1. Maintenance within Physical Asset Management

1.1. Physical Asset Management

Overview

- Understanding the concept of Physical Asset Management
- Ability to interpret the company policy

Subject	Knowledge	Skills	Responsibility and autonomy
1.1.1 Physical Asset Management	**An engineer/A supervisor should be able to:** - Explain Physical Asset Management and its effects on the maintenance processes	**An engineer/A supervisor should be able to:** - Plan and carry out the maintenance work according to the Physical Asset Management ideas	**An engineer/A supervisor should be able to:** - Manage the work for planning maintenance in a total project
1.1.2 Company processes	**An engineer/A supervisor should be able to:** - Explain company strategies, targets, and business processes - Describe legislation, technical standards, management system for safety, health, environment and quality, company's and external specialist resources - Describe processes and projects management	**An engineer/A supervisor should be able to:** - Identify the company´s different processes - Adapt maintenance strategies, targets and business to the company´s processes	**An engineer/A supervisor should be able to:** - Carry out maintenance planning as a part of total investment in a total project
1.1.3 Company policy	**An engineer/A supervisor should be able to:** - Explain why a company policy has to be set up - Explain in which way the maintenance aspects are in a company management policy	**An engineer/A supervisor should be able to:** - Interpret and carry out the company policy - Adapt the maintenance policy to the company´s policy	**An engineer/A supervisor should be able to:** - Support the management with the key maintenance part in the total company policy
1.1.4 Quality and Environmental regulations and systems	**An engineer/A supervisor should be able to:** - Describe quality and environmental regulations and systems	**An engineer/A supervisor should be able to:** - Follow quality and environmental regulations in maintenance planning	**An engineer/A supervisor should be able to:** - Adapt the maintenance plan to the company strategic quality and environmental plan including capability to follow up results

	– Describe the basics in recommended environmental regulations and systems		
1.1.5 Maintenance within Physical Asset Management	**An engineer/A supervisor should be able to:** – Describe data that is needed for maintenance within Physical Asset Management – Describe the standard EN 16646:2014 Maintenance within physical asset management – Explain the relations between maintenance and other processes – Mention systems for production planning, account system, maintenance planning and CMMS, and the relation between them	**An engineer/A supervisor should be able to:** – Define what data is needed and carrying out maintenance within Physical Asset Management	**An engineer/A supervisor should be able to:** – Develop a maintenance plan according to the Physical Asset Management plan

References

ISO 55000:2014 – Asset management Overview, principles and terminology:

– This standard gives an overview of asset management, its principles and terminology, and the expected benefits from adopting asset management. It can be applied to all types of assets and by all types and sizes of organizations.

EN 16646:2014 – Maintenance within physical asset management:

– This standard introduces physical asset management as a framework for maintenance activities. It also introduces the relationship between organizational strategic plan and maintenance management system and describes the interrelations between maintenance process and all the other physical asset management processes. It addresses the role and importance of maintenance within physical asset management system during the whole life cycle of an item. It can be applied to production organizations of all sizes and consists of guidance and recommendations.

1.2. Production

Overview

- Understanding the relation between maintenance and production planning, safety and quality
- Quality management system (EN 15628:2014 B.4:c)
- Productivity measurement and improvement methods (EN 15628:2014 B.9:d)

Subject	Knowledge	Skills	Responsibility and autonomy
1.2.1 Production planning	**An engineer/A supervisor should be able to:** – Explain systems for production planning, account system and maintenance planning / CMMS and the relation between them – Explain how production is planned	**An engineer/A supervisor should be able to:** – Adapt the maintenance plan according to adjustments in both production and maintenance planning	**An engineer/A supervisor should be able to:** – Integrate the maintenance plan with the production planning
1.2.2 Production safety	**An engineer/A supervisor should be able to:** – Explain the relations between the production safety regarding maintenance affects – Explain different types of incidents that the maintenance activities shall prevent (e.g. consequences on health, safety, and environment) – Describe predicted, and prevent safety consequences – Mention external parties interested in production safety preventions	**An engineer/A supervisor should be able to:** – Plan and act preventively and/or correctively to increase production safety	**An engineer/A supervisor should be able to:** – Develop and integrate safety system in the production control system
1.2.3 Production quality	**An engineer/A supervisor should be able to:** – Describe the essential contribution from the maintenance activities to achieve good product quality – Explain how quality production is formed by personal engagements	**An engineer/A supervisor should be able to:** – Plan and act preventively and/or correctively to maintain or increase production quality	**An engineer/A supervisor should be able to:** – Verify that needed maintenance activities are integrated in the production quality activities

	– Define quality and quality assurance – Mention standards and methods for quality assurance regarding maintenance – Mention the basics in TQC Total Quality Control – Mention 4M Man, Machine, Method, Material – Explain how maintenance activities will have an influence on the production quality		

References

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2. Maintenance Management

2.1. Maintenance management

Overview

- Good knowledge in Maintenance Management
- Maintenance strategies and policies, methods and technologies (EN 15628:2014 B.1:a)
- Procedures (EN 15628:2014 B.1:d)
- Provide essential key performance indicators of maintenance process (EN 15628:2014 B.1:f)
- Business objectives (EN 15628:2014 B.1:i)
- Prepare a decision-making process (EN 15628:2014 B.7:c)

Subject	Knowledge	Skills	Responsibility and autonomy
2.1.1 Maintenance management	**An engineer/A supervisor should be able to:** – Describe Maintenance Management and the different parts in the process	**An engineer/A supervisor should be able to:** – Implement and run an effective maintenance management process	**An engineer/A supervisor should be able to:** – Understand management of maintenance activities in the total working requirements
2.1.2 Maintenance policy	**An engineer/A supervisor should be able to:** – Describe the process of the development of a maintenance policy – Explain the general requirements for a maintenance policy – Describe how to formulate a maintenance policy	**An engineer/A supervisor should be able to:** – Define and apply a maintenance policy based on the company's policy	**An engineer/A supervisor should be able to:** – Develop guiding parts in the maintenance policy
2.1.3 Maintenance objectives	**An engineer/A supervisor should be able to:** – Describe the general requirements for maintenance objectives	**An engineer/A supervisor should be able to:** – Define and apply maintenance objectives based on the maintenance policy	**An engineer/A supervisor should be able to:** – Perform controlling parts in the company's maintenance objectives
2.1.4 Maintenance strategies	**An engineer/A supervisor should be able to:** – Describe different maintenance strategies – Explain the reasons behind the choice of a certain strategy	**An engineer/A supervisor should be able to:** – Use relevant maintenance strategies based on the maintenance policy and strategies	**An engineer/A supervisor should be able to:** – Develop strategies in relation to specific production lines

2.1.5 Key Performance Indicators (KPI)	**An engineer/A supervisor should be able to:** – Mention Key Performance Indicators for the economic and technical control – Describe how to use the Key Performance Indicators in the control and development of the maintenance activities	**An engineer/A supervisor should be able to:** – Choose and use relevant key performance indicators (KPI) for technical and economical control	**An engineer/A supervisor should be able to:** – Collect data and use various KPI´s

References

EN 17007:2017-MAN.1 – Establish the maintenance policy, strategy and development actions:

- Based on the company's missions, values, regulations compliance and general objectives, the policy establishes the direction, which gives priority to:
  - Safety of individuals and items, product quality, environmental protection.
  - Availability and useful life of the items.
  - Optimization of maintenance costs, etc.
- The maintenance strategy, which results from the maintenance policy, requires that choices be made for:
  - Developing, adapting or implementing maintenance methods.
  - Organizing the internal resources (maintenance teams, stocks of spare parts and consumables, documentation, tools, etc.).
  - Insourcing and/or outsourcing and/or contracting some or all the maintenance tasks.
  - Studying the economic impact of item modifications or improvements.
- The development of maintenance processes according to the strategy and the process to determine and prioritize improvements are defined and decided.

EN 17007:2017-MAN.5 – Oversee the actions:

- All the actions included in the maintenance process are coordinated, supervised and, if applicable, decided on by Management in order to achieve the goals and objectives defined in terms of safety, availability, costs, environment, quality, etc.

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

2.2. Maintenance economics and budgeting

Overview

- Good knowledge the basics in maintenance economics and budgeting
- Contribute to the development of the maintenance budget according to business objectives (EN 15628:2014 B.1:a)
- Economical thinking and acting (E) (EN 15628:2014 B.9:a)
- Economical decision options (EN 15628:2014 B.9:b)
- Cost calculation methods and schemes (EN 15628:2014 B.9:c)

Subject	Knowledge	Skills	Responsibility and autonomy
2.2.1 Maintenance economics	**An engineer/A supervisor should be able to:** – Explain the most common economical models regarding maintenance – Describe the difference between direct and indirect maintenance costs	**An engineer/A supervisor should be able to:** – Define, compile cost elements and calculate or estimate actual costs (EN 17007:2017 BUD.1)	**An engineer/A supervisor should be able to:** – Calculate individual maintenance works and put it together to a budget or following ups
2.2.2 Maintenance budget	**An engineer/A supervisor should be able to:** – Describe the components in maintenance budgeting – Describe the difference between internal and external costs for maintenance activities	**An engineer/A supervisor should be able to:** – Carry out budgets according to the processes: ▪ Create a budget and estimate for regular or infrequent or exceptional maintenance tasks (EN 17007:2017 BUD.2, EN 17007:2017 BUD.3) ▪ Extract budgeted and actual expenditures (EN 17007:2017 BUD.4) ▪ Analyse, explain and, if applicable, take corrective actions (EN 17007:2017 BUD.5)	**An engineer/A supervisor should be able to:** – Calculate individual maintenance works and put it together to a budget
2.2.3 Economical maintenance plan	**An engineer/A supervisor should be able to:** – Describe how to develop economic maintenance plans distributed on activities and needed resources	**An engineer/A supervisor should be able to:** – Prepare and carry out the economical maintenance for activities, items, equipment and assets	**An engineer/A supervisor should be able to:** – Calculate individual maintenance works and put it together to an economical plan

References

EN 17007:2017-MAN.4 – Prepare and negotiate the budgets:

- Economic plans (Budgets) are approved and adjusted by Management based on the budgeting process (BUD).

EN 17007:2017-BUD – Budget maintenance of items:

- Schedule economic planning (short, medium and long-term) based on a defined cycle, for regular maintenance (expenditures and costs related to the company's operation) and exceptional maintenance (investments) activities.

2.3. Maintenance activities

Overview

- Very good knowledge in different internal and external maintenance activities
- Control costs, progress and quality of services (EN 15628:2014 B.1:e)
- Tools and techniques for technical, organizational and economic monitoring (EN 15628:2014 B.5:d)
- Reliability analysis methods and techniques (EN 15628:2014 B.5:e)
- Perform audits and, inspections to control the status of asset and processes (E) (EN 15628:2014 B.5:g)
- Present different solution options to the customers or physical asset owner/operating manager (EN 15628:2014 B.7:b)
- Assess the reliability, availability and maintainability of asset and the lifecycle cost (E) (EN 15628:2014 B.8:f)
- Principles, logic and parameters of operation and utilization of assets and items (EN 15628:2014 B.8:h)
- Maintenance and diagnostic techniques (EN 15628:2014 B.8:i)
- Take decisions (E) (EN 15628:2014 B.9:b)
- Perform analysis and studies of the given processes and applied methods during actions taken (E) (EN 15628:2014 B.9:c)

Subject	Knowledge	Skills	Responsibility and autonomy
2.3.1 Requirements for maintenance activities	**An engineer/A supervisor should be able to:** – Describe the different maintenance activities – Define different requirements for the maintenance activities – Describe the process of the identification, formulation, and the communication of the requirements of different maintenance activities	**An engineer/A supervisor should be able to:** – Apply relevant maintenance activities in relation the production requirements	**An engineer/A supervisor should be able to:** – Analyse the technical requirements and based on that plan the work
2.3.2 Quality assurance of maintenance activities	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Explain quality assurance of maintenance activities – Mention different methods and techniques to achieve an optimized result for the company by the maintenance tasks, including the economical and safety aspects for these methods and techniques – Mention different general aspects that must be considered for analysis	– Carry out quality assurance activities for the maintenance tasks	– Quality assure the maintenance activities in relation to the quality in production
2.3.3 Analyse the results of maintenance activities	**An engineer/A supervisor should be able to:** – Explain how to analyse the results of maintenance activities – Mention different methods to measure the result of the maintenance activities, the advantages and disadvantages with the methods and their handling of the economic aspects and what is not covered by these methods	**An engineer/A supervisor should be able to:** – Carry out and use models for measurement and analysis of the maintenance activities	**An engineer/A supervisor should be able to:** – Analyse the pros and cons in results of maintenance activities
2.3.4 Life cycle extension	**An engineer/A supervisor should be able to:** – Mention different methods for life cycle extensions	**An engineer/A supervisor should be able to:** – Use strategies and carry out methods for life cycle extensions	**An engineer/A supervisor should be able to:** – long term thinking based on achieved on information from operation and models to create strategies for life cycle extension
2.3.5 Operator maintenance	**An engineer/A supervisor should be able to:** – Describe what operators should do regarding maintenance – Describe how operators should report tasks	**An engineer/A supervisor should be able to:** – Support the production with knowledge concerning maintenance activities and resources for operator-based maintenance	**An engineer/A supervisor should be able to:** – Analyse suitable activities for operators and adapted information for acceptance of technical and economic goals

References

EN 17007:2017-MAN.2 – Identify the internal or external activities:

- The maintenance policy and strategy make it possible to clearly identify the activities carried out internally and those assigned to participating companies. In connection to budgeting this identification leads to choosing between those assigned to participating companies and between “making” and “buying” and specifying the required skills.

2.4. Maintenance organisation

Overview

- Good knowledge in a maintenance organisation
- Business job descriptions and roles (EN 15628:2014 B.1:e)
- Manage employees and ensure compliance with legislation, technical standards and company procedures on safety, health and environment (EN 15628:2014 B.3:c)
- Organizational responsibilities (EN 15628:2014 B.9:a)
- Choose the appropriate organization (E) (EN 15628:2014 B.9:d)
- Legislation and technical standards (EN 15628:2014 B.9:e)
- Ensure consideration of legal and technical standards for the given tasks (E) (EN 15628:2014 B.9:e)
- Methodologies and tools to develop fit-for purpose organizations (EN 15628:2014 B.9:f)
- Manage own and third party forces (E) (EN 15628:2014 B.9:f)
- Management tools to conduct combined teams of own and third party forces (EN 15628:2014 B.9:g)

Subject	Knowledge	Skills	Responsibility and autonomy
2.4.1 Maintenance organisation	**An engineer/A supervisor should be able to:** – Describe different types of maintenance organizations (e.g. centralized, decentralized, co-operation with the equipment supplier and/or servicing companies and integration with the production) – Explain the advantages and the disadvantages with the different types of organizations and the combination of them	**An engineer/A supervisor should be able to:** – Develop and maintain the competence in actual organization – Organize and control insourcing and/or outsourcing and/or contracting some or all the maintenance tasks	**An engineer/A supervisor should be able to:** – Carry out plans for maintenance organization using own and purchased resources
2.4.2 Jobs and competences	**An engineer/A supervisor should be able to:** – Explain how to assure the right competence within the organisation	**An engineer/A supervisor should be able to:** – Define the needed jobs and competences for the maintenance work force	**An engineer/A supervisor should be able to:** – Analyse needed competence for the various types of work and mapping status of existing labour force

2.4.3 Labour laws and regulations	**An engineer/A supervisor should be able to:** – Mention relevant national laws and regulations	**An engineer/A supervisor should be able to:** – Follow the required labour laws and regulations for maintenance work	**An engineer/A supervisor should be able to:** – Plan and carry out maintenance tasks according to labour agreement and legislation in labour market

References

EN 17007:2017-MAN.3 – Determine the organization, job profiles and responsibilities:

- Based on the direction and choices expressed in the policy and strategy, an organization is set up to realize the maintenance processes. Tasks and job profiles are established as well as possible needs to update present skills Responsibilities are defined and assigned to the company's personnel.

2.5. Leadership, training and coaching

Overview

- Very good knowledge in technical training and coaching methods and techniques
- Ability to lead, train and coach working groups
- Communication techniques (EN 15628:2014 B.1:h)
- Educate and train maintenance specialized professionals, developing and enhancing their skills and the ability to work as a team (EN 15628:2014 B.3:a)
- Organize and diffuse technical, technological and process solutions knowledge (EN 15628:2014 B.3:b)
- Execute training and education for staff (EN 15628:2014 B.3:g)
- Control and improve technical and professional skills of maintenance personnel (S) (EN 15628:2014 B.5:a)
- Basic principles of the communication (EN 15628:2014 B.7:a)
- Communicate with different types of persons like workers, master craftsmen, technicians and engineers (EN 15628:2014 B.7:a)
- Sound capability of customers language, needs and requirements (EN 15628:2014 B.7:b)
- Negotiation techniques (EN 15628:2014 B.7:c)
- Communication and presentation techniques (EN 15628:2014 B.7:d)
- Negotiate positions due to fixed limits (EN 15628:2014 B.7:e)
- Moderate conflict situations to accepted solutions (EN 15628:2014 B.7:f)
- Communication techniques (EN 15628:2014 B.8:b)
- Technical training and coaching (EN 15628:2014 B.8:e)

Subject	Knowledge	Skills	Responsibility and autonomy
2.5.1 Communication and presentation techniques	**An engineer/A supervisor should be able to:** – Explain pedagogical methods to communicate and present in the best way	**An engineer/A supervisor should be able to:** – Professionally communicate and present actual and relevant information	**An engineer/A supervisor should be able to:** – Understand and practise different pedagogical ways to communicate oral and in text and results

2.5.2 Leadership	**An engineer/A supervisor should be able to:** – Explain the basics in a professional leadership	**An engineer/A supervisor should be able to:** – Use a professionally leadership as a manager	**An engineer/A supervisor should be able to:** – Practice a professionally leadership regarding to actual situation
2.5.3 Methods and techniques for training	**An engineer/A supervisor should be able to:** – Explain actual local needs within competence for technical education and training – Explain International qualifications for maintenance work	**An engineer/A supervisor should be able to:** – Plan, organise and execute education and training	**An engineer/A supervisor should be able to:** – Use different pedagogical ways to transfer technical subjects in respect of used machinery
2.5.4 Coaching	**An engineer/A supervisor should be able to:** – Mention coaching methods for improving maintenance	**An engineer/A supervisor should be able to:** – Coach the employees in a professional manner	**An engineer/A supervisor should be able to:** – Plan for and use methods for coaching and supporting labour force in the process to be more efficient
2.5.5 Working groups	**An engineer/A supervisor should be able to:** – Mention different types of working groups	**An engineer/A supervisor should be able to:** – Lead, train and coach working groups	

References

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3. Maintenance Execution

3.1. Failure and fault theory

Overview

- Good knowledge in theories regarding failures and faults
- Principles, logic and parameters of operation and utilization of asset and item in combination with wear and damage mechanisms (EN 15628:2014 B.1:c)
- Monitor the development of abnormalities and check the performance parameters (EN 15628:2014 B.5:c)

Subject	Knowledge	Skills	Responsibility and autonomy
3.1.1 Failure patterns	**An engineer/A supervisor should be able to:** – Describe the mechanism that causes the failures – Describe the theory of failure patterns – Describe the definitions of a failure and a fault – Explain different causes for a fault (e.g. specification, design, installation, operation, maintenance) – Mention different types of human failures and what causes them – Mention how human failures can be prevented and avoided – Describe different statistical distributions for failures (e.g. Exp, Ln, Weibull, etc.)	**An engineer/A supervisor should be able to:** – Characterize undesirable events (EN 17007:2017 PRV.1) – Characterize and prioritize failures, malfunctions due to latent or hidden faults that can have harmful and significant consequences on availability, reliability, personal safety, environment, product or service quality, value of the assets and costs – Choose the appropriate maintenance method depending on the actual failure distribution (e.g. corrective, preventive, condition based, modification) – Classify and consider the different consequences of a fault – Analyse the results to make it possible to define actions to be taken to avoid these events or control their consequences – Perform a human error analysis	**An engineer/A supervisor should be able to:** – Manage the process to identify different types of failures and used maintenance methods to improve the processes
3.1.2 Wear and tear	**An engineer/A supervisor should be able to:** – Describe different types of wear and tear	**An engineer/A supervisor should be able to:** – Plan for counteractions to minimize wear and tear	**An engineer/A supervisor should be able to:** – Optimize the process to take care of the maintenance tasks related to wear and tear

	– Describe how to avoid wear and tear		
3.1.3 System and functional analysis	**An engineer/A supervisor should be able to:** – Describe how processes are designed and programmed for preparing activities for troubleshooting and modification	**An engineer/A supervisor should be able to:** – Plan for system and functional analysis – Lead activities for troubleshooting and modification	**An engineer/A supervisor should be able to:** – Practice system and functional analysis with the goal to optimize the process and CBM methods

References

EN 17007:2017-PRV – Prevent undesirable events by avoiding failures and faults:

- Characterize and prioritize the events (failures, malfunctions due to la-tent or hidden faults) that can have harmful and significant consequences on availability, reliability, personal safety, the environment, product or service quality, the value of the assets and costs. (PRV.1)
- Determine the actions to be taken on the items to achieve the objectives set in the maintenance policy (availability, reliability, safety, costs, etc.). (PRV.2)

3.2. Planning and scheduling

Overview

- Very good knowledge in planning and scheduling
- Methods and techniques of organization and planning (EN 15628:2014 B.1:b)
- Cooperate in the development of annual and perennial maintenance plans (EN 15628:2014 B.1:b)
- Define criteria, methods, and frequency of maintenance tasks (EN 15628:2014 B.1:c)
- Maintenance and diagnostic techniques (EN 15628:2014 B.1:f)
- Negotiate the program of required maintenance works with the physical asset owner/operating manager (EN 15628:2014 B.2:a)
- Methods and techniques of organization, planning and project management (EN 15628:2014 B.2:b)
- Plan maintenance tasks falling under his area of responsibility, define the necessary resources and control the tasks organization and the reporting (EN 15628:2014 B.2:c)
- Principles, logic and parameters of operation and utilization of asset and item (EN 15628:2014 B.2:c)
- Standards and operational methods of work (EN 15628:2014 B.2:d)
- Provide the necessary information to employees to carry out the assigned works (EN 15628:2014 B.2:e)
- Develop plans for maintaining and updating the equipment and machines, according to current legislation on safety, health, and environmental protection (EN 15628:2014 B.3:e)

Subject	Knowledge	Skills	Responsibility and autonomy
3.2.1 Planning and scheduling	**An engineer/A supervisor should be able to:** – Describe planning and scheduling methods	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Describe the different steps in the work order process; planning, scheduling, realization, and reporting	– Carry out and implement an effective planning and scheduling process in maintenance	– Develop and follow up maintenance plans including optimizing activities
3.2.2 Prioritizing maintenance activities	**An engineer/A supervisor should be able to:** – Explain different prioritizing tools – Explain SLA (Service Level Agreement)	**An engineer/A supervisor should be able to:** – Prioritize the maintenance events in short or medium terms according to their importance and realization constraints – Rank the maintenance events according to operation demands (EN 17007:2017 ACT.1)	
3.2.3 Maintenance plans	**An engineer/A supervisor should be able to:** – Explain how to establish the initial maintenance plans and thereafter keep the plans up to date in working conditions	**An engineer/A supervisor should be able to:** – Create, use and update the Maintenance Plans (EN 17007:2017 PRV.2) – Determine the actions to be taken on the items to achieve the objectives set in the maintenance policy (availability, reliability, safety, costs, etc.) – Use real time data for forming plans when maintenance is needed	
3.2.4 Work order process	**An engineer/A supervisor should be able to:** – Describe the work order process and use of the maintenance management system (CMMS) – Describe needed information in a work order	**An engineer/A supervisor should be able to:** – Prepare maintenance information to complete maintenance tasks safely – Set the timeline of the planned tasks in order, based on the sequencing constraints and constraints related to required resources (material, human, etc.) to create a schedule that considers any uncertainties that may arise	**An engineer/A supervisor should be able to:** – Coordinate and develop the process aiming to improve CMMS
3.2.5 Maintenance planning	**An engineer/A supervisor should be able to:** – Describe the aim of maintenance planning – Mention different tools for maintenance planning	**An engineer/A supervisor should be able to:** – Prepare maintenance resources for the tasks (EN 17007:2017 ACT.2) – Prepare maintenance information to complete maintenance tasks safely	**An engineer/A supervisor should be able to:** - Guide and control the maintenance work based on developed activities via the CMMS

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

3.2.6 Maintenance scheduling	**An engineer/A supervisor should be able to:** – Describe Maintenance scheduling in relation to production requirements – Mention different tools for maintenance scheduling	**An engineer/A supervisor should be able to:** – Schedule the maintenance tasks (EN 17007:2017 ACT.4) – Prepare the schedule (start date, end date) of the tasks – Decide the intervals between preventive maintenance tasks	**An engineer/A supervisor should be able to:** – Present in CMMS an active and living plan for maintenance tasks
3.2.7 Maintenance realization	**An engineer/A supervisor should be able to:** – Describe different methods and techniques for maintenance realization	**An engineer/A supervisor should be able to:** – Start, perform, and finalize the tasks by assigning the corresponding actions to the necessary individuals who are competent and available on the planned date of the tasks according to the processes: ▪ Begin the scheduled maintenance tasks (EN 17007:2017 ACT.5) ▪ Perform the scheduled maintenance tasks (EN 17007:2017 ACT.6) ▪ Finish the scheduled maintenance tasks (EN 17007:2017 ACT.7) – Prepare for using digital twins as a tool for improvements	**An engineer/A supervisor should be able to:** – Initiate and realize a planned maintenance program and eventually use twin techniques for improvements
3.2.8 Verification before start	**An engineer/A supervisor should be able to:** – Explain the principles of verification tests and measures before start or restart	**An engineer/A supervisor should be able to:** – Assure that verification before start/restart is executed properly all the time	**An engineer/A supervisor should be able to:** – Develop tasks before first start and restart after maintenance activities

References

EN 17007:2017-ACT – Act preventively and/or correctively on the items to maintain:

- The events to deal with in the short or medium term with preventive maintenance (potential or actual failures) are prioritized according to their importance and realization constraints. A ranked list of events is established and updated continuously. (ACT.1)
- Prepare the maintenance information needed to complete a maintenance task safely. (ACT.2)
- Set in order the timeline of the planned tasks based on the sequencing constraints and constraints related to required resources (material, human, etc.) in order to create a schedule that takes into account any uncertainties that may arise. (ACT.3)

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- Prepare the provisional schedule (start date, end date) of the tasks. (ACT.4)

3.3. Preventive maintenance

Overview

- Good knowledge in preventive maintenance activities

Subject	Knowledge	Skills	Responsibility and autonomy
3.3.1 Preventive maintenance	**An engineer/A supervisor should be able to:** – Describe preventive maintenance and the different strategies to ensure a high dependability	**An engineer/A supervisor should be able to:** – Plan and implement effective preventive maintenance plans	**An engineer/A supervisor should be able to:** – Analyse and optimize the process for all preventive maintenance tasks
3.3.2 Predetermined maintenance	**An engineer/A supervisor should be able to:** – Describe methods and techniques for predetermined maintenance – Describe how to perform predetermined maintenance	**An engineer/A supervisor should be able to:** – Realize plans for predetermined maintenance	**An engineer/A supervisor should be able to:** – Analyse and optimize the process for all predetermined maintenance tasks
3.3.3 Condition-based maintenance	**An engineer/A supervisor should be able to:** – Describe methods and techniques for condition-based maintenance (e.g. subjective and objective condition-based maintenance methods) – Describe different types of condition monitoring systems (e.g. continuous, by intervals, on request, centralized or decentralized) – Describe P-F Interval and how it is used – Describe methods and techniques for inspection (condition-based maintenance)	**An engineer/A supervisor should be able to:** – Decide about and carry out plans for the intervals between inspections and condition-based maintenance – Carry out a suitable plan for inspection and condition-based maintenance system – Decide and communicate where non-predictive maintenance should be carried out	**An engineer/A supervisor should be able to:** – Analyse and optimize the process for all condition-based maintenance tasks

3.3.4 Predictive maintenance	**An engineer/A supervisor should be able to:** – Describe how to perform predictive maintenance – Describe predictive maintenance methods – Describe the difference between predictive and non-predictive maintenance – Describe how to perform non-predictive maintenance – Describe non-predictive maintenance methods	**An engineer/A supervisor should be able to:** – Decide about and carry out plans where predictive maintenance should be carried out – Use suitable systems for predictive maintenance	**An engineer/A supervisor should be able to:** – Analyse and optimize the process for all predictive maintenance tasks

References

EN 17007:2017-ACT – Act preventively and/or correctively on the items to maintain:

- Start the tasks by assigning the corresponding actions to the necessary individuals who are competent and available on the planned date of the tasks. (ACT.5)
- Restore the item to the required state. This restoration may be carried out either as a preventive measure or after a fault is detected. (ACT.6)
- Finalize the task by restoring the maintenance area, returning the item to the user and compiling the feedback. (ACT.7).

3.4. Corrective maintenance

Overview

- Good knowledge in corrective maintenance activities
- Ability to restore the items to their required state

Subject	Knowledge	Skills	Responsibility and autonomy
3.4.1 Corrective maintenance	**An engineer/A supervisor should be able to:** – Describe corrective maintenance and the different strategies to minimize unplanned stops	**An engineer/A supervisor should be able to:** – Make decisions about, and carry out corrective maintenance	**An engineer/A supervisor should be able to:** – Analyse the result of corrective maintenance work to plan for preventive activities
3.4.2 Fault diagnosis	**An engineer/A supervisor should be able to:** – Describe how to detect and diagnose faults	**An engineer/A supervisor should be able to:** – Detect faults, locate them, and identify the primary cause according to the processes:	**An engineer/A supervisor should be able to:** – Analyse functions and system and find out where faults can be located

	– Describe the different fault detection and diagnose methods and techniques	▪ Classify the actual events (EN 17007:2017 COR.1) ▪ Diagnose the state of the items in question (EN 17007:2017 COR.2)	
3.4.3 Immediate Corrective Maintenance	**An engineer/A supervisor should be able to:** – Describe the difference between immediate and deferred corrective maintenance – Describe the work when to perform immediate corrective maintenance	**An engineer/A supervisor should be able to:** – Decide when a corrective maintenance action is considered to be immediate – Take immediate corrective action in cases of exceptional events	**An engineer/A supervisor should be able to:** – Optimize the process to take care of rapid realization to minimize down time
3.4.4 Deferred Corrective Maintenance	**An engineer/A supervisor should be able to:** – Describe the difference between immediate and deferred corrective maintenance – Describe when to perform deferred corrective maintenance	**An engineer/A supervisor should be able to:** – Decide when a corrective maintenance action is deferred	**An engineer/A supervisor should be able to:** – Optimize the process to minimize down time
3.4.5 Restoration techniques	**An engineer/A supervisor should be able to:** – Describe different restoration techniques	**An engineer/A supervisor should be able to:** – Decide which restoration technique to use	**An engineer/A supervisor should be able to:** – Optimize restoration activities for minimizing down time

References

EN 17007:2017-COR – Restore the items to their required state:

- The actual events to deal with in the short or medium term with corrective maintenance are prioritized according to their importance and realization constraints. A ranked list of events is established and updated continuously. (COR.1)
- Detect any faults, locate them and identify the primary cause(s). (COR.2)

EN 17007:2017-ACT – Act preventively and/or correctively on the items to maintain:

- Start the tasks by assigning the corresponding actions to the necessary individuals who are competent and available on the planned date of the tasks. (ACT.5)
- Restore the item to the required state. This restoration may be carried out either as a preventive measure or after a fault is detected. (ACT.6)
- Finalize the task by restoring the maintenance area, returning the item to the user and compiling the feedback. (ACT.7).

3.5. Continuous improvement

Overview

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

- Very good knowledge in continuous improvements
- Problem solving methods (EN 15628:2014 B.7:e)
- Sustainability principles (EN 15628:2014 B.8:a)
- Fundamentals of processes and projects management (EN 15628:2014 B.8:c)
- Support the maintenance manager to propose improvements (E) (EN 15628:2014 B.8:c)
- Promote the continuous improvement of reliability, availability, maintainability and safety performance of assets (E) (EN 15628:2014 B.8:d)
- Concepts / methodologies, techniques and tools of continuous improvement (EN 15628:2014 B.8:j)
- Methods and tools of engineering maintenance (EN 15628:2014 B.8:k)
- Procedures (EN 15628:2014 B.8:m)
- Methodologies and tools for continuous improvement (EN 15628:2014 B.8:n)
- Reliability analysis methods and techniques (EN 15628:2014 B.8:o)
- Process re-engineering techniques (EN 15628:2014 B.8:p)

Subject	Knowledge	Skills	Responsibility and autonomy
3.5.1 Continuous improvement	**An engineer/A supervisor should be able to:** – Describe continuous improvement and what effect these will have on the dependability	**An engineer/A supervisor should be able to:** – Develop and implement a plan for continuous improvement	**An engineer/A supervisor should be able to:** – Develop a way to work by picking up all ideas to improve and develop structural reforms
3.5.2 Improvement of items	**An engineer/A supervisor should be able to:** – Describe common methods for data collection – Describe mathematical and statistical formulas to be used in the specifications and for verifications – Describe requirements regarding reliability performance (e.g. what is regarded as failures, active maintenance time, waiting time and how the availability is defined) – Describe basic mathematical formulas within availability, reliability, maintainability and supportability – Describe how a verification will be performed – Describe consequences if the verified results are different from the requirements – Describe how to perform in steps, an RCA (Root Cause Analysis)	**An engineer/A supervisor should be able to:** – Manage the organisation to perform improvement of items according to the processes: ▪ Collect data (EN 17007:2017 IMP.1) ▪ Define reliability, maintainability, safety and logistic support requirements (EN 17007:2017 IMP.2) ▪ Establish specifications for the required improvements of the item (EN 17007:2017 IMP.3) ▪ Issue an invitation to tender to internal or external suppliers (EN 17007:2017 IMP.4) ▪ Analyse and choose options and validate the solutions (EN 17007:2017 IMP.5) ▪ Carry out realization (EN 17007:2017 IMP.6)	**An engineer/A supervisor should be able to:** – Develop methods to support the process to improve the items aiming to optimize the production results

		▪ Verify conformity with the reliability, maintainability, safety and logistic support requirements (EN 17007:2017 IMP.7) ▪ Establish the initial maintenance plan (EN 17007:2017 IMP.8) ▪ Determine the initial logistical resources (EN 17007:2017 IMP.9) ▪ Identify skills and training needs (EN 17007:2017 IMP.9) – Perform an RCA analysis	
3.5.3 Improvement of results	**An engineer/A supervisor should be able to:** – Describe different improvements techniques due to maintenance results – Explain how to calculate OEE (Overall Equipment Effectiveness) – Describe different ways to improve the production results in reference to the OEE	**An engineer/A supervisor should be able to:** – Specify, plan, control and follow up improvements according to the processes: ▪ Determine areas for improvements, prioritize areas of improvements (EN 17007:2017 OPT.1) ▪ Prioritize areas of improvement related to other processes (EN 17007:2017 OPT.1 EN 17007:2017 OPT.5) ▪ Prioritize and specify modifications of existing items (EN 17007:2017 OPT.6) – Use the indicator OEE to measure and improve the results	**An engineer/A supervisor should be able to:** – Implement various methods and techniques to improve the production results
3.5.4 Improvement techniques	**An engineer/A supervisor should be able to:** – Mention different improvements techniques due to maintenance requirements (e.g. Kaizen, TPM (Total Productive Maintenance), PDCA (Plan, Do, Check, Act), 5 why 1 how, 5S (Systematic order in 5 steps), 6M (Man, Machine, Method, Material, Measurement and Management) and 7QCT (Seven Quality Control Tools)	**An engineer/A supervisor should be able to:** – Develop, plan and execute different improvement and life extension techniques	

	– Name different methods of life extensions, and how to execute them – Mention how different maintenance activities will have an influence on the lifetime of the production equipment		
3.5.5 Maintenance and industry 4.0	**An engineer/A supervisor should be able to:** – Describe the fundamentals of industrial digitizing – Describe how the new technology can be used for maintenance activities: ▪ IIoT (Industrial Internet of Things) ▪ Digital twins ▪ eMaintenance ▪ AI (Artificial Intelligence) ▪ Machine Learning – Describe how maintenance will change due to the new technologies	**An engineer/A supervisor should be able to:** – Implement adapted tools for maintenance within Industry 4.0	**An engineer/A supervisor should be able to:** – Support the process to implement new technique and methods in maintenance
3.5.6 Benchmarking	**An engineer/A supervisor should be able to:** – Describe bench marking and various ways to compare maintenance results	**An engineer/A supervisor should be able to:** – Perform a bench marking aiming to optimize the own processes	**An engineer/A supervisor should be able to:** – Use benchmarking to support the development of the maintenance processes and share the knowledge of the improvements
3.5.7 Future maintenance needs	**An engineer/A supervisor should be able to:** – Explain the future needs of maintenance and its influence on the actual activities in the long run (e.g. workload, type of work, quality and quantity) – Mention which factors that are important for the need of maintenance activities and how they might be changed in the future (e.g. new requirements regarding goals, strategies, and results)	**An engineer/A supervisor should be able to:** – Define and estimate the future maintenance needs – Prioritize maintenance improvements for future investments (EN 17007:2017 OPT.7)	**An engineer/A supervisor should be able to:** – Develop methods to improve the future maintenance needs including calculating investments and implement planned maintenance

	– Describe the importance for maintenance of taking part in the design and development phases		

References

EN 17007:2017-MAN.7 – Define policy and strategy areas of improvement:

- All information (technical, organizational, economic and social) is analysed to continuously adjust and improve the maintenance policy and strategy.

EN 17007:2017-IMP – Improve the items:

- The purpose of this process is to define, monitor or realize and validate improvements of the item when improvement is a better solution than preventive or corrective actions to manage failures or their consequences. The item is improved in terms of reliability and/or maintainability and/or safety at a convenient cost. It defines the initial reliability, maintainability and maintenance support requirements. Initial maintenance plans, the maintenance providers' related skills and the various logistical resources (hardware, documentation, spare parts, etc.) needed to implement the maintenance plan on the improved item are also defined.

EN 17007:2017-OPT – Improve the results:

- This process represents a part of continuous improvement loop which analyses the internal and external feedback data to determine actions to be taken, targets to be achieved and best practices to be applied for each of the processes.

4. Health, Safety & Environment in maintenance

4.1. Health, Safety & Environment

Overview

- Good knowledge in health, safety and environment in maintenance
- Legislation, technical standards and integrated management systems for safety, health and environmental protection (EN 15628:2014 B.4:a)
- Comply with the objectives and directives of the management system in terms of quality, safety, workers health and the environment (EN 15628:2014 B.4:a)
- Procedures (EN 15628:2014 B.4:b)
- Ensure compliance of employees with company standards and procedures on safety, health and the environment (EN 15628:2014 B.4:b)
- Techniques and methods for risk assessment (EN 15628:2014 B.4:d)
- Identify the risks arising from maintenance tasks (EN 15628:2014 B.4:c)
- Develop and update policies, tools, methodologies and technical standards for maintenance in accordance with the laws and rules on safety, health and environmental protection (E) (EN 15628:2014 B.8:b)

Subject	Knowledge	Skills	Responsibility and autonomy
4.1.1 Risk assessment	**An engineer/A supervisor should be able to:** – Describe risk assessment in maintenance work – Describe different conditions in the production equipment that may cause risks for health, safety, and the environment (inside and outside the company) – Describe the possibility to prevent incidents by maintenance activities, including co-operation with other departments in the company and external parties	**An engineer/A supervisor should be able to:** – Plan the work in relation to the health and safety and the right environment conditions according to the processes: ▪ Prepare a carry out risk assessment (EN 17007:2017 HSE.1) ▪ Identify risks (EN 17007:2017 HSE.2) ▪ Prioritize risks (EN 17007:2017 HSE.3) ▪ Propose and carry out measures for preventing risks and consequences of identified risks (EN 17007:2017 HSE.4) ▪ Monitor risk management (EN 17007:2017 HSE.5)	**An engineer/A supervisor should be able to:** – Understand various types of risks and identify which risks that can be reduced or eliminated by proactive activities
4.1.2 Safety and environment protection equipment	**An engineer/A supervisor should be able to:** – Describe what safety equipment is needed to perform maintenance tasks	**An engineer/A supervisor should be able to:** – Assure that the maintenance personnel are familiar with and uses necessary safety and environment protection equipment	**An engineer/A supervisor should be able to:** – Carry out correct balance between risks and activities in machine lines and processes and develop proactive activities

	– Explain individual and collective protective equipment – Explain environmental protection equipment		
4.1.3 Relations with auditing and safety organizations	**An engineer/A supervisor should be able to:** – Describe which national auditing and safety organizations there are – Explain information regarding auditing and safety organizations requirements	**An engineer/A supervisor should be able to:** – Discuss HSE issues with auditing and safety organizations for development and implementation of measures	**An engineer/A supervisor should be able to:** – Handle guidelines in official documents and own requirements and from that form active measures
4.1.4 Human error analysis	**An engineer/A supervisor should be able to:** – Describe human error analysis – Explain different types of human errors and risks connected to these	**An engineer/A supervisor should be able to:** – Perform human risk analysis – Implementing and keep daily systems for analysing human risks before a task will start	**An engineer/A supervisor should be able to:** – Develop active measures to minimize human errors based on individual reports
4.1.5 Laws and regulations	**An engineer/A supervisor should be able to:** – Describe laws and regulations regarding health, safety, liability, environment, energy, etc. – Describe different methods to measure the fulfilment of the laws and regulations with respect to labour, liability, environment, energy, etc. – Mention national laws and regulations (technical aspects) – Mention governmental organizations that are responsible for laws and regulations regarding maintenance – Mention organizations that are checking the application of these laws and regulations – Explain laws and regulations that have a direct influence on the maintenance activities	**An engineer/A supervisor should be able to:** – Follow laws and regulations regarding HSE aspects – Follow laws and regulations regarding technical aspects	**An engineer/A supervisor should be able to:** – Handle international and national laws, rules and regulations in the own organization
4.1.6 Environment	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Describe risk assessment in maintenance work – Describe different conditions in the production equipment that may cause risks for health, safety, and the environment (inside and outside the company) – Describe the possibility to prevent incidents by maintenance activities, including co-operation with other departments in the company and external parties	– Plan the work in relation to the health and safety and the right environment conditions according to the processes: ▪ Prepare a carry out risk assessment (EN 17007:2017 HSE.1) ▪ Identify risks (EN 17007:2017 HSE.2) ▪ Prioritize risks (EN 17007:2017 HSE.3) ▪ Propose and carry out measures for preventing risks and consequences of identified risks (EN 17007:2017 HSE.4) ▪ Monitor risk management (EN 17007:2017 HSE.5)	– Understand various types of risks and from good knowledge identify parts which can be solved

References

EN 17007:2017-HSE – Ensure personal health and safety to individuals and preserve environment in maintenance:

– The purpose of this process is to ensure personal health and safety and protect the items and the environment during maintenance tasks. It therefore entails evaluating the risks related to these tasks and Define measures for preventing and responding to the accidental situations described in the Prevention and Safety Plan.

5. Maintenance Engineering Techniques

5.1. Mechanics

Overview

- Good knowledge in mechanics
- Ability to discuss mechanical issues with maintenance personnel and / or suppliers

Subject	Knowledge	Skills	Responsibility and autonomy
5.1.1 Mechanics	**An engineer/A supervisor should be able to:** – Explain general mechanics for relevant industry	**An engineer/A supervisor should be able to:** – Discuss general mechanical issues with maintenance personnel and suppliers for developments	**An engineer/A supervisor should be able to:** – Have a basic knowledge in mechanical design to understand used techniques
5.1.2 Mechanical parts and components	**An engineer/A supervisor should be able to:** – Explain basic physical principles for mechanical parts and components	**An engineer/A supervisor should be able to:** – Handle different actual physical principles	
5.1.3 Hydraulics and pneumatics	**An engineer/A supervisor should be able to:** – Explain what is significant with hydraulic system – Explain environmental factors and risks associated with hydraulics – Explain what is significant with pneumatic systems	**An engineer/A supervisor should be able to:** – Discuss hydraulic issues with maintenance personnel and suppliers for development – Perform maintenance work with pneumatics in advanced automated solutions	**An engineer/A supervisor should be able to:** – Have a basic knowledge in mechanical design to understand basics in hydraulics and pneumatics in automation
5.1.4 Bearings	**An engineer/A supervisor should be able to:** – Explain different types of bearings – Mention factors: friction, vibration, greasing of plain (babies) and rolling bearings	**An engineer/A supervisor should be able to:** – Discuss bearing issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Have a basic knowledge in mechanical design to understand the function of various types of bearings
5.1.5 Welding and soldering	**An engineer/A supervisor should be able to:** – Explain different welding techniques	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Mention the standards, rules, and regulations for welding	– Discuss welding techniques with maintenance personnel and suppliers for development	– Have a basic knowledge in mechanical design to understand welding principles and soldering
5.1.6 Vibration	**An engineer/A supervisor should be able to:** – Explain the principles of vibration	**An engineer/A supervisor should be able to:** – Discuss vibration issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Have a basic knowledge in mechanical design to understand vibration and resonance
5.1.7 Tribology	**An engineer/A supervisor should be able to:** – Explain the fundamentals of: – Friction – Wear – Lubrication – Different lubrication techniques	**An engineer/A supervisor should be able to:** – Discuss tribology issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Have a basic knowledge in mechanical design to understand friction and tribology

References

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5.2. Electrics

Overview

– Good knowledge in general electrics

Ability to discuss electrical issues with maintenance personnel and / or suppliers

Subject	Knowledge	Skills	Responsibility and autonomy
5.2.1 Electrics	**An engineer/A supervisor should be able to:** – Explain general electrics for relevant industry	**An engineer/A supervisor should be able to:** – Discuss general electrical issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Have a basic knowledge in electrical design to understand used techniques
5.2.2 Electro techniques	**An engineer/A supervisor should be able to:** – Explain resistant, impedance, currant, voltage and frequents and the relations between these	**An engineer/A supervisor should be able to:** – Discuss electro techniques with maintenance personnel and suppliers for development – Calculate AC and DC circuits	

	– Explain single-phase and three-phase circuits including areas, currants, voltage, and earthing		
5.2.3 Electrical safety	**An engineer/A supervisor should be able to:** – Explain the risks with high voltage and high currents – Explain different methods for personal protection	**An engineer/A supervisor should be able to:** – Plan and carry out electrical work in a safe way – Develop safety rules and regulations for working in electrical installations	**An engineer/A supervisor should be able to:** – Have a basic knowledge in electrical design to understand general safety regulations
5.2.4 Power distribution	**An engineer/A supervisor should be able to:** – Explain methods for distribution of energy with different voltage, currants, transformers earthing, safety etc.	**An engineer/A supervisor should be able to:** – Follow safety rules and regulations for working in electrical installations	**An engineer/A supervisor should be able to:** – Have a basic knowledge in electrical design to understand used distribution high voltage and distribution principles.

References

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5.3. Automation

Overview

– Good knowledge in automation systems

– Ability to discuss automation issues with maintenance personnel and / or suppliers

Subject	Knowledge	Skills	Responsibility and autonomy
5.3.1 Automation	**An engineer/A supervisor should be able to:** – Describe general automation with different types of structure, on both system and functional level	**An engineer/A supervisor should be able to:** – Discuss general automation issues with maintenance personnel and suppliers and carry out solutions – Understand and handle system and function for improvement of the maintenance process	**An engineer/A supervisor should be able to:** – Have a good knowledge in automation with principles for design in various levels and IT technology
5.3.2 Programming	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Mention sequence programming of PLC based on analysing functions and system requirements	– Discuss programming issues with maintenance personnel and suppliers for development	– Have a good knowledge in how programs can be designed and working together in systems
5.3.3 Electronics	**An engineer/A supervisor should be able to:** – Explain how to handle electronic parts in production equipment	**An engineer/A supervisor should be able to:** – Discuss electronical issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Be familiar with electronics parts regarding automation and the vocabulary

References

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5.4. Material technology

Overview

– Good knowledge in material technology

– Ability to discuss material technology issues with maintenance personnel and / or suppliers

Subject	Knowledge	Skills	Responsibility and autonomy
5.4.1 Material technology	**An engineer/A supervisor should be able to:** – Explain different material groups; steel, copper, aluminium, ceramics, polymers – Explain mechanical, chemical, electrical, thermal, optical, and magnetic properties – Explain how different materials react to wear, tear, temperature, media etc. – Explain degradation and corrosion processes	**An engineer/A supervisor should be able to:** – Discuss general automation issues with maintenance personnel and suppliers and carry out solutions	**An engineer/A supervisor should be able to:** – Have a good understanding in material technology and use of right material for specific application
5.4.2 Non-destructive Testing	**An engineer/A supervisor should be able to:** – Mention the five most common level 1 NDT methods	**An engineer/A supervisor should be able to:** – Discuss NDT issues with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Know how to work with the most common NDT methods

5.4.3 Heat treatment	**An engineer/A supervisor should be able to:** – Mention different heat treatment techniques – Mention processes for hardening – Mention what happens in materials when heated	**An engineer/A supervisor should be able to:** – Discuss heat treatment techniques with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** – Know the basic principles for heat treatments

References

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5.5. Design and modification

Overview

– Very good knowledge in the requirements for design

– Principles and techniques of design, construction and maintainability (EN 15628:2014 B.1:g)

Subject	Knowledge	Skills	Responsibility and autonomy
5.5.1 Design requirements	**An engineer/A supervisor should be able to:** – Describe the general requirements for design – Explain how to formulate design requirements regarding design – Describe the process of the development of design requirements – Explain system design and functions in an item for a modification	**An engineer/A supervisor should be able to:** – Transfer production requirements into functional requirements (e.g. equipment dependability) and into quantitative and qualitative maintenance requirements (e.g. reliability and maintainability) and optimize the resources according to the processes: ▪ Collect feedback data (EN 17007:2017 MRQ.1) ▪ Perform risk analyses (EN 17007:2017 MRQ.2) ▪ Develop reliability, maintainability and logistic support requirements (EN 17007:2017 MRQ.3) ▪ Oversee or contribute to the drafting of specifications (EN 17007:2017 MRQ.4)	**An engineer/A supervisor should be able to:** – Maintain the platform for progress for the company based on a solid design understanding in: – Production requirement – Maintenance plan – Facility plan – Future requirements

		▪ Issue an invitation to tender to suppliers (EN 17007:2017 MRQ.5) ▪ Participate in the analysis and choice of options and validate the solutions (EN 17007:2017 MRQ.6) ▪ Follow up realization (EN 17007:2017 MRQ.7) ▪ Verify conformity with the reliability, maintainability and logistic support requirements (EN 17007:2017 MRQ.8) ▪ Establish the initial maintenance plan (EN 17007:2017 MRQ.9) ▪ Determine the initial logistical resources (EN 17007:2017 MRQ.10) ▪ Identify skills and training needs (EN 17007:2017 MRQ.11)	
5.5.2 LCC/LCP techniques/methods	**An engineer/A supervisor should be able to:** – Describe the methods of LCC/LCP, and when they can be used – Describe how to organize the work when using the concepts of LCC/LCP – Describe how the concepts of LCC/LCP can be used in different situations – Specify the LCC requirements in a procurement process	**An engineer/A supervisor should be able to:** – Use the LCC/LCP method to motivate the best purchase of an item or a system – Make fundamental calculations of LCC/LCP for investments and lifetime decisions – Verify the LCC values and make relevant decisions about the consequences if the verified result is not in accordance with the specified requirements	**An engineer/A supervisor should be able to:** – Calculate and follow up the figures of LCC and LCP in the company
5.5.3 Modification	**An engineer/A supervisor should be able to:** – Describe difference between modification and improvement	**An engineer/A supervisor should be able to:** – Discuss and make decisions about modification and improvement in production	**An engineer/A supervisor should be able to:** – Active improve modification with the goal to minimise problem and improve production

References

EN 17007:2017-MRQ – Deliver maintenance requirements during items design and modification:

- The purpose of this process is to define, monitor or realize and validate item investments, modifications and when the operational objectives are no longer reachable or have been changed. It defines the initial reliability, maintainability and maintenance support requirements, maintenance plans, the maintenance providers' related skills and the various logistical resources (hardware, documentation, spare parts, etc.) needed to implement the maintenance plan on these items.

5.6. Facility maintenance

Overview

- Understanding in facility maintenance
- Ability to plan for facility maintenance tasks

Subject	Knowledge	Skills	Responsibility and autonomy
5.6.1 Maintenance services for buildings	**An engineer/A supervisor should be able to:** - Mention the most common systems in a facility as; ventilation, heating, sewage, water, gas installations etc.	**An engineer/A supervisor should be able to:** - Discuss facility maintenance with maintenance personnel and suppliers for development	**An engineer/A supervisor should be able to:** - Have a basic knowledge in the estate design to perform necessary maintenance

References

EN 15331:2011 – Criteria for design, management and control of maintenance services for buildings:

- This European Standard specifies the criteria and the general methods that can be used in the planning, management and control of maintenance in buildings and their surrounding area according to the applicable legal requirements, objectives of the owners and users and the required quality of maintenance.

6. Maintenance Support

6.1. Documentation

Overview

- Very good knowledge in documentation handling
- Ability to manage documentation
- Ensure the proper documentation management (EN 15628:2014 B.4:d)
- Ensure the preparation of manuals and instructions for training and continuous technical updating (E) (EN 15628:2014 B.8:e)
- Documentation and knowledge management (EN 15628:2014 B.8:q)

Subject	Knowledge	Skills	Responsibility and autonomy
6.1.1 Maintenance documents	**An engineer/A supervisor should be able to:** – Describe which documents are needed to perform the maintenance tasks, including, work order, technical instructions, maintenance procedures, list of necessary resources, maintenance plans, time schedules, maintenance records and any other document needed to perform maintenance – Explain common systems for managing documentation	**An engineer/A supervisor should be able to:** – Carry out and use the documentation according to the processes: ▪ Define and manage rights to the documentation (EN 17007:2017 DOC.1) ▪ Classify and structure the documentation (EN 17007:2017 DOC.2) ▪ Compile (collect, create) and update the reference documentation (EN 17007:2017 DOC.3) ▪ Ensure access at all times to necessary information (EN 17007:2017 DOC.4)	**An engineer/A supervisor should be able to:** – Bring order in the required maintenance documents including validity and actuality
6.1.2 Technical documentation and maintenance manuals	**An engineer/A supervisor should be able to:** – Describe how to produce and maintain technical documentation: – Maintenance manuals – Electrical, mechanical pneumatic, electronic, hydraulic schemes and building drawings and CAD-systems	**An engineer/A supervisor should be able to:** – Use electrical, mechanical pneumatic, electronic, hydraulic schemes, building drawings and maintenance manuals	**An engineer/A supervisor should be able to:** – Manage and organize that the staff can read and understand different standards in maintenance document

6.1.3 Documentation systems	**An engineer/A supervisor should be able to:** – Explain methods and relevant tools for systemizing the documentation	**An engineer/A supervisor should be able to:** – Manage the way in which operational documentation is made available (EN 17007:2017 DOC.5) – Maintain and/or update the maintenance documentation system to ensure that all documentation is up to date	**An engineer/A supervisor should be able to:** – Organize a proper handling system for maintenance documentation

References

EN 17007:2017-DOC – Deliver the operational documentation:

– To provide all those concerned, at the place of use, with all the up-to-date and usable documents they need to prepare for and perform the tasks for which they are responsible while optimizing logistic times.

6.2. Information and data management

Overview

– Very good knowledge in information and data management
– Ability to manage information and data
– Fundamentals of data acquisition and control management (EN 15628:2014 B.5:a)
– Business objectives (EN 15628:2014 B.5:b)
– Principles, logic and parameters of operation and utilization of asset and item (EN 15628:2014 B.5:c)
– Supervise the compliance with the maintenance budget through the summarizing data (EN 15628:2014 B.5:d)
– Monitor performance, reliability, availability of asset and maintenance costs through the indicators (E) (EN 15628:2014 B.5:e)
– Control and update the information in the maintenance information system useful for the proper materials and services management (EN 15628:2014 B.6:e)
– Methods and techniques of organization and planning (EN 15628:2014 B.8:d)
– Features and capabilities of computerized maintenance management systems and tools (EN 15628:2014 B.8:f)
– Use the computerized maintenance management systems and tools for data acquisition, monitoring and reporting (E) (EN 15628:2014 B.8:j)
– Legislation and technical standards (EN 15628:2014 B.8:l)

Subject	Knowledge	Skills	Responsibility and autonomy

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

6.2.1 Maintenance information systems	**An engineer/A supervisor should be able to:** – Explain common types of information systems and how they are combined (e.g. the customer requirements on maintenance, the efficiency of the plant equipment and the machinery, the different contracts for the maintenance performance)) – Explain common Maintenance Information Systems (for planning, work order, technical/economical analysis, and so on) and different modules in CMMS – Explain different types of information for maintenance activities (e.g. workorder, work control, planning, work preparation, spare parts, LCC/LCP, safety, risks, environment, production results, betterment, modifications, investments, etc) – Explain requirements for information systems that will handle maintenance activities	**An engineer/A supervisor should be able to:** – Define, develop, implement and arguing the use of maintenance information systems	**An engineer/A supervisor should be able to:** – Use a maintenance information system including CMMS system if such system is in use.
6.2.2 Information handling systems	**An engineer/A supervisor should be able to:** – Explain how to use the information handling systems for maintenance tasks – Explain how different standards of documents shall look like (e.g. maintenance instructions, equipment lists, drawings, spare part lists, education/personnel information, handbooks, etc.) – Explain how different ideas regarding Information handling systems (e.g. paper – computerized, local – central, advantages – disadvantages, etc.) shall be handled	**An engineer/A supervisor should be able to:** – Organize and carry out the work to keep the information handling systems updated – Use the information handling systems for maintenance tasks	**An engineer/A supervisor should be able to:** – Use an information handling system including a CMMS system if such system is in use
6.2.3 Maintenance data collection	**An engineer/A supervisor should be able to:** – Describe how to collect maintenance data	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Explain common data management systems – Describe how to use the data management systems for maintenance tasks – Describe fundamental requirements regarding the security for data management and the need of backup for computer systems	– Develop, use and update the data in the systems according to the processes: ▪ Store and validate the raw data in a library and/or a database (EN 17007:2017 DTA.1) ▪ Evaluate the reliability and maintainability of the items by maintaining an actual state assessment of the items (EN 17007:2017 DTA.2) – Draw up and maintain an up-to-date list of critical items (EN 17007:2017 DTA.3)	– Collect data and store it in a maintenance information system including CMMS system if such system is in use.
6.2.4 Data evaluation	**An engineer/A supervisor should be able to:** – Describe techniques for data evaluation for maintenance processes	**An engineer/A supervisor should be able to:** – Evaluate the data in the systems according to the processes: ▪ Evaluate and analyse maintenance data and HSE data (EN 17007:2017 DTA.4) ▪ Evaluate and analyse data related to spare parts (EN 17007:2017 DTA.5) ▪ Evaluate and analyse cases of known or predictable obsolescence (EN 17007:2017 DTA.6) ▪ Collect and analyse events at other organizations (EN 17007:2017 DTA.7) ▪ Compare maintenance practices and materials used by other operators or recommended by suppliers (EN 17007:2017 DTA.8)	**An engineer/A supervisor should be able to:** – Use a maintenance data system including CMMS system if such system is in use for evaluating data
6.2.5 Data monitoring	**An engineer/A supervisor should be able to:** – Describe techniques for data monitoring of maintenance processes	**An engineer/A supervisor should be able to:** – Develop, use and present the data in the systems according to the processes: ▪ Monitor methods, technologies, regulations, standards, etc. (EN 17007:2017 DTA.9)	**An engineer/A supervisor should be able to:** – Process data from the production with the goal to improve the maintenance

		▪ Save and provide access to data in a data processing system (EN 17007:2017 DTA.10 ▪ Calculate, save, and provide access to performance and monitoring indicators (EN 17007:2017 DTA.11)	
6.2.6 Computerized Maintenance Management Systems (CMMS)	**An engineer/A supervisor should be able to:** – Describe the different structures in a CMMS – Describe how to use the CMMS for maintenance tasks – Describe principal concept how to handle a project regarding the implementation of a new CMMS (e.g. the choice of system, preparation, installation, training)	**An engineer/A supervisor should be able to:** – Select, develop, and implement a CMMS system that is suitable for the maintenance department – Promote and carry out routines for the use of the CMMS throughout the company´s organisation	**An engineer/A supervisor should be able to:** – Manage and develop an existing CMMS including proper use in the organization
6.2.7 Technical process control systems	**An engineer/A supervisor should be able to:** – Explain common technical process control systems and limits and uncertainties that might exist in these systems – Describe the relationship between the process control system and the maintenance information system – Explain common types and the principle of expert systems	**An engineer/A supervisor should be able to:** – Adjust and implement technical process control systems that are suitable for the items and systems to be maintained	**An engineer/A supervisor should be able to:** – Manage and develop existing various technical PC and PLC process control system including proper use in the organization

References

EN 17007:2017-MAN.6 – Define, select, analyse and communicate the information:

– The technical, organizational, economic and social information that shall be communicated internally and/or externally is defined, selected, analysed and made available to the relevant entities.

EN 17007:2017-DTA – Manage data:

– Collect, analyse, store and transmit all data needed to document and improve the maintenance process.

6.3. Resource management

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

Overview

- Good knowledge in needed recourses regarding infrastructures, Human Resources, external maintenance services and material, tools and equipment
- Ability to manage resources
- Develop and propose insourcing/outsourcing concepts to meet the maintenance strategy (EN 15628:2014 B.1:g)
- Define the organizational arrangements for the execution of maintenance tasks (EN 15628:2014 B.2:b)
- Business job descriptions and roles (EN 15628:2014 A.2:d)
- Coordinate maintenance works performed by maintenance personnel or contractors, ensuring the effectiveness and efficiency of the execution and verifying the proper functionality of asset by conducting a formal hand-over together with the physical asset owner/operating manager at the end of the work, before using it (EN 15628:2014 B.2:d)
- Optimize the use of human and technical resources (EN 15628:2014 B.2:f)
- Principles and techniques distinctive of the profession (EN 15628:2014 A.2:g)
- Provide project leadership (EN 15628:2014 B.2:g)
- Methods and techniques of organization and planning (EN 15628:2014 B.3:a)
- Principles, logic and parameters of operation and utilization of asset and item (EN 15628:2014 B.3:b)
- Procedures (EN 15628:2014 B.3:c)
- Business job descriptions and roles (EN 15628:2014 B.3:d)
- Define types and quantities of equipment and machines for maintenance tasks (EN 15628:2014 B.3:d)
- Legal constraints related of the management of resources, equipment and tools (EN 15628:2014 B.3:e)
- Skills of employees (EN 15628:2014 B.3:f)
- Support Human Resource by assistance in recruiting, assessment and training of staff (EN 15628:2014 B.3:f)
- Training and coaching techniques and methods (EN 15628:2014 B.3:g)
- Define the request for technical materials and ensure the logistics operations (S) (EN 15628:2014 B.6:a)
- Provide, in the framework of a contract, the necessary information to the contractor to carry out the assigned work, supervise the execution of the work in progress, ensure the proper, effective and efficient execution of work and ensure the technical and economic completion of work (to do-list) together with the contractor (S) (EN 15628:2014 B.6:b)

Subject	Knowledge	Skills	Responsibility and autonomy
6.3.1 Infrastructure	**An engineer/A supervisor should be able to:** – Explain needed infrastructural recourses; appropriate and safe premises and areas, necessary power, utilities, and services for maintenance	**An engineer/A supervisor should be able to:** – Define and plan needed resources according to the processes: ▪ Plan and provide appropriate and safe premises and areas (EN 17007:2017 IST.1) ▪ Plan and provide the necessary power, utilities, and services (EN 17007:2017 IST.2) ▪ Maintain and/or update the infrastructures and facilities (EN 17007:2017 IST.3)	**An engineer/A supervisor should be able to:** – Handle the total structure for support of roads, transports, electrical power, water, trash, and outlets

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Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

6.3.2 Human resources	**An engineer/A supervisor should be able to:** – Describe needed Human Resources to carry out planning and scheduling including, planning for training of personnel, lifelong learning, contacts between operation and maintenance, work scheduling, work execution and reporting – Describe how to develop and optimize the Human Resources, their location, quality, and quantity – Describe why a Human Resources policy must be set up and what the fundamental requirements are for such a policy	**An engineer/A supervisor should be able to:** – Define, plan and provide internal human recourses for the maintenance organization according to the processes: ▪ Manage jobs and skills (EN 17007:2017 RES.1) ▪ Recruit competent staff (EN 17007:2017 RES.2) ▪ Ensure training, qualification, and certification of internal staff (EN 17007:2017 RES.3) ▪ Provide internal Human Resources (EN 17007:2017 RES.4) – Implement the Human Resource policy for maintenance	**An engineer/A supervisor should be able to:** – Manage the manpower including recruiting, improvements of work and handling physical and drug problem
6.3.3 External maintenance services	**An engineer/A supervisor should be able to:** – Describe the needed external maintenance services to carry out planning and scheduling including, contacts between external and internal maintenance personnel, work scheduling, work execution and reporting – Describe how to develop and optimize the external maintenance services and their quality and quantity including the importance of reporting the work	**An engineer/A supervisor should be able to:** – Define and plan the external maintenance services and their quality and quantity according to the processes: ▪ Identify competent external companies (EN 17007:2017 SER.1) ▪ Contract with external companies (EN 17007:2017 SER.2) ▪ Manage contracts and evaluate companies and services (EN 17007:2017 SER.3) ▪ Provide external services (EN 17007:2017 SER.4)	**An engineer/A supervisor should be able to:** – Manage how to optimize external resources as a part of total maintenance in the company. These activities include reporting activities and in cooperation in CMMS system
6.3.4 Material, tools and equipment	**An engineer/A supervisor should be able to:** – Describe needed equipment to perform maintenance tasks; material, tools, measuring and control equipment, computer equipment, handling equipment (slings, fork-	**An engineer/A supervisor should be able to:** – Plan the supply of the material, tools and equipment and their location, quality and quantity according to the processes:	**An engineer/A supervisor should be able to:** – Handle basic material, tools, and equipment for maintenance

	lift trucks, hoists, etc.), means of access (scaffolding, ladders, platforms, etc.) – Describe common requirements for handling materials, tools, and equipment	▪ Determine and provide the support equipment needed for maintenance (EN 17007:2017 TOL.1) ▪ Store the support tools and equipment (EN 17007:2017 TOL.2) ▪ Maintain and/or Update the support equipment (EN 17007:2017 TOL.3) ▪ Deliver the tools and other support equipment (EN 17007:2017 TOL.4) ▪ Determine and provide a maintenance management, decision support software tools and documentation system (EN 17007:2017 TOL.5) ▪ Maintain and/or update the maintenance documentation system (EN 17007:2017 TOL.6)	
6.3.5 Remote maintenance	**An engineer/A supervisor should be able to:** – Describe common remote maintenance methods	**An engineer/A supervisor should be able to:** – Plan and carry out for remote maintenance	**An engineer/A supervisor should be able to:** – Handle remote maintenance outside the own plant
6.3.6 Contracting, outsourcing and insourcing	**An engineer/A supervisor should be able to:** – Describe ways of contracting, outsourcing, and insourcing maintenance resources – Explain common models and standards for contracting – Mention the pros and cons of outsourcing maintenance	**An engineer/A supervisor should be able to:** – Develop and/or use relevant documents for contracting, outsourcing, and insourcing maintenance resources	**An engineer/A supervisor should be able to:** – Handle legal aspects round own and supporting maintenance resources

References

EN 17007:2017-IST – Provide the needed infrastructures:

- Provide the infrastructures and facilities that all maintenance personnel need to fully perform their tasks in a manner that is safe for the individuals, the items and the environment.

EN 17007:2017-RES – Provide internal Human Resources:

- Provide in a timely manner the internal Human Resources who have the necessary skill levels and certification to perform the maintenance activities.

EN 17007:2017-SER – Provide external maintenance services:

- Provide in a timely manner the maintenance services carried out by external companies who have the necessary skill levels and certification to perform the maintenance activities.

EN 17007:2017-TOL – Deliver the tools, support equipment and information system:

- Provide users with the operational technical resources needed for maintenance (conventional and specialized tools, test, handling and other equipment, and information and maintenance management systems)

6.4. Spare parts management

Overview

- Very good knowledge in maintenance logistics
- Ability to manage spare parts
- Negotiate the needs of stocks of technical and strategic materials necessary to maintenance tasks with the maintenance manager (EN 15628:2014 B.6:d)

Subject	Knowledge	Skills	Responsibility and autonomy
6.4.1 Spare parts management	**An engineer/A supervisor should be able to:** – Describe the key factors regarding spare parts management	**An engineer/A supervisor should be able to:** – Carry out and implement an efficient spare parts management	**An engineer/A supervisor should be able to:** – Manage spare part handling and routines for purchase and delivery adapted for planned maintenance
6.4.2 Spare part calculations	**An engineer/A supervisor should be able to:** – Explain common methods for spare parts calculations, e.g. Wilson formula, ABC-analysis – Describe how to calculate the total amount of spare parts and how many of each type, inclusive the typical mathematical formulas for this purpose	**An engineer/A supervisor should be able to:** – Determine the spare items and the volumes to keep in stock for maintenance (EN 17007:2017 SPP.1)	**An engineer/A supervisor should be able to:** – Calculate best stock of spare parts in relation to the needs and eventually emergency situations
6.4.3 Material and store handling	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**

	– Describe different ways of organizing the spare part store (e.g., centralized, decentralized, at the supplier)	– Manage stocks for an efficient maintenance (EN 17007:2017 SPP.2)	– Develop and keep a system for spare stock management
6.4.4 Logistics support	**An engineer/A supervisor should be able to:** – Explain routines and organization for an optimized logistic support (e.g. purchasing, quality control, delivery systems inside the maintenance organization, etc.)	**An engineer/A supervisor should be able to:** – Plan, organize and carry out the logistic support of maintenance resources according to the processes: ▪ Reserve or issue a purchase request for spare items (EN 17007:2017 SPP.3) ▪ Order spare items from suppliers (EN 17007:2017 SPP.4) ▪ Establish and monitor contracts with suppliers (EN 17007:2017 SPP.5)	**An engineer/A supervisor should be able to:** – Develop and keep a total system for handling spare parts in the store including quality and meeting ageing problem
6.4.5 Spare part handling	**An engineer/A supervisor should be able to:** – Describe the different factors that will have an influence on an optimized organisation of the spare part consumption (e.g. cost for lack of spare parts, cost for storage, cost for interest, etc.)	**An engineer/A supervisor should be able to:** – Plan, organize and carry out for an efficient spare part handling according to the processes: ▪ Receive ordered or repaired spare items (EN 17007:2017 SPP.6) ▪ Add the spare items to stock (EN 17007:2017 SPP.7) ▪ Perform preventive maintenance on spare items in stock (EN 17007:2017 SPP.8) ▪ Deliver spare items (EN 17007:2017 SPP.9) ▪ Assess replaced items (EN 17007:2017 SPP.10) ▪ Repair replaced items (EN 17007:2017 SPP.11) ▪ Dispose faulty or damaged items (EN 17007:2017 SPP.12)	**An engineer/A supervisor should be able to:** – Plan, organize and administrate a spare part store

References

EN 17007:2017-SPP – Deliver spare parts:

- Provide the maintenance teams with the spare parts and, more generally, all spare items (spare parts, consumables, materials, etc.) needed for the maintenance actions within the required timeframes.

6.5. Procurement

Overview

- Very good knowledge in procurement of maintenance parts and services
- Methods and policies for the procurement of materials, materials and spare parts logistics and the management of materials and warehouses (EN 15628:2014 B.6:a)
- Contractor's policies and management systems (EN 15628:2014 B.6:b)
- Contractual general conditions and technical specifications (EN 15628:2014 B.6:c)
- Collaborate to define the criteria and procedures for the management and procurement of materials and services, (EN 15628:2014 B.6:c)
- Procedures and company policies (EN 15628:2014 B.6:d)

Subject	Knowledge	Skills	Responsibility and autonomy
6.5.1 Procurement	**An engineer/A supervisor should be able to:** - Explain the different steps in procurement of maintenance recourses - Explain the influence of maintenance in the procurement - Explain procedures regarding procurement including technical specifications	**An engineer/A supervisor should be able to:** - Discuss and make decisions regarding procurement issues with the procurement department	**An engineer/A supervisor should be able to:** - Handle the legal aspects of procurement including technical specifications
6.5.2 Replacement investments	**An engineer/A supervisor should be able to:** - Explain company rules for replacement investments	**An engineer/A supervisor should be able to:** - In cooperation with production, advise when to invest in replacements	

References

EN 13269:2016 – Guideline on preparation of maintenance contracts:

- This European Standard provides guidance on the preparation of private contracts for maintenance services.

6.6. Risk based maintenance

Overview

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

- Good knowledge in Risk Based Maintenance
- Ability to use risk assessment in maintenance prepare the risk assessment, identify risks, prioritize risks, propose measures for preventing risks and consequences of identified risks and monitor risk management

Subject	Knowledge	Skills	Responsibility and autonomy
6.6.1 Risk assessment in maintenance	**An engineer/A supervisor should be able to:** - Describe common risks and how it is defined - Describe common steps in general risk analysis - Describe common technical and human related risks and how to handle them	**An engineer/A supervisor should be able to:** - Calculate and prevent risks within maintenance - Judge the quality on performed risk analysis	**An engineer/A supervisor should be able to:** - Manage risk prevention related to production and to maintenance.
6.6.2 Methods for risk analysis	**An engineer/A supervisor should be able to:** - Describe common methods for risk analysis and when they can be used (e.g. FMEA, RCM, Criticality Analysis, Fault-tree) - Describe the different steps in a Reliability Centred Maintenance (RCM) - Describe the different steps in a Criticality Analysis	**An engineer/A supervisor should be able to:** - Apply and carry out different methods for risk analysis	**An engineer/A supervisor should be able to:** - Handle existing methods on the market and implement best methods
6.6.3 Monitor risk management	**An engineer/A supervisor should be able to:** - Describe common methods for risk monitoring	**An engineer/A supervisor should be able to:** - Plan and perform risk monitoring	**An engineer/A supervisor should be able to:** - Handle accrued incidents.

References

EN 16991:2018 – Risk-based inspection framework:

- This European Standard specifies the Risk-Based Inspection Framework (RBIF) and gives guidelines for Risk-Based Inspection and Maintenance (RBIM).

7. Basic knowledge

7.1. Maintenance terminology

Overview

- Very good knowledge in maintenance terminology
- Ability to use the proper terminology when discussing maintenance with maintenance personnel, production, and suppliers

Subject	Knowledge	Skills	Responsibility and autonomy
7.1.1 General terminology	**An engineer/A supervisor should be able to:** - Describe general maintenance terminology	**An engineer/A supervisor should be able to:** - Use proper general terminology when discussing maintenance with maintenance personnel, production, and suppliers	**An engineer/A supervisor should be able to:** - Understand and correct use common technical words and concepts.
7.1.2 Availability	**An engineer/A supervisor should be able to:** - Describe how reliability has to do with the time of the ready state for the equipment - Describe the definition of availability - Describe the connection and differences between dependability, availability, reliability, maintainability, and supportability - Describe the measure of availability - Describe the influence of availability on the production - Describe different ways to improve the availability	**An engineer/A supervisor should be able to:** - Use the proper terminology when discussing availability with maintenance personnel, production, and suppliers - Calculate the availability with respect to down time, running time, operational cycles, production, calendar time, etc. - Analyse what causes low availability	**An engineer/A supervisor should be able to:** - Understand how the availability affects the production process including calculation, vocabulary, and concepts
7.1.3 Reliability	**An engineer/A supervisor should be able to:** - Describe how reliability has to do with the number of failures and the disabled states due to maintenance activities - Describe the definition of reliability	**An engineer/A supervisor should be able to:** - Use the proper terminology when discussing reliability with maintenance personnel, production, and suppliers	**An engineer/A supervisor should be able to:** - Understand how the reliability affects the production process including calculation, vocabulary, and concepts

	– Describe different measures of reliability (MTBF and MTTF) – Describe different types of redundancies – Describe different ways to improve the reliability (e.g. the choice of components, redundancies, design, preventive maintenance, better operational use)	– Calculate the reliability probability for single, serial, and parallel system and for active and passive redundancies	
7.1.4 Maintainability	**An engineer/A supervisor should be able to:** – Describe how reliability has to do with active time for maintenance – Describe the definition of maintainability – Describe different measures of maintainability (MRT and M) – Describe different ways to improve the maintainability (e.g. design, documentation, maintenance equipment, education) – Describe which time elements that are included or not included in the calculation (e.g. preparation time, functional check out, waiting for resources)	**An engineer/A supervisor should be able to:** – Use the proper terminology when discussing maintainability with maintenance personnel, production, and suppliers – Calculate the maintainability and analyse what causes the length of active maintenance times	**An engineer/A supervisor should be able to:** Understand how the maintainability affects the production process including calculation, vocabulary, and concepts
7.1.5 Maintenance Supportability	**An engineer/A supervisor should be able to:** – Describe how reliability has to do with waiting times for maintenance resources – Describe the definition of supportability – Describe the measure of supportability (MWT) – Describe different ways to improve the supportability (e.g. assure faster access of personnel, documentation, spare parts, maintenance equipment, transports and assure faster administrative routines)	**An engineer/A supervisor should be able to:** – Use the proper terminology when discussing supportability with maintenance personnel, production, and suppliers – Calculating supportability and analyse what causes the length of the waiting times	**An engineer/A supervisor should be able to:** Understand how the maintenance supportability affects the production process including calculation, vocabulary, and concepts

References

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

EN 13306:2017 – Maintenance terminology:

- This European Standard specifies generic terms and definitions for the technical, administrative and managerial areas of maintenance.

7.2. Basics in mathematics, physics and chemistry

Overview

- Good knowledge in mathematics, physics, and chemistry
- Ability to use the basics in mathematics, physics, and chemistry

Subject	Knowledge	Skills	Responsibility and autonomy
7.2.1 Mathematics	**An engineer/A supervisor should be able to:** – Describe basic academical and practical mathematics	**An engineer/A supervisor should be able to:** – Use the basics in mathematic calculations	**A maintenance practician should be able to:** – Use mathematics, physics, chemistry, and statistics in daily work
7.2.2 Physics	**An engineer/A supervisor should be able to:** – Describe basic academical and practical physics	**An engineer/A supervisor should be able to:** – Use the basics in physics applications	
7.2.3 Chemistry	**An engineer/A supervisor should be able to:** – Describe basic academical and practical chemistry	**An engineer/A supervisor should be able to:** – Use the basics in chemistry applications	
7.2.4 Statistical methods	**An engineer/A supervisor should be able to:** – Describe common statistical methods	**An engineer/A supervisor should be able to:** – Use the common statistical methods for analysis	

References

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7.3. Maintenance standards

Qualifications for Maintenance Engineers and Supervisors (EQF level 6)

Overview

- Understanding in European standards within maintenance

Subject	Knowledge	Skills	Responsibility and autonomy
7.3.1 EN 13269:2016 Guideline on preparation of maintenance contracts	**An engineer/A supervisor should be able to:** - Mention the standard EN 13269:2016 Guideline on preparation of maintenance contracts	**An engineer/A supervisor should be able to:** - Use the standard EN 13269:2016 Guideline on preparation of maintenance contracts	**An engineer/A supervisor should be able to:** - Use the standard in normal work including vocabulary and concepts
7.3.2 EN 13306:2017 Maintenance Terminology	**An engineer/A supervisor should be able to:** - Mention the standard EN 13306:2017 Maintenance Terminology	**An engineer/A supervisor should be able to:** - Use the standard EN 13306:2017 Maintenance Terminology	
7.3.3 EN 13460:2009 Maintenance Documentation	**An engineer/A supervisor should be able to:** - Mention the standard EN 13460:2009 Maintenance Documentation	**An engineer/A supervisor should be able to:** - Use the standard EN 13460:2009 Maintenance Documentation	
7.3.4 EN 15331:2011 Criteria for design, management and control of maintenance services for buildings	**An engineer/A supervisor should be able to:** - Mention the standard EN 15331:2011 Criteria for design, management, and control of maintenance services for buildings	**An engineer/A supervisor should be able to:** - Use the standard EN 15331:2011 Criteria for design, management, and control of maintenance services for buildings	
7.3.5 EN 15341:2019 Maintenance Key Performance Indicators	**An engineer/A supervisor should be able to:** - Mention the standard EN 15341:2019 Maintenance Key Performance Indicators	**An engineer/A supervisor should be able to:** - Use the standard EN 15341:2019 Maintenance Key Performance Indicators	

7.3.6 EN 15628:2014 Qualifications of maintenance personnel	**An engineer/A supervisor should be able to:** – Mention the standard EN 15628:2014 Qualifications of maintenance personnel	**An engineer/A supervisor should be able to:** – Use the standard EN 15628:2014 Qualifications of maintenance personnel	
7.3.7 EN 16646:2014 Maintenance within physical asset management	**An engineer/A supervisor should be able to:** – Mention the standard EN 16646:2014 Maintenance within physical asset management	**An engineer/A supervisor should be able to:** – Use the standard EN 16646:2014 Maintenance within physical asset management	
7.3.8 EN 16991:2018 Risk-based inspection framework	**An engineer/A supervisor should be able to:** – Mention the standard EN 16991:2018 Risk-based inspection framework	**An engineer/A supervisor should be able to:** – Use the standard EN 16991:2018 Risk-based inspection framework	
7.3.9 EN 17007:2017 Maintenance process and associated indicators	**An engineer/A supervisor should be able to:** – Mention the standard EN 17007:2017Maintenance process and associated indicators	**An engineer/A supervisor should be able to:** – Use the standard EN 17007:2017Maintenance process and associated indicators	

References

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7.4. Technical English

Overview

– Very good knowledge in technical English

Subject	Knowledge	Skills	Responsibility and autonomy
7.4.1 Maintenance technical English	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:**	**An engineer/A supervisor should be able to:** – Read and understand technical documents

	– Describe the basics in English maintenance vocabulary – Explain maintenance terms in the English language	– Understand and apply technical text and maintenance terms in English	

References

– Language test in English is adapted for test takers which have other mother tongue than English.