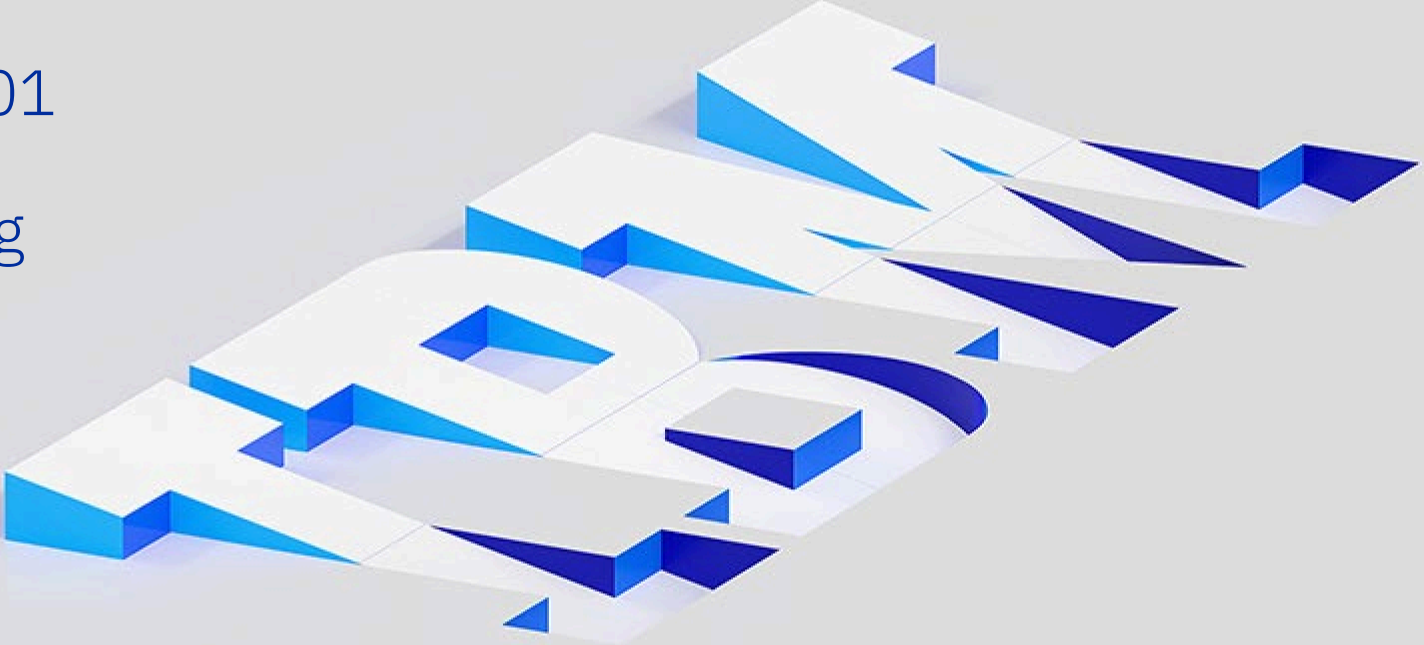
RCM 101

Training

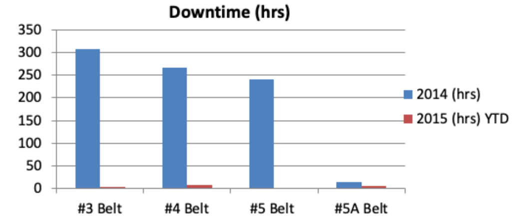


RCM 101
Objective: Provide a basic understanding of the RCM Process, Challenges and Benefits

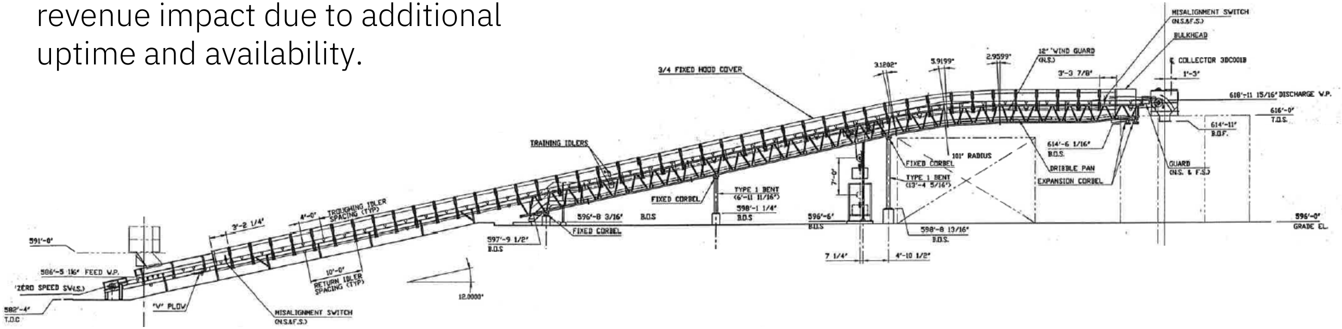
Why is RCM important to customers?

- One petrochem customer, applying RCM for one asset type, was able to:
  - Reduce repair costs by 44% ($678K) year to year
  - Reduce nonproductive downtime by 97% year to year, resulting in a <u>$60M</u> revenue impact due to additional uptime and availability.

Results in numbers: Costs/Benefits

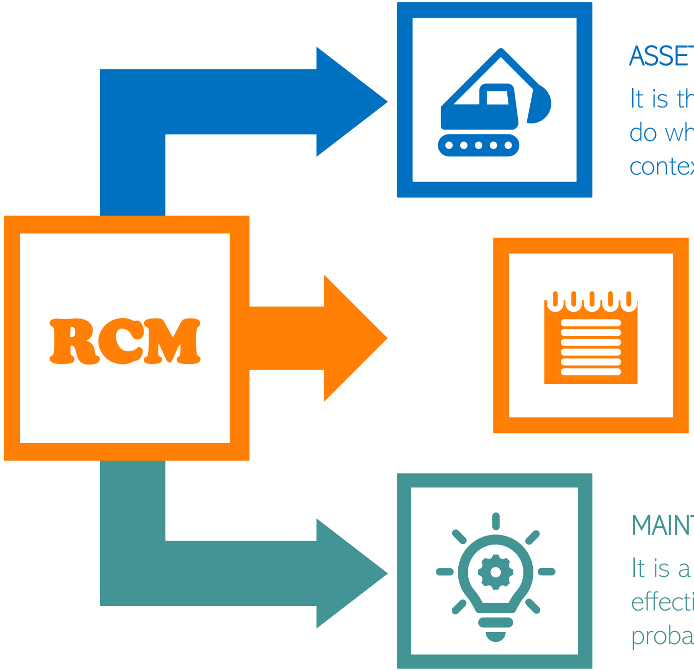


	#3 Belt	#4 Belt	#5 Belt	#5A Belt	Total
Downtime 2014 (hrs)	307	267	240	14	828
Downtime 2015 (hrs) YTD	5	12.6	0.3	5.2	23.1
Cost reduction 2015/2014 %	36%	106%	69%	39%	56%



Reliability Centered Maintenance: Background

An analytical & methodical process used to determine appropriate failure management strategies to ensure safe and cost-effective operations of a physical asset in a specific operating environment



ASSET MANAGEMENT

It is the process to ensure that assets continue to do what their users require in their present operating context, and throughout its lifecycle.

RELIABILITY

It represents tactics that maximize the asset's reliability and availability

MAINTENANCE

It is a structured process to develop an efficient and effective maintenance plan for an asset to minimize the probability of failure

Reliability Centered Maintenance: Background

In 1999, Society of Automotive Engineers (SAE) decided to emit a rule which contained the minimum requirements that a methodology had to accomplish in order to define itself as RCM

SAE JA1011
Provides specifying the minimum criteria that a process must have in order to be an RCM process

INTERNATIONAL®

SAE JA1012
A Guide to Reliability-Centered Maintenance (RCM)

Both rules try to establish a minimum requirements that a methodology has to accomplish in order to be called RCM.

RCM Process Example - Pump

Question	Defines:	Example
1. What is the item supposed to do and what are its associated performance standards?	Functions	*To provide cooling water to process line electric drive motor bearings at not less than 800 gallons per minute and 30 psi*
2. In what ways can it fail to provide the required functions?		*Fails To provide 800 gallons per minute of cooling water at 30 psi*
3. What are the even cause each failure?		*r worn due to cavitation*
4. What happens wh failure occurs?		*ion line slows to prevent bearing ting*
5. In what way does failure matter?		*$10,000/hr for every 10% of lost ion*
6. What task(s) can be performed, or technology applied to prevent or the consequences of the failure?		*1. Inspection* *2. Pump Performance Test*
7. What must be done if a suitable preventive task cannot be found?	Default Actions	*1. Replace Impeller* *2. Redesign pump* *3. Modify operating procedures*

FMEA

RCM

Function: simply what the

Functional Failure: A state in which a physical asset or system is unable to perform a specific function to a desired level of performance.

How: Cavitation

*more detailed definitions in the appendix

RCM Benefits Are Significant

Optimized Reliability Routines

Creates an avenue to optimize preventive maintenance tasks by eliminating non-value -added maintenance activities.

Improved Safety Culture

With RCM, organizations can easily identify asset failure consequences that contribute to safety and compliance risks and select appropriate mitigation strategies.

Increased revenue

Results in value-based reliability that ensures that assets are not over or under maintained

Optimized Asset Performance

Takes asset's function and operating environment into context resulting in optimized performance

Improved Maintenance Culture

RCM creates an opportunity for organizations to move away from reactive to proactive strategy-based maintenance

So why is RCM not widely implemented?

Very Time Consuming

Studies are time consuming and require all the best people to be offline

Highly Resource Dependent

Takes considerable man-hours that would have been otherwise spent on maintaining equipment

Lack of Data Availability

Data availability and disparate systems make conducting the study and implementing the actions difficult

Scaling RCM is difficult

Scaling RCM based methods, integrating systems and leveraging standardize data across sites is costly or just doesn't happen

Draft

Introducing “*Reliability Strategies with Reliability Strategy Libraries*”

Maintenance Strategies with Reliability Strategy Libraries

makes it easy to select and apply Reliability Strategies and speeds time to value

A dedicated RCM/FMEA application with included library. Together, it becomes a game-changer with rapid time to value.

Challenges

We have struggled w RCMs in the past

“RCM studies take forever, and tie up our resources for weeks”

IBM Solution

Value based strategies out of box

- 75% faster than traditional RCM studies
- 20%⬇in maintenance $

RCM Key Definitions

Reliability Centered Maintenance (RCM)

RCM is a process used to identify the policies which must be implemented to manage the failure modes which could cause the functional failure of any physical asset in a given operating context. RCM typically includes Failure Modes and Effects Analysis (FMEA).

Failure Modes and Effects Analysis (FMEA)

FMEA is the process of reviewing components, assemblies, and subsystems to identify potential failure modes and their causes and effects.

Function

The objective of the RCM process is to develop a set of policies that preserve the functions of the asset or system under consideration to standards of performance that are acceptable to its owner/user. As a result, the RCM process starts by identifying all the functions of the asset in its operating context.

A Function is simply what the owner or user of a physical asset or system needs it to do.

Functions are often divided into two categories: primary and secondary functions.

PRIMARY FUNCTIONS—The reason why any organization acquires any asset or system is to fulfill a specific function or functions. These are known as primary functions of the asset. For instance, the main reason why someone acquires a car may be “to transport up to five people at speeds up to 90 km an hour along suitable roads.”

SECONDARY FUNCTIONS—Most assets are expected to perform other functions, in addition to the primary functions. These are known as their secondary functions. Secondary functions are usually less obvious than primary functions. But the loss of a secondary function can still have serious consequences, sometimes more serious than the loss of a primary function. As a result, secondary functions often need as much if not more attention than primary functions, so they too must be clearly identified.

Functional Failure

All the failed states associated with each function shall be identified.

A Functional Failure is a state in which a physical asset or system is unable to perform a specific function to a desired level of performance.

4 types of functional failures are:

- Safety – personnel or public (health or harm, environment)
- Operational – economic loss (e.g. lost production) plus cost of repair/replacement
- Non-Operational – cost of repair/replacement
- Hidden-failure – undetected failure leading to a functional loss (generally leads to Operational or Safety)

Failure Mode

Examples Failure Modes

- Bearing seized
- Stem broken
- Winding burned out
- Filter blocked

Failure mode is a description of how a component potentially fails.

- The failure mode description normally has a reference to a component.
- It is not a description of how something is not happening.
- Preferably without using a negative “verb” (e.g. doesn’t or incorrectly) or the word fail. If it does have a negative verb it is most likely a functional failure (i.e. functional failure of the system instead of asset).

Failure mechanism

Examples Failure Mechanisms

- Fatigue
- Corrosion
- Overload
- Damage

A Failure mechanism is how a failure mode originates.

- It normally helps if you complete your failure mode with “due to..”. The answer is the failure mechanism. E.g. pump blocks “due to” debris or Bearing seizes “due to” wear.
- The failure mechanism also indicates on what the inspection will be focusing on (e.g. failure mode is blocks break and the condition is wear. The action could be physical inspection on wear of blocks.)

Failure Effects

Failure effects statements are used to assess the consequences of each failure mode. They also provide the basic information needed to decide what failure management policies must be implemented to avoid, eliminate or minimize these consequences to the satisfaction of the owners/users of the asset.

Failure effects describe what would happen if no specific task is done to anticipate, prevent or detect the failure.

- It is essential to assume that no proactive maintenance is being carried out, when identifying the failure modes and associated effects. In other words, in order to start from a true zero base, it is essential to assume that the failure mode does in fact cause the associated functional failure. Failure modes need to be described, and failure effect statements need to be written, accordingly.

Failure Consequences

The extent to which each failure mode matters depends on the operating context of the asset, the performance standards that apply to each function, and the physical effects of each failure mode.

Failure consequences The way(s) in which the effects of a failure mode or a multiple failure matter

- The primary source of information used to assess failure consequences is the description of the failure effects.

Hidden Failure

Is a failure that is not detected during normal operations and only becomes evident after another event or action.

- Hidden failures have no direct impact, but they expose the organization to failures with serious, often catastrophic, consequences.

- Most of these failures are associated with protective devices which are not fail-safe.

Examples of hidden failures are

Emergency stop blocked

Sprinkler system misdirected

Gas detection sensor damaged

Low measurement settings drifted