

## 5 R'S IN SAFE MAINTENANCE MANAGEMENT

Hana PAČAIOVÁ<sup>1</sup>

Review article

**Abstract:** Why 5 R's for a maintenance manager? The reason is very simple. First - maintenance management has been necessary from the "birth" of machinery. Design **R**equirements for safety, availability, maintainability are the first step of control of potential losses coming from future operation and depending on the state of maintenance strategy. Second - **R**egulatory and legislative acts create a basis for data identification which is under legal control and important to effective management. Third - **R**easonable maintenance strategy supports compliance with stakeholders' expectations. **R**epression must not be a winner over prevention, i.e. preventive strategies must prevail over corrective strategies. And last - all these steps lead to effective operation with systematic control of **R**isk. To achieve the objectives of companies, activities of the companies have to be based on "**intelligent maintenance management**".

**Keywords:** Risk, maintenance, management, cost.

### Introduction

Maintenance requirements can be defined, on the one hand, as a basic parameter of quality and reliability of machinery, emphasized by safety and environmental aspects determined in legislative and standardized requirements (Legát et al., 2013) and, on the other hand, as a so-called "only" supporting process that is a burden for the budget of the organization. In quite a high degree, maintenance is evaluated by the management of the organization as a cost item, i.e. loss-making item that is to be transferred to another organization in order to save these costs. (Grondahl, 2012)

However, development in the area of management systems, the need of their integration especially in relation to the effective accomplishment of the set objectives, create these days room requiring the analysis, assessment and management of activities so that potential losses (errors) threatening the attainment of these objectives may be under control on a long-term basis (Dongen, 2014). It is the case of the effort to develop such procedures from the corporate management to the functional level that will reduce all risks to the level of acceptability determined by the management (ISO, 2010). These trends affect significantly maintenance management. What is meant is the following:

- orientation towards the objectives of the company,
- problems of globalization and growth of competition,
- increasing of financial risks,
- radical changes in the business policy - long versus short terms,
- attitude to property has changed - service life is not identical to ownership duration,
- capital intensity in some branches of industry increases,
- increasing of market turbulence,
- pressure on high profitability and return on assets,
- technological system ageing,
- growing pressure on maintenance added value demonstration,
- more complicated and uncertain room for decision making,
- growing requirements for safety and protection of the environment.

When analysing these trends following from the external and internal environments of the organization, it is necessary to use primarily all existing standards and requirements as a basis (Pačaiová, 2014), Tab. 1.

<sup>1</sup> Technical university of Košice, MF, Safety and quality production department, Košice, Slovak Republic, hana.pacaiova@tuke.sk

Tab. 1 An example of the use of standards and legislative frameworks to support maintenance management

Management level	Standard	Area
<b>Corporate</b>	ISO 31000 ISO 55000 ISO 22301 -	Risk management Asset management (AM) Business continuity management
<b>Business unit</b> <i>System standards</i>	ISO 14001 ISO 9001 BS OHSAS 18001 ISO 27000 ISO 50001 ISO 55001	Environmental management Quality management OHS management Information security management Energy management system Asset management
<b>Maintenance management</b> <i>System standards</i>	prPEN 16646 EN 60300-3-14	Maintenance management within AM Maintenance and maintenance support
<i>Supporting tools and areas</i>		
<b>Maintenance</b>	STN EN 13306 STN EN 13460 STN EN 13269 STN EN 15341 TNI CEN/TR 15628 CWA 15740:2008	Maintenance terminology Documentation for maintenance Guideline on preparation of maintenance contracts Key Performance Indicators Qualification of Maintenance Personnel Risk Based Inspection and Maintenance Procedures for European Industry
<b>Reliability</b>	STN EN 60300-3-2 STN EN 60300-3-3 STN IEC 60300-3-9 IEC 60300-3-11	Collection of dependability data from the field Life cycle costing Risk analysis of technological systems Reliability centred maintenance
<b>Tools</b>	STN EN ISO 14121-1,2 STN EN ISO 12100-1,2  IEC 60812  IEC 61025	Safety of machinery - Risk assessment Safety of machinery: Basic concepts, general principles for design; Technical principles Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA) Fault tree analysis (FTA)

## Materials and Methods

The 5 R's methodology represents a certain framework of basic rules that should not be forgotten by maintenance managers during maintenance management with regard to the objectives of the company and the life cycles of objects.

It can be defined as follows:

- **The first R - Rule** saying don't touch what you don't know! - risk identification as early as the stage of design of machinery.
- **The second R - Respect** agreed procedures! - correct information and its documentation as a basis for the selection of maintenance management concept.
- **The third R - Respect** and understand customer's requirements! - what a customer needs.

- **The fourth R - Repressive** strategies must not prevail over preventive strategies! - maintenance strategy selection and improvement.
- **The fifth R - Risk** is not the way to win! - maintenance measurement and improvement.

### *The first R principle*

**The first R - Rule** saying don't touch what you don't know! - emphasizes the need to comply with the requirements for the control over new machinery purchase while taking into account the basic aspects of safety, reliability and service life. The objective of this first R is to point to the necessity of satisfying those legislative requirements that support the selection of such machinery that does not represent, from the point of view of installation, operation and maintenance and perhaps further disposal, any

risk with regard to direct and indirect losses of the organization. (Pačaiová at al., 2009)

**Motto:** Do not buy a cheap machine if you cannot afford it.

**Requirements:**

- Emphasis on the design stage - identification of requirements - a feedback from machinery operation and maintenance (early management of new machinery, CE designation).

Rules of conformity - "SAFETY MACHINERY" - observance of legal regulations: DIRECTIVE 2006/42/EC. Checking compliance with the requirement for risk assessment, methodological procedures and outputs "residual risks".

- Valid documentation, e.g. the use of check by means of specification of necessary documentation according to the standard EN 13460: Maintenance. Documentation for maintenance.

### The second R principle

**The second R - Respect agreed procedures!** - enables the analysis of needs of the management of the documentation itself as well as the necessity of analysis and collection of the data that are of importance with reference to the decision making of the management.

**Motto:** Identify, elaborate and maintain valid documentation - do you really have what you need at your disposal?

**Requirements:**

There are a lot of information systems in maintenance management. Nevertheless, practice points to the necessity of mastering the basic methodologies applied in software for supporting maintenance management. The basic objective of this step is to have the correct data in the correct place for the purpose of a correctly selected maintenance strategy (and activities). It is inevitable to consider and to apply systematic steps leading to the measurement of the effectiveness of maintenance by means of "performance indicators" (so-called KPIs). (Grenčík et al., 2013)

### The third R principle

**The third R - Respect and understand customer's requirements!** The importance of this step consists in the identification of "customers" of maintenance. What is essential is that in this stage, the maintenance manager should be able to identify the objectives of maintenance supporting the objectives of the company (possibly corporation).

**Motto:** Do you know where you are, what is threatening you and who you are threatening?

**Requirements:**

It is taking into account customer's requirements, pursuing the objectives and using the methodological tools and procedures that is substantial in this stage, Fig. 1.

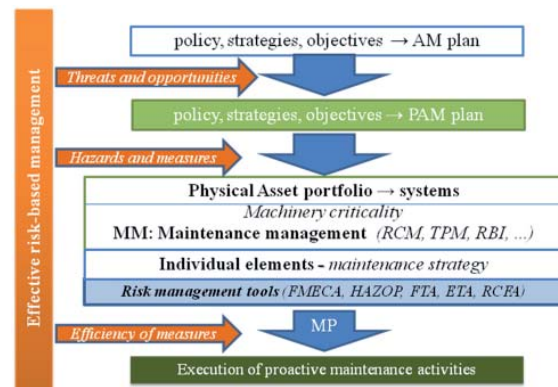


Fig. 1 Relations between requirements for asset management (AM) and proactive maintenance with support of risk-based management tools (Pačaiová and Grenčík, 2014)

(PAM - Physical Asset Plan; RCM - Reliability Centred Maintenance; TPM - Total Productive Maintenance; RBI - Risk Based Maintenance; FMECA - Failure Mode and Criticality Effect Analysis; HAZOP - Hazard & Operability Analysis; FTA - Failure Tree Analysis; ETA - Even Tree Analysis, RCFA - Root Cause Failure Analysis; PM - Maintenance Plan)

### The fourth R principle

**The fourth R - Risk is not the way to win!** The application of preventive activities following from the analyses of the previous step is the basic approach of this step. The effectiveness of maintenance costs when making decisions concerning the extent of activities for selected risk-based maintenance strategies is a criterion for maintenance management, Fig. 2.

**Motto:** Use the tools according to the level of severity - level of risk!

**Requirements:**

The measurement of the effectiveness of costs, ratio between corrective and preventive maintenance (Cost Benefit Ratio) - this is a basis for the confirmation or maybe reassessment of applied maintenance strategies at considering the analysed areas of losses of the organization.

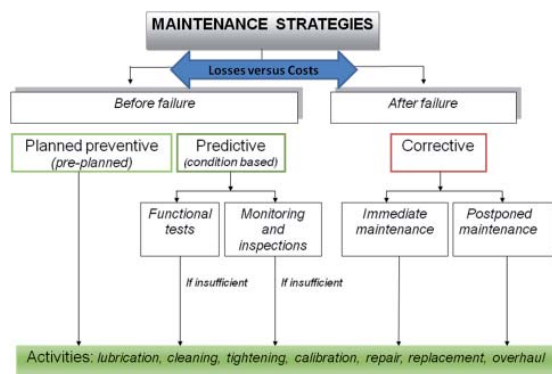


Fig. 2 Diagram of division of preventive and corrective maintenance strategies

### The fifth R principle

**5R - Risk** is not the way to win! This step is the most significant from the point of view of decision making of the management both on the level of enterprise management and the level of corporation. Results of measurement of maintenance processes are interconnected with the effectiveness of operation of machinery.

**Motto:** Measure effectiveness and efficiency of your measures!

#### Requirements:

Application of KPIs in maintenance processes (standard EN 15341) and tools for maintenance improvement (Grenčík et al., 2013). Education of personnel, managerial skills and improving communication with stakeholders are basic preconditions for the fulfilment of determined rules and the long-term maintenance of positive trends in maintenance management.

### Results

Results of 5R's principles application can be describe like benefits of each "R" as follow:

- **"1-th R" - Benefit:** The first R benefit is the planning and purchase of machinery the operation and maintenance of which take into account possible losses of the organization. Maintenance strategy is one of essential requirements for structural design and reliability and effectiveness of operation of future machinery.

### References

- BÁRTLOVÁ, Ivana, PEŠÁK, Miloš, (2003). *Analýza nebezpečí a prevence průmyslových havárií II*. Ostrava: VŠB TU, 2003, 138 p. ISBN 80-86634-30-2.
- DONGEN, Rob van (2014). Discovering the Added Value of Maintenance. *Maintworld*. Operational Reliability. Vol. 6, No. 1, 2014. Forssa Print. ISSN 1798-7024.

- **"2-nd R" Benefit:** The development of a process approach in maintenance management to manage information reliably and to measure the efficiency of maintenance activities.
- **"3-th R" Benefit:** This step enables maintenance managers to "set" maintenance management so that the requirements of all stakeholders may be considered with the use of risk assessment methodologies applied in the basic maintenance management concepts. (Wilson et al., 2013)
- **"4-th R" Benefit:** A systematic approach (process) will be developed for the reassessment of maintenance strategies and activities based on fixed criteria, taking into account the objectives of the organization. A significant tool is the determination of machinery criticality, e.g. based on the extent and severity of losses, analysed as part of prevention of major industrial accidents. (Bártlová and Pešák, 2003)
- **"5-th R" Benefit:** Support of the effective accomplishment of objectives, competitive advantage and reputation of the company - sustainable development.

### Conclusion

The philosophy of the 5 R's for the maintenance manager is a simplified process for the implementation of strategic procedures of risk-based maintenance management that are assessed in relation to potential threats to the objectives of the company. This approach only emphasizes the need to educate the company management, not only the maintenance management, in basic trends - approaches in current management integrating the existing systems and requirements and using the analytical tools of risk assessment. It was created for emphasizing the need of analysis of all aspects threatening the sustainable development of the company following from the external and internal environments of activities of the company.

### Acknowledgments

This paper is the result of the implementation of project KEGA No. 049TUKE-4/2014 "Designing a Model for E-learning Support of the Education in the Production Quality Bachelor Study Program".

- GRENČÍK, Juraj et al., (2013). *Manažerstvo údržby - Synergia teórie a praxe*. BEKI design. 2013, Košice. SSU. 630 p. ISBN 978-80-89522-03-3.
- GRONDAHL, Palle. (2012). Adding Value. Through qualified external technicians. *Maintworld*. Vol. 4, No. 3, 2012. Forssa Print. ISSN 1798-7024.
- ISO 31000 (2010). *Manažerstvo rizík - Princípy a smernice*. SÚTN Bratislava.
- ISO 3100 (2013). *Principles and Management - Training material*. iNTeg-Risk. 2013 Stuttgart.
- LEGÁT, Václav. et al. (2013). *Management a inženýrství údržby*. Příbram: PBtisk Příbram., 570 p. ISBN 978-80-7431-119-2.
- PAS 55-1 (2008). *Asset Management. Part 1: Specification for the optimized management of physical assets*. BSI.
- PAČAIOVÁ, Hana, GLAT, Juraj, KACVINSKÝ, Štefan (2013). Systematic approach in maintenance management improvement. *International Journal of Strategic Engineering Asset Management*. Vol. 1, No. 3, 2013, pp. 228-237. ISSN 1759-9733.
- PAČAIOVÁ, Hana, SINAY, Juraj, GLATZ, Juraj (2009). *Bezpečnosť a riziká technických systémov*. Edícia SĽF TUKE Košice, Vienala Košice 2009. ISBN 978-80-553-0180-8-60-30-10.
- PAČAIOVÁ, Hana, GRENČÍK, Juraj (2014). Risk management as an integrated part of the Asset Management. In *Euromaintenance 2014*, Helsinky, Finland.
- WILSON, Allan et al. (2013). *Asset Management focusing on developing maintenance strategies and improving performance*. Conference communication, UK. ISBN 978-0-9506465-6-5.