varying degrees of reliability program definition. Prioritizing assets by risk and selecting the right combination of Reliability Strategy Development methodologies is key to achieving rapid results.

No one method for reliability program development will satisfy all situations. The optimal plan to address the reliability programs in an organization includes multiple, parallel methodologies.

In theory, non-rigorous methodologies should be applied quickly, with low resource intensity rapidly covering the asset base. Once the 'low hanging fruit' is addressed, what remains are problems requiring a more rigorous approach to find a solution.

As the organization progresses, more of the effort expended on the Reliability Strategy Development function will be directed to applying rigorous approaches. Eventually, RCM2 will become the primary application to perfect the reliability program, minimize risk and maximize results.

ACKNOWLEDGMENTS

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