Adopting Risk-Based Maintenance: Enabled by SAP Asset Strategy and Performance Management

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- Solution Manager, SAP SE
- Dean is a member of SAP’s global Enterprise Asset Management (EAM) solutions team. Dean is based at SAP Global Headquarters in Walldorf, Germany. Dean joined SAP in 1998 as a Plant Maintenance (PM) Consultant with SAP Africa, before moving to Germany in 2001.
- Fun fact: Rode the Cape Argus cycle tour 26 consecutive times
Key Outcomes/Objectives

1. A risk-based maintenance approach enables better decision-making for maintenance planning and reduces the probability of asset failure
2. Minimize environmental and safety risks
3. Enhance asset reliability and availability
Agenda

• SAP Intelligent Asset Management
• Business Background and Drivers
• Solution Overview
• Summary
• Q & A
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SAP Enterprise Asset Management Portfolio – Business Capabilities

**State-of-the-art business processes**
Leverage new technologies to enable new asset management business processes anywhere and anytime.

**Real-time insights**
Bring together information from operational and business systems using IoT for scalable transparency.

**Risk-based asset strategies**
Adopt risk based approach to determine critical assets driving optimal asset strategies.

**The power of prediction, optimization and simulation**
Drive smarter decisions, improve reliability, and reduce outages.

**Collaboration throughout the asset lifecycle**
Share asset information, access one version of the truth, and collaborate on a cloud-based business network with integrated processes.
Asset Central Foundation enables asset information to be modelled utilizing templates based on ISO standards e.g. ISO14224. Models, equipment, locations, systems, groups, spare parts, documents, instructions, failure modes are all included in Asset Central Foundation.

The Risk and Criticality assessment ranks assets by risk and criticality which can then be used as the basis for further analysis. This is achieved by setting up a matrix of consequence of failure vs probability of failure.

Use proven methodologies like Reliability Centred Maintenance (RCM), Failure Modes and Effects Analysis (FMEA), Preventive Maintenance Review* (PMR), Risk Based Inspection** (RBI), Root Cause Analysis* (RCA) or Checklists to identify the optimal maintenance strategies for your assets.

*planned  
** partner planned
Business Background and Drivers
Good Asset Management Leads to Improved Business Outcomes

- Reduction in safety incidents
- Reduction in Environmental Incidents
- Adherence to Statutory Regulations

- Reduced Annual service and maintenance cost
- Adherence to Planned maintenance budget vs. actual cost
- Reduced energy and input costs

Drive Safe operations

Reduce Costs

Maximize Asset Productivity

- Increased Overall Equipment Effectiveness
- Increased Return on assets
- Reduction in Unplanned outages
Technology is changing our approach to maintenance

*Use of Maintenance Strategy – **Today**

- Reactive
- Preventive
- Predictive

*Use of Maintenance Strategy – **Future**

- Reactive
- Preventive
- Predictive

Although still relevant, **preventive** maintenance can result in over-maintaining assets and higher costs.

The Internet of Things is leading to increased use of **predictive** maintenance.

The goal is to enable more **IT driven** (data science & rules driven) approaches to predictive maintenance in order to reduce unplanned failures and the number of overall maintenance actions.

*Proportion of maintenance strategies are for illustration purposes only and will vary based on many factors.
Determining the Correct Maintenance Strategy
Apply industry standard methodologies to determine optimal asset strategies

Methodologies
- Risk & Criticality Analysis (RC)
- Reliability Centered Maintenance (RCM)
- Failure Modes & Effects Analysis (FMEA)
- Preventive Maintenance Review (PMR)
- *Root Cause Analysis (RCA)
- *Risk Based Inspection (RBI)

Asset Strategies
- Preventive
- On-Condition
- Predictive
- Failure Finding
- Run to Failure
- Modification

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Solution overview
SAP Asset Central Foundation
Next-Generation Master Data Layer

Asset Classification
- Classes
- Subclasses

Asset Modelling
- Templates
- Models
- Attributes
- Indicators

Asset Representation
- Equipment
- Systems
- Locations
- Groups
- Function
- Functional Failure

Asset Information
- Instructions
- Alert Types / Rules
- Announcements
- Spare Parts
- Performance Improvement
- Notifications
- Documents
- Work Orders
- Failure Modes

Organization Representation
- Company Profile
- IAM
Models and Equipment

Template System

CLASS:
- Transformer
- Power
- Instrument
- Motor
- Pump
- Switchgear

MODEL Template
- E-23
- E-24

MODEL
- E-23-8384
- E-23-9547
- E-24-7487
- E-24-8748

EQUIPMENT
- E-23-8384 Ser No: 981 4981
- E-23-9547 Ser No. 978 2547
- E-24-7487 Ser No: 898 8742
- E-24-8748 Ser No: 257 6884

CLASS:
- Transformer
- Motor
- Pump
- Switchgear

SUBCLASS:
- Power
- Instrument
SAP Asset Strategy and Performance Management

Equipment: Features

VALVES / PSV-CONVENTIONAL /

PSV Emerson JOS-E 1010  EQ-1010

Manufacturer: SAP Manufacturer  Location: 20PSV001  External IDs  Phase: Planned  Status: Published  Risk/Criticality: ⚫ High  Languages: EN

Shared With: 1 Partners

INFORMATION  STRUCTURE & PARTS  DOCUMENTATION  MONITORING  MAINTENANCE & SERVICE  ASSESSMENT  TIMELINE

Highlights

Data Sheet

Equipment Information

Business Partners

Installation Location

Systems

Groups

Highlights

Structure

Spare Parts

Visual Parts

Highlights

Documents

Instructions

Failure Modes

Alert Types

Announcements

Improvement Requests

Indicators

Component Indicators

Highlights

Notifications

Work Orders

Highlights

Matrix

Risk and Criticality

Questionnaire

FMEA

Checklists

RCM
**Systems:**
Define the boundaries and function of the systems that contain the selected equipment

- A system is an overview with a logical structure throughout complex assets or asset structures.
- Examples are fluid systems, braking systems or piping systems.
- Systems can be nested.
- In parallel the topology of a system can be visualized using the functionality of our Hilscher Net IoT partnership.
Groups
Models, Equipment and Locations

- There are different types of groups e.g. assign equipment into different groups based on risk and criticality assessment.

- Objects that are grouped can be analyzed by population or age. You can filter by all kinds of objects (Equipment, Model, Subclass, Manufacturer etc.)

- An FMEA Assessment can be performed on a group
Location
Asset Hierarchies

- Flexible configuration of naming conventions for master data standardization
- Parent/child relationships for master data inheritance
**Documents**

Stores and shares multiple documents across objects

<table>
<thead>
<tr>
<th>Document</th>
<th>File Name</th>
<th>File Type</th>
<th>Confidentiality</th>
<th>Language</th>
<th>Phase</th>
<th>Category</th>
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| Created On: | Aug 25, 2018 |     |                 |          |       |          |        |
| Data Sensitivity: | No Sensitive Information | |             |          |       |          |        |

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| Assignments: | Yes      |          |                 |          |       |          |        |
Failure Modes

- A failure mode is a probable failure that could occur to a piece of equipment.
- Failure Modes can be assigned to Models, Equipment, Locations, Spare Parts, and Groups.
- They are based on a subclass and have different categories and types.
- RAMS Figures (Reliability, availability, maintainability, and safety) and KPIs (MTTF, MTTR, MTBF).
Instructions

Instructions describe how to execute maintenance

- There are different types of Instructions e.g. Breakdown, Installation, Operations, Planned Maintenance

- Instructions can be assigned to Models, Equipment and Groups

- Failure Modes can only be assigned to Breakdown Instructions.

- You can define the number of steps, duration, criticality, safety rules, tools and required spare parts.

- Additionally you can define preconditions, the steps themselves and post checks.

- You can add different documents. If you added an animated 3D file (.vds) the end user can view the sequences.
Function

Functions are used to define how the assigned objects are intended to operate. You can assign functions to equipment, models, locations and systems.

You can currently use this feature in the Reliability Centred Maintenance (RCM) assessment.
## Functional Failure

A functional failure is assigned to a function during RCM assessment.

<table>
<thead>
<tr>
<th>Functional Failures</th>
<th>Failure Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not tripping when current ≥ 80 Amps</td>
<td>Alert</td>
</tr>
<tr>
<td>FF.OP:ER 2</td>
<td></td>
</tr>
<tr>
<td>Internal leakage below setpoint</td>
<td>Notification</td>
</tr>
<tr>
<td>FF.OP:ER 3</td>
<td></td>
</tr>
<tr>
<td>Not venting when pressure ≥ 80 Bar</td>
<td>Notification</td>
</tr>
<tr>
<td>FF.OP:ER 1</td>
<td></td>
</tr>
</tbody>
</table>

Last Updated: Mar 17, 2019
Asset Central Foundation
ERP Integration

• Integration scenario ensures asset information is kept current between Asset Central (ACF) and Enterprise Asset Management (EAM).

• Integration between AC & EAM, covers both data & user experience improvements.

• Integration provides Bi-directional synchronization of asset information for technical objects –
  o Equipment
  o Functional Location
  o Documents
  o Notifications
  o Work orders


Checkout the new integration guide!
SAP Asset Strategy and Performance Management

- Define Systems & Assets to Analyze
- Identify Critical Assets
- Perform Analysis
- Develop Recommended Actions
- Implement Maintenance Strategies
- Monitor and Improve
Assess which are the **critical assets** to determine which assets are likely to benefit most from application of RCM, FMEA or PM Review

**Description:**
- Assessment of asset(s) (equipment, location, group or system) criticality based on risk score.
- Calculation of risk score based on different dimensions and scales and for different impact categories.
- Supporting the selection of the most appropriate analytical process (i.e. RCM/FMEA, PM review, CM) based on the result of the criticality assessment
- Informed assessment based on historical maintenance data and relevant KPIs (EAM/PdMS integration).
Risk and Criticality Assessment
Questions & Answers View

Matrix

Dimensions (2)

<table>
<thead>
<tr>
<th>Question</th>
<th>Question Text</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔ What is Category of Failure Consequence?</td>
<td>What is Category of Failure Consequence?</td>
<td>Moderate</td>
</tr>
<tr>
<td>✔ What is the consequence to Operations?</td>
<td>What is the consequence of Failure to Operations?</td>
<td>XII</td>
</tr>
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</table>

Answers (4)

<table>
<thead>
<tr>
<th>Answers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Failure resulting in death - system loss</td>
</tr>
<tr>
<td></td>
<td>Severe Injury. Damage &lt; 100000 USD</td>
</tr>
<tr>
<td></td>
<td>Minor Injury or illness. Damage &lt; 250000 USD</td>
</tr>
<tr>
<td></td>
<td>Very minor Injury. Damage &lt; 50000 USD</td>
</tr>
</tbody>
</table>

Note:
### Risk & Criticality Assessment

**Matrix View**

<table>
<thead>
<tr>
<th>What is the consequence to Operate...</th>
<th>Catastrophic</th>
<th>Severe</th>
<th>Moderate</th>
<th>Minor</th>
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<tbody>
<tr>
<td>IV</td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>4.00</td>
</tr>
<tr>
<td>VIII</td>
<td>2.00</td>
<td>4.00</td>
<td>6.00</td>
<td>8.00</td>
</tr>
<tr>
<td>XII</td>
<td>3.00</td>
<td>6.00</td>
<td>9.00</td>
<td>12.00</td>
</tr>
<tr>
<td>XVI</td>
<td>4.00</td>
<td>8.00</td>
<td>12.00</td>
<td>16.00</td>
</tr>
</tbody>
</table>

**What is Category of Failure Consequence?**

- Catastrophic
- Severe
- Moderate
- Minor
Equipment
Assessment Overview

Circuit Breaker - Type 1000

Risk and Criticality
Updated By Fitt, Dean (Nov 5, 2018)
Risk/Criticality: 11.5 A “High”
Normalized Risk: 70.0% OEM guidelines

Risk Type Score Difference
Current Risk: 8.25
Mitigated Risk: 3.25

FMEA
Updated By Fitt, Dean (Nov 14, 2018)
RPN: 108
Preventive Activities: 1
Corrective Activities: 1

Pending Assessment
Risk and Criticality 0
Questionnaire 0
FMEA 0
Checklist 1
RCM 0

Checklist Records
Substation Inspection 3.00
Equipment List
Showing Risk, Criticality and Recommended Action
SAP Asset Strategy and Performance Management

- Define Systems & Assets to Analyze
- Identify Critical Assets
- Perform Analysis
- Develop Recommended Actions
- Implement Maintenance Strategies
- Monitor and Improve
Reliability Centered Maintenance (RCM)

The purpose of the standard SAE JA1011, published in 1999, is to set out the criteria that any process must comply with in order to be called “RCM.” The twelve pages’ document, revised in August 2009, describes the minimum criteria for a process to be considered an RCM-compliant method. The standard provides the criteria to establish if a given process follows the creeds of RCM as originally proposed. It can also serve as a guide for organizations seeking RCM training, facilitation or consulting.

Document SAE JA1011, AUG 2009, establishes that for a Process be acknowledged as RCM it must follow the seven steps in the order shown below:

1. What are the functions and associated desired standards of performance of the asset in its present operating context (functions)?
2. In what ways can it fail to fulfill its functions (functional failures)?
3. What causes each functional failure (failure modes)?
4. What happens when each failure occurs (failure effects)?
5. In what way does each failure matter (failure consequences)?
6. What should be done to predict or prevent each failure (proactive tasks and task intervals)?
7. What should be done if a suitable proactive task cannot be found (default actions)?

* Reliability Centered Maintenance (RCM) is a process standardized through SAE JA1011 - SAP ASPM supports asset centric companies to apply this standard and allow partners & customers to enrich and extend complying with more specific RCM processes like RCM™ by the Aladon Network
Reliability Centered Maintenance (RCM*)

7 + 1 Questions

0. Which Assets or Systems do I want to Analyze?
   Scope – **Switchgear System**

1. What are the desired functions and performance in it’s operating context?
   Functions – **Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream.**

2. In what ways does it fail to fulfil its functions?
   Functional Failures – **Not tripping when current >= 80 Amps**

3. What causes each functional failure?
   Failure Modes – **Circuit Breaker Fails to Close**

4. What happens when each failure occurs?
   Failure Effects – **Loss of Power**

5. In what way does each failure matter?
   Failure Consequences – **Network operation impacted**

6. What can be done to predict or prevent each failure?
   Proactive Tasks & Task Intervals – **Yearly inspection to check for water ingress**

7. What can be done if the failure cannot be predicted or prevented?
   Default Actions – **Replace switchgear**

Result: Recommendations
- Preventive Tasks
- Corrective Tasks
= ‘Maintenance Strategy’

* Reliability Centered Maintenance (RCM) is a process standardized through SAE JA 1011. SAP ASPM supports asset centric companies to apply this standard and allow partners & customers to enrich and extend complying with more specific RCM processes like RCM 3™ by the Aladon Network.
Reliability Centered Maintenance (RCM):
RCM Assessment

RCM for SWITCH-1000

Status: Published
Assessment Template: AT.OPER.153

INFORMATION  ASSESSMENT  DOCUMENTATION

SWITCH-1000 / De-energize equipment / Not tripping when current >= 80 Amps / Circuit Breaker Fails to Close /

Effects (1)

Loss of Power
EF.OPER.25

Consequence Evaluation

Can the network still be operated?
Switchgear Risk Analysis

Is a replacement possible in the short term?
Switchgear Risk Analysis

Is this switchgear part of the 3% to be replaced this year?
Switchgear Risk Analysis

Impacts / Sections:
Recommended Mitigation Step: Perform combination of On-Condition/Restoration/Replacement Task

Preventive / Corrective Instructions

Description | Activity | Estimated Cost (Euro) | Estimated Frequency | Risk Reduction (%) | Performed By
--- | --- | --- | --- | --- | ---
Visual inspection | Inspection | 500 | 12 Time Months | 75 | Electrician
### Decision Diagram (Advanced Check List)

#### Switchgear Risk Analysis (5)

<table>
<thead>
<tr>
<th>Question</th>
<th>Question Text</th>
<th>Answers</th>
<th>Next Step</th>
<th>Secondary Step</th>
</tr>
</thead>
<tbody>
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<td>Can the network still be operated?</td>
<td>No</td>
<td>Is this switchgear part of the 3% to be replaced this year?</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>Is a replacement possible in the short term?</td>
<td></td>
</tr>
<tr>
<td>DM.OPER.196</td>
<td>Is a replacement possible in the short term?</td>
<td>No</td>
<td>Would maintenance improve the durability of the switchgear?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>Is this switchgear part of the 3% to be replaced this year?</td>
<td></td>
</tr>
<tr>
<td>DM.OPER.197</td>
<td>Is this switchgear part of the 3% to be replaced this year?</td>
<td>No</td>
<td>Perform scheduled Replacement Task</td>
<td>Create Work Order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>Perform combination of On-Condition/Restoration/Replacement Task</td>
<td>Create Work Order</td>
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<tr>
<td>DM.OPER.198</td>
<td>Would maintenance improve the durability of the switchgear?</td>
<td>No</td>
<td>Perform a re-design to increase Availability</td>
<td>Create Service Ticket</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>Perform scheduled Replacement Task</td>
<td>Perform a re-design to increase Availability</td>
</tr>
<tr>
<td>DM.OPER.199</td>
<td>Is this switchgear part of the 3% to be replaced this year?</td>
<td>No</td>
<td>Perform scheduled Replacement Task</td>
<td>Create Work Order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>Perform combination of On-Condition/Restoration/Replacement Task</td>
<td>Create Work Order</td>
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SAP Asset Strategy and Performance Management

Monitor and Improve

Define Systems & Assets to Analyze

Implement Maintenance Strategies

Identify Critical Assets

Develop Recommended Actions

Perform Analysis
Instructions

Instructions describe how to execute maintenance

- There are different types of Instructions e.g. Breakdown, Installation, Operations, Planned Maintenance
- Instructions can be assigned to Models, Equipment and Groups
- Failure Modes can only be assigned to Breakdown Instructions.
- You can define the number of steps, duration, criticality, safety rules, tools and required spare parts.
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SAP Asset Strategy and Performance Management

Monitor and Improve

Implement Maintenance Strategies

Develop Recommended Actions

Define Systems & Assets to Analyze

Identify Critical Assets

Perform Analysis

SAP Asset Strategy and Performance Management
Implement RCM/FMEA Recommendations

Object
- Equipment
- Model
- Location

Methodology
- RCM
- FMEA
- ...

Recommendation
- Strategy
- Priority
- Status
- Frequency
- Instruction

Rule Engine
- Frequency
- Rule Vocabulary
- Rule Expression

if Rule is true & applies to Object then Create

Notification

Lab Preview
- Recommendation
- Work Order
- Task List
SAP Asset Strategy and Performance Management

Monitor and Improve

Define Systems & Assets to Analyze

Implement Maintenance Strategies

Identify Critical Assets

Develop Recommended Actions

Perform Analysis
SAP Predictive Maintenance and Service
Advanced analytics to support maintenance execution and strategy decisions

Capability Highlights

Failure Mode Analytics
Utilizes machine learning to generate KPIs around documented failure modes

Fingerprint Management
A visual approach to capturing asset reference states. Used for visual comparison to current operating performance. (i.e., trend analysis)

IT/OT Data Fusion Views
Equipment lists and geospatial views combining model data and sensor based health indicators to prioritize maintenance actions and support strategy decisions

Advanced Rule-based Alert Creation
Generate value added alerts for maintenance professionals through an intuitive and flexible rules engine
SAP S/4HANA Maintenance Management
Technical Object Breakdowns

• Analyze Breakdown and its impact on Reliability
• Evaluate effective time to repair and time between repair
• Evaluate Mean and Total time between repair as well time to repair
• Real time evaluation of statistical KPIs without storing aggregates
• identify where the equipment was installed if the breakdown is identified after the equipment was dismantled.
• Identify equipment that fails often or long time to repair
• Identify location where equipment fails quite often
• Compare reliability of the equipment from different manufacturers
• Identify repair frequencies for a type or make of an equipment
SAP S/4HANA Maintenance Management

Damage Analysis

Main KPIs
- Detailed failure mode analysis
- Number of damages recorded, related causes and activities
- Covers all the features covered by MCI5 / IW69

High-level innovation description
For malfunction report and activity reports, it is critical to record parts that were observed as damaged. Number of damages and corresponding causes could help in analyzing reliability of equipment.

Value Proposition
Increased reliability due to
- Identify failure modes of an equipment
- Identify parts that gets damaged and activities that are needed to repair or replace them
- Identifying main causes observed by technicians and plan preventive or inspections activities to avoid future unplanned breakdown.
- Identify parts that are over maintained and remove them from preventive activities.

Capabilities
- Analyze frequent offenders that create reliability issues for an equipment
- Identify relation between Failure mode, damages, causes and effect it has on operation of asset

Improvements over PMIS
- Calculation and aggregation is in real time with transactional data and not stored in S-structure.
- KPIs can be aggregated at equipment type, manufacturer, model or any other critical attributes.
- Much easy navigation that lets user drill down to notification or order and get better visibility for historical failures.
SAP S/4HANA Cloud for Asset Management
Actual Cost Analysis

The SAP Fiori app Actual Cost Analysis supports the Maintenance Planner in monitoring and evaluating actual costs resulting from current maintenance orders.

Value Proposition
- Easily identify the maintenance activities leading to the highest costs or parts of the asset that were particularly costly on inspections
- Evaluate actual maintenance costs stored in the Universal Journal Entry
- Seamless navigation within one page that combines transactional and analytical data using chart and table visualization

Capabilities
- Analyze the actual costs for materials and labor in maintenance
- Compare the total maintenance cost for unplanned, corrective and preventive maintenance activities
- Filters allow you to analyze critical costs in a fiscal year from different perspectives, such as the order type, the construction type, the location, the planner group or the manufacturer
Summary

- Define Systems & Assets to Analyze
- Identify Critical Assets
- Perform Analysis
- Develop Recommended Actions
- Implement Maintenance Strategies
- Monitor and Improve

SAP Asset Strategy and Performance Management
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http://info.asug.com/2019-ac-slides
Q&A

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