1. Maintenance within Physical Asset Management

1.1. Physical Asset Management

Overview

- Understanding the concept of Physical Asset Management

Subject	Knowledge	Skills	Responsibility and autonomy
1.1.1 Physical Asset Management	**A maintenance practitioner should be able to:** - Mention in brief the industry design of a production plant - Mention the steps from early planning into a production line and controlled settle	**A maintenance practitioner should be able to:** - In simple sketches show the industrial process	**A maintenance practitioner should be able to:** - Carry out the maintenance work in a production plant
1.1.2 Company processes	**A maintenance practitioner should be able to:** - Mention different industrial processes with organization to plan and ways to administrate the production	**A maintenance practitioner should be able to:** - Follow rules and regulations with maintenance work in a production plant	**A maintenance practitioner should be able to:** - Follow and do the work according to the maintenance planning
1.1.3 Company policy	- Not applicable	- Not applicable	- Not applicable
1.1.4 Quality and Environmental regulations and systems	- Not applicable	- Not applicable	- Not applicable
1.1.5 Maintenance within Physical Asset Management	**A maintenance practitioner should be able to:** - Mention the relation between the maintenance and the planning of the production	**A maintenance practitioner should be able to:** - Follow maintenance plans according to maintenance and production planning	**A maintenance practitioner should be able to:** - Carry out maintenance work integrated in production

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 processes and all the other physical asset management processes. It addresses the role and importance of maintenance within the 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

Subject	Knowledge	Skills	Responsibility and autonomy
1.2.1 Production planning	**A maintenance practitioner should be able to:** – Mention some planning system of production and how the maintenance has an influence	**A maintenance practitioner should be able to:** – Follow given planning and carry out the maintenance work	**A maintenance practitioner should be able to:** – Integrate plan for maintenance with the planning of production
1.2.2 Production safety	**A maintenance practitioner should be able to:** – Mention superior requirements regarding safety and how to handle safety in a production process	**A maintenance practitioner should be able to:** – Understand and follow the safety rules and regulations when performing maintenance work	**A maintenance practitioner should be able to:** – Integrate safety system in the production control system
1.2.3 Production quality	**A maintenance practitioner should be able to:** – Mention system for handling quality in production including the standard framework in ISO 9000 – Mention standards and methods for quality assurance regarding maintenance: – Mention the basics in TQC - Total Quality Control	**A maintenance practitioner should be able to:** – Carry out work in the company on a quality adapted way – Work for that maintenance activities are integrated in production quality activities	**A maintenance practitioner should be able to:** – Integrate maintenance in production work according to quality standards and methods

	− Mention 4M — Man, Machine, Method, Material − Mention how maintenance activities will have an influence on the production quality		

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 processes and all the other physical asset management processes. It addresses the role and importance of maintenance within the 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.

2. Maintenance Management

2.1. Maintenance management

Overview

- Understanding the basics in Maintenance Management

Subject	Knowledge	Skills	Responsibility and autonomy
2.1.1 Maintenance management	**A maintenance practitioner should be able to:** - Mention how to use written instructions to install and dismantle individual components (sensors, actuators, drives, motors, transport systems, racks) that form a functional group of mechatronic systems	**A maintenance practitioner should be able to:** - Carry out the work to install and dismantle individual components	**A maintenance practitioner should be able to:** - Practically do planned work
2.1.2 Maintenance policy	**A maintenance practitioner should be able to:** - Mention why it is important to use and follow policies and guidelines in a company	**A maintenance practitioner should be able to:** - Carry out the work with guidelines as direction for the maintenance work	
2.1.3 Maintenance objectives			
2.1.4 Maintenance strategies			
2.1.5 Key Performance Indicators (KPI)	Not Applicable	Not Applicable	Not Applicable

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.

2.2. Maintenance economics and budgeting

Overview

– Understanding the basics in maintenance economics and budgeting

Subject	Knowledge	Skills	Responsibility and autonomy
2.2.1 Maintenance economics	**A maintenance practitioner should be able to:** – Mention basics in economics with income and costs – Explain costs associated with materials, tools, equipment, and their areas of use as well as estimated service life	**A maintenance practitioner should be able to:** – Support with economical facts in the organization process	**A maintenance practitioner should be able to:** – Select and use materials and equipment regarding care and costs – Carry out work adapted to the environment and sustainability and to avoid waste
2.2.2 Maintenance budget	**A maintenance practitioner should be able to:** – Mention normal economical items in a maintenance budget		
2.2.3 Economical maintenance plan	– Not applicable	– Not applicable	– Not applicable

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

- Understanding in different internal and external maintenance activities

Subject	Knowledge	Skills	Responsibility and autonomy
2.3.1 Requirements for maintenance activities	**A maintenance practitioner should be able to:** - Mention how to handle tools and instruments related to maintenance work	**A maintenance practitioner should be able to:** - Carry out planned work with relevant systems, tools and instruments and report performed activities in CMMS	**A maintenance practitioner should be able to:** - Use required equipment to carry out and document the maintenance work
2.3.2 Quality assurance of maintenance activities	**A maintenance practitioner should be able to:** - Mention ways to use CAD functions and other document system developments (parts lists descriptions of function, Operating instructions) - Explain how to document the results with quality-control systems		
2.3.3 Analyse the results of maintenance activities	- Not applicable	- Not applicable	- Not applicable
2.3.4 Life cycle extension	- Not applicable	- Not applicable	- Not applicable
2.3.5 Operator maintenance	- Not applicable	- Not applicable	- Not applicable

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

- Understanding in a maintenance organisation

Subject	Knowledge	Skills	Responsibility and autonomy
2.4.1 Maintenance organisation	**A maintenance practitioner should be able to:** – Mention different organization methods for maintenance with pros and cons	**A maintenance practitioner should be able to:** – Carry out work in different organizations including ways to pick up work and report	**A maintenance practitioner should be able to:** – Be active and responsible both individually and as a partner in working groups – Perform maintenance work according to laws and regulations
2.4.2 Jobs and competences	**A maintenance practitioner should be able to:** – Mention actual specialists which can be involved in maintenance work	**A maintenance practitioner should be able to:** – If needed, carry out work in cooperation with specialists	
2.4.3 Labour laws and regulations	**A maintenance practitioner should be able to:** – Mention important laws, rules, and regulation in maintenance	**A maintenance practitioner should be able to:** – Act according to laws and regulations when performing maintenance work	

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

- Understanding in technical training and coaching methods and techniques

Qualifications for Maintenance Mechanics, Electricians & Automation electricians (EQF level 4)

Subject	Knowledge	Skills	Responsibility and autonomy
2.5.1 Communication and presentation techniques	**A maintenance practitioner should be able to:** – Mention different pedagogical methods to communicate oral and in text	**A maintenance practitioner should be able to:** – Carry out communication on an effective way – Communicate relevant information when handing over work	**A maintenance practitioner should be able to:** – Communicate relevant information
2.5.2 Leadership	– Not applicable	– Not applicable	– Not applicable
2.5.3 Methods and techniques for training	**A maintenance practitioner should be able to:** – Explain methods for training of system and function parameters which are important for the equipment's functions	**A maintenance practitioner should be able to:** – Transfer key information about system and function parameters to others – Independently assess and document the wear and general conditions of the mechatronic equipment	**A maintenance practitioner should be able to:** – Perform and participate in training activities
2.5.4 Coaching	– Not applicable	– Not applicable	– Not applicable
2.5.5 Working groups	**A maintenance practitioner should be able to:** – Explain ways to work in groups for faster solutions of problem and work	**A maintenance practitioner should be able to:** – Carry out work for solving problems with help of different working groups with adapted manner	**A maintenance practitioner should be able to:** – Plan, perform, and participate in working groups

References

--

3. Maintenance Execution

3.1. Failure and fault theory

Overview

- Good knowledge in theories regarding failures and faults

Subject	Knowledge	Skills	Responsibility and autonomy
3.1.1 Failure patterns	**A maintenance practitioner should be able to:** - Mention the definitions of failure patterns based on the standard - Explain common methods for troubleshooting covering systems and functions	**A maintenance practitioner should be able to:** - Choose the appropriate maintenance method depending on the actual failure distribution - Follow the standard in the work for troubleshooting	**A maintenance practitioner should be able to:** - Perform work in accordance with requirements
3.1.2 Wear and tear	**A maintenance practitioner should be able to:** - Explain the process to take care of tear and wear including to optimize the work	**A maintenance practitioner should be able to:** - Carry out needed exchange of components	
3.1.3 System and functional analysis	**A maintenance practitioner should be able to:** - Describe how to break down systems and functions to facilitate program handling for system design and troubleshooting	**A maintenance practitioner should be able to:** - Carry out activities for troubleshooting and modification of system and functions	**A maintenance practitioner should be able to:** - Perform work in accordance with system and functional requirements

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

- Good knowledge in planning and scheduling

Subject	Knowledge	Skills	Responsibility and autonomy
3.2.1 Planning and scheduling	**A maintenance practitioner should be able to:** - Mention companies' main goal for the production and maintenance - Explain methods to have contacts between operators and maintenance according to: ▪ scheduling of work ▪ execution of work ▪ reporting of work	**A maintenance practitioner should be able to:** - Carry out planned work for maintenance in cooperation with the production - Follow normal work planning, executions, and reporting for the maintenance	**A maintenance practitioner should be able to:** - Understand companies' main goal for the production and maintenance, and the influence of automation
3.2.2 Prioritizing maintenance activities	**A maintenance practitioner should be able to:** - Mention why it is important to make priority of maintenance activities	**A maintenance practitioner should be able to:** - Handle the work in relation to needed activities for the production	**A maintenance practitioner should be able to:** - Follow the companies needs and carry out the maintenance work according to maintenance plans including prioritizing of activities and reporting in CMMS
3.2.3 Maintenance plans	**A maintenance practitioner should be able to:** - Explain how to implement and follow maintenance plans	**A maintenance practitioner should be able to:** - Carry out work following given maintenance plan	
3.2.4 Work order process	**A maintenance practitioner should be able to:** - Explain the total process to order and report jobs in CMMS	**A maintenance practitioner should be able to:** - Carry out the maintenance work and follow up maintenance plans including prioritizing of activities by following CMMS	
3.2.5 Maintenance planning	**A maintenance practitioner should be able to:** - Mention the relationship between administrative and technical systems in a company	**A maintenance practitioner should be able to:** - Render companies' maintenance in relation to the main production goal	**A maintenance practitioner should be able to:** - Understand work planning for own activities and for a team in relation to maintenance and production requirements

	– Mention the basic factors/definitions in maintenance and the relations to production planning – Explain how the company is planning maintenance including preventive and corrective maintenance and how the CMMS data and production results might have influenced the maintenance planning	– Practically render different maintenance methods and systems	
3.2.6 Maintenance scheduling	– Not applicable	– Not applicable	– Not applicable
3.2.7 Maintenance realization	**A maintenance practitioner should be able to:** – Explain different methods and techniques for maintenance realization	**A maintenance practitioner should be able to:** – Start, perform, and finalize the work	**A maintenance practitioner should be able to:** – Carry out a planned maintenance program
3.2.8 Verification before start	**A maintenance practitioner should be able to:** – Explain the principles of verification tests and measures before start or restart	**A maintenance practitioner should be able to:** – Assure that verification before start/restart is executed properly all the time	**A maintenance practitioner should be able to:** – Carry out the verification 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)
- Prepare the provisional schedule (start date, end date) of the tasks. (ACT.4)

3.3. Preventive maintenance

Overview

- Good knowledge in preventive maintenance activities

Qualifications for Maintenance Mechanics, Electricians & Automation electricians (EQF level 4)

Subject	Knowledge	Skills	Responsibility and autonomy
3.3.1 Preventive maintenance	**A maintenance practitioner should be able to:** – Explain the background for preventive maintenance – Explain how different factors; cycles, calendar-time, and running-time influence preventive maintenance – Explain the difference between preventive measures and acute measures	**A maintenance practitioner should be able to:** – Read and understand maintenance outline – Identify reasons for aberration for forming preventive measures	**A maintenance practitioner should be able to:** – Carry out different levels in maintenance in relation to given standards
3.3.2 Predetermined maintenance	**A maintenance practitioner should be able to:** – Mention methods and techniques for predetermined maintenance – Mention how to perform predetermined maintenance	**A maintenance practitioner should be able to:** – Plan and carry out predetermined maintenance	**A maintenance practitioner should be able to:** – Carry out activities in predetermined maintenance
3.3.3 Condition-based maintenance	**A maintenance practitioner should be able to:** – Explain the principle behind Condition Based Maintenance (CBM) and how these measures will create improvements – Explain the five subjective methods and the way to incorporates the results	**A maintenance practitioner should be able to:** – Carry out to follow trends in equipment status and how to optimize maintenance	**A maintenance practitioner should be able to:** – Carry out CBM rounds, including evaluation of trends and reporting in CMMS
3.3.4 Predictive maintenance	**A maintenance practitioner should be able to:** – Explain predictive maintenance methods and how to perform predictive maintenance	**A maintenance practitioner should be able to:** – Carry out and follow plans and relevant methods where predictive maintenance should be done	**A maintenance practitioner should be able to:** – Analysing and optimizing process activities in predictive maintenance

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

Subject	Knowledge	Skills	Responsibility and autonomy
3.4.1 Corrective maintenance	**A maintenance practitioner should be able to:** - Explain corrective maintenance methods and how to perform corrective maintenance - Explain the different ways to act correctly when acute problems or breakdowns arise - Explain the risks with postpone maintenance and how this influence maintenance and organization	**A maintenance practitioner should be able to:** - Carry out corrective maintenance and report the fault in CMMS and the reason behind	**A maintenance practitioner should be able to:** - Evaluate the balance between preventive and corrective measures in total maintenance
3.4.2 Fault diagnosis	**A maintenance practitioner should be able to:** - Explain how to handle troubleshooting in production lines using analysing system and function - Explain how to detect and diagnose faults - Explain different methods and techniques for fault detection and diagnose	**A maintenance practitioner should be able to:** - Carry out troubleshooting for fault detection - Decide when a corrective maintenance action is immediate - Take immediate corrective action in cases of exceptional events	**A maintenance practitioner should be able to:** - Analyse functions and system where the fault can be located using right methods and techniques for fault detection
3.4.3 Immediate Corrective Maintenance	**A maintenance practitioner should be able to:** - Explain the differences between immediate and deferred maintenance - Explain methods to minimise panic actions with development of preventive measures	**A maintenance practitioner should be able to:** - Take immediate corrective action in cases of exceptional events - Carry out the maintenance work and report in CMMS	**A maintenance practitioner should be able to:** - Optimizing the maintenance process to take care of rapid realization to minimise stop time

3.4.4 Deferred Corrective Maintenance	**A maintenance practitioner should be able to:** – Explain the differences between immediate and deferred maintenance – Explain methods to minimise corrective activities	**A maintenance practitioner should be able to:** – Carry out the maintenance work and report in a CMMS	**A maintenance practitioner should be able to:** – Optimizing the maintenance process to minimize stop time
3.4.5 Restoration techniques	**A maintenance practitioner should be able to:** – Explain the way to bring the equipment in production to planned production volume with correct quality, after maintenance activities – Note the difference between planned capacity and maximum capacity of an item in restoration maintenance	**A maintenance practitioner should be able to:** – Carry out restoration maintenance according to production requirements in relation to planned production	**A maintenance practitioner should be able to:** – Handle working orders and correctly report faults and measures

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

- Understanding in continuous improvements

Subject	Knowledge	Skills	Responsibility and autonomy

3.5.1 Continuous improvement	**A maintenance practitioner should be able to:** – Explain the principles of continuous improvements – Mention different methods to develop improvements in an organization – Mention continuous improvement and what effect these will have on the dependability	**A maintenance practitioner should be able to:** – Apply the principles for continuous improvement in the daily work	**A maintenance practitioner should be able to:** – Create the way to work by picking up all small ideas to improve and develop structural reforms
3.5.2 Improvement of items	– Not applicable	– Not applicable	– Not applicable
3.5.3 Improvement of results	– Not applicable	– Not applicable	– Not applicable
3.5.4 Improvement techniques	**A maintenance practitioner should be able to:** – Mention methods to develop tools and measuring equipment to facilitate the work – Mention different improvements techniques due to maintenance results – Explain how to calculate OEE (Overall Equipment Effectiveness)	**A maintenance practitioner should be able to:** – Carry out maintenance work and use the experience for developing ideas for improvement – Use the indicator OEE to measure the production and improve the results of productivity	**A maintenance practitioner should be able to:** – Use various methods and techniques to take care of the results to improve the production conditions
3.5.5 Maintenance and industry 4.0	– Not applicable	– Not applicable	– Not applicable
3.5.6 Benchmarking	– Not applicable	– Not applicable	– Not applicable
3.5.7 Future maintenance needs	– Not applicable	– Not applicable	– Not applicable

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

Subject	Knowledge	Skills	Responsibility and autonomy
4.1.1 Risk assessment	**A maintenance practitioner should be able to:** - Describe the importance of perform risk judgment before starting the work, and safety analysis with the goal to minimize risks	**A maintenance practitioner should be able to:** - Perform risk assessment before start and plan and carry out the work with relevant safety equipment and considering identified risks	**A maintenance practitioner should be able to:** - Working with "build in" safety manner
4.1.2 Safety and environment protection equipment	**A maintenance practitioner should be able to:** - Describe the needs concerning hot work, and certificate as hot work operator - From safety aspects, explain how to handle heavy lifting - Explain the basics in building scaffolds - Explain the important roles when working on ladders - Explain important roles when working on sky lifts - Explain the risks for oxygen shortage, panic etc. when working in narrows place - Explain methods to make sure that all pressure is drained before work	**A maintenance practitioner should be able to:** - Practically understand a working site, where it can be dangerous and necessary safety arrangements - Work as a safety guard during and after welding and other "hot work" - Know how to be a useful and active partner and capable to act correct during heavy lifting - Understand the risks when working on heights and the necessary rules and regulations - Practically handling the work in narrow spaces - Practically work safe when going into pressurized components	**A maintenance practitioner should be able to:** - Plan the work based on safety regulations and use relevant security equipment when performing the maintenance
4.1.3 Relations with auditing and safety organizations	**A maintenance practitioner should be able to:**	**A maintenance practitioner should be able to:**	**A maintenance practitioner should be able to:**

	– Mention how the safety organization can be organized in a company	– Act in work situation to minimize the risks related to the maintenance work	– Perform the maintenance work with considerations to rules and regulations
4.1.4 Human error analysis	**A maintenance practitioner should be able to:** – Mention how the human can generate faults and methods to avoid human created risks		
4.1.5 Laws and regulations	**A maintenance practitioner should be able to:** – Mention the background to the Machine Directive and how its influence on daily work – Mention what CE-mark stands for	**A maintenance practitioner should be able to:** – Observe if measures can result in new CE-mark process	**A maintenance practitioner should be able to:** – Carry out maintenance of a unit in line with process requirements and announce if a new CE-mark will be needed
4.1.6 Environment	**A maintenance practitioner should be able to:** – Mention how maintenance activities can have effect on the environment	**A maintenance practitioner should be able to:** – Perform the maintenance in relation to environmental plans and regulations	**A maintenance practitioner should be able to:** – Carry out activities to minimize influences on environment outside the plant and indoors for better conditions

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

- Very good knowledge in mechanics

Maintenance mechanic

Subject	Knowledge	Skills	Responsibility and autonomy
5.1.1 Mechanics	**A maintenance mechanic should be able to:** – Explain the basics in movement, mass, force, moment of inertia, kinetic energy, friction – Explain basic physical principles for mechanical parts and components	**A maintenance mechanic should be able to:** – Carry out work in the mechanical area based on the relations between the mechanical factors and based on that be capable to carry out simple calculations	**A maintenance mechanic should be able to:** – Manage to handle mechanical systems, both on paper and in reality
5.1.2 Mechanical parts and components	**A maintenance mechanic should be able to:** – Describe common V-belt transmissions and judge wears – Explain belt design and conditions – Explain the principles for common shaft couplings, including wear and gape – Explain the main principles for gearboxes, gearings, greasing, capacity, temperatures – Mention the different types of tooth profiles, gap and wear limits for gearboxes – Describe the principles for lining, and the risk if lining is missing – Describe the different standards for screw threads – Explain the techniques behind torque tools – Explain the differences in screw qualities	**A maintenance mechanic should be able to:** – Capable to change V-belts – Knowledge in how to exchange common types of couplings – Capable to handle common gear boxes with shaft seals, packings etc. – Carry out, based on manuals, lubricant to oil changes – Capable to dismount and mounting in correct order by following drawings, and manuals – Carry out mechanical measuring – Capable to use some lining equipment – Decide on the correct screw quality given the conditions – Capable to use a torque wrench – Understand and use drawings in 2D and 3D – Choose and use right kind of measuring tools	**A maintenance mechanic should be able to:** – Manage to work with mechanical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

	– Explain how mechanical system is designed, including safety and functional sketches – Explain the basics in mechanical drawings – Explain the basics in mechanical measuring techniques		
5.1.3 Hydraulics and pneumatics	**A maintenance mechanic should be able to:** – Explain what is significant with hydraulic systems, including environmental aspects and risks – Explain how a hydraulic system is designed, including safety and functional drawings – Describe how to write hydraulic system with symbols and how to show functional drawings with tubes, horses, vales, and signals for control – Explain symbols on drawings and system designs, including control system – Explain how to handle hydraulic pressure in a safe way – Describe the techniques with various design for cleaning of oil and generation of wear particles – Explain dirt in compressed air – Explain how compressed air is distributed – Explain how to grease compressed air and when it is needed – Describe basic pneumatic symbols and render symbols and how to read functions on drawings – Describe different types of valves and their specific functions	**A maintenance mechanic should be able to:** – Handle, in a safe and clean way, hydraulic components before installation and in existing systems – Understand how to handle pressurized hydraulic systems – Understand how the hydraulic system is designed to follow control signals and functions – Carry out to identify different types of filters and filtering effect (particle dimension) and carry out safe and clean exchange of filters – Carry out oil sampling and decide if oil change or a new filter is needed – Carry out both installation work and troubleshooting of pneumatics – Capable to use compressed air as support in the work in a safe way and as working media in automation – Connect air-based component and electricity correctly	**A maintenance mechanic should be able to:** – Manage to work with hydraulic items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work – Capable to work in a safe way in hydraulic systems – Manage to handle hydraulic systems, both on paper and in reality – Manage to work with pneumatic items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work – Using pneumatics in automation systems, as a part of the control system
5.1.4 Bearings	**A maintenance mechanic should be able to:**	**A maintenance mechanic should be able to:**	**A maintenance mechanic should be able to:**

	– Explain friction, vibration, greasing in direct and rolling bearings and preventive maintenance with changes in noise, vibration, temperature, clean handling, and lubrication – Describe the principles with changing different type of bearings – Explain the best conditions for bearings including methods for lining for best lifetime without vibration – Explain rotating machines lifetime and conditions in selected applications	– Identify simple faults, such as vibrations and high temperature – Manage to change bearings with high cleanliness – Carry out bearing exchange including control of functions – Analyse faults in bearings through measuring techniques – Carry out exchange of various types of bearings following manuals, including functional tests	– Manage to work with bearing items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.1.5 Welding and soldering	**A maintenance mechanic should be able to:** – Explain the rules and regulations for welding including in which kind of welding operations IW-license (International Welder) is required for the work – Explain differences in use for the welding methods, and how the methods are used – Gas heating and shaping. Explain how a gas flame is formed with temperatures using acetylene and oxygen with risks with gas, lockage, and hoses – MMA, TIG, MIG. Explain the differences between different welding methods and how to use them – Explain the welding requirements for different stainless steel – Mention the welding requirements for pressurised tubes – Mention common strength properties – Explain what happens around a welding joint in relation changing in material and strength	**A maintenance mechanic should be able to:** – Plan and carry out welding work related to the requirements of IW-license for the type of welding – To lit up a gas flame and adjust the flame to correct temperature without soot and capable to heat up a part for it to loosen – Manage to use welding for simple repair welding – Observe if stainless steel is used – Understand a construction, aiming to eventually to know if it can be strength problem – Perform welding work according to the rules of “Hot Work”	**A maintenance mechanic should be able to:** – Manage to work with welding items using relevant tools, descriptions, drawings, and regulations to perform the maintenance work

	– Explain what happens in materials when they are heated – Mention common NDT methods for analysing strength problem round welding, weak design or vibration related problems		
5.1.6 Vibration	**A maintenance mechanic should be able to:** – Explain basics in acceleration, rotation, frequency, and amplitude – Explain sensors for vibration – Explain the differences between vibration and resonance	**A maintenance mechanic should be able to:** – Use manuals for vibration instruments to measure vibrations in planned activities – Analyse vibration and resonance in practice and evaluate measuring data in trend analyses to form measures	**A maintenance mechanic should be able to:** – Manage to work with vibration analyses using relevant instruments and descriptions to perform the maintenance work
5.1.7 Tribology	**A maintenance mechanic should be able to:** – Describe the fundamentals of: ▪ Friction ▪ Wear ▪ Lubrication ▪ Different lubrication techniques – Explain different type of common greasing substances and oils	**A maintenance mechanic should be able to:** – Carry out tribological tasks	**A maintenance mechanic should be able to:** – Have a basic knowledge and skills in mechanical design to understand friction and tribology

References

--

Maintenance electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.1.1 Mechanics	**A maintenance electrician should be able to:** – Explain the basics in movement, mass, force, moment of inertia, kinetic energy, friction – Explain basic physical principles for mechanical parts and components	**A maintenance electrician should be able to:** – Carry out work in the mechanical area based on the relations between the mechanical factors and based on that be capable to carry out simple calculations	**A maintenance electrician should be able to:** – Manage to handle mechanical systems, both on paper and in reality

Qualifications for Maintenance Mechanics, Electricians & Automation electricians (EQF level 4)

5.1.2 Mechanical parts and components	**A maintenance electrician should be able to:** – Describe common V-belt transmissions and judge wears – Explain the principles for common shaft couplings – Explain the main principles for gearboxes – Describe the principles for lining – Describe the different standards for screw threads – Explain the techniques behind torque tools	**A maintenance electrician should be able to:** – Capable to change V-belts – Knowledge in how to exchange common types of couplings – Capable to handle common gear boxes – Capable to dismount and mounting in correct order by following drawings, and manuals – Carry out mechanical measuring – Capable to use some lining equipment – Capable to use a torque wrench	**A maintenance electrician should be able to:** – Manage to work with mechanical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.1.3 Hydraulics and pneumatics	**A maintenance electrician should be able to:** – Explain what is significant with hydraulic systems, including environmental aspects and risks – Explain dirt in compressed air – Explain how compressed air is distributed – Explain how to grease compressed air and when it is needed – Describe basic pneumatic symbols and render symbols and how to read functions on drawings – Describe different types of valves and their specific functions	**A maintenance electrician should be able to:** – Understand how to handle pressurized hydraulic systems – Understand how the hydraulic system is designed to follow control signals and functions – Carry out both installation work and troubleshooting of pneumatics – Capable to use compressed air as support in the work in a safe way and as working media in automation – Connect air-based component and electricity correctly	**A maintenance electrician should be able to:** – Capable to work in a safe way in hydraulic systems – Manage to handle hydraulic systems, both on paper and in reality – Manage to work with pneumatic items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work – Using pneumatics in automation systems, as a part of the control system
5.1.4 Bearings	**A maintenance electrician should be able to:** – Explain friction, vibration, greasing in direct and rolling bearings and preventive maintenance with changes in noise, vibration, temperature, clean handling, and lubrication – Describe the principles with changing different type of bearings	**A maintenance electrician should be able to:** – Carry out bearing exchange including control of functions – Analyse faults in bearings through measuring techniques	**A maintenance electrician should be able to:** – Manage to work with bearing items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

5.1.5 Welding and soldering	**A maintenance electrician should be able to:** – Explain the rules and regulations for welding including in which kind of welding operations IW-license (International Welder) is required for the work – Gas heating and shaping. Explain how a gas flame is formed with temperatures using acetylene and oxygen with risks with gas, lockage, and hoses	**A maintenance electrician should be able to:** – To lit up a gas flame and adjust the flame to correct temperature without soot and capable to heat up a part for it to loosen – Perform welding work according to the rules of "Hot Work"	**A maintenance electrician should be able to:** – Manage to work with gas flame to perform the maintenance work
5.1.6 Vibration	**A maintenance electrician should be able to:** – Explain basics in acceleration, rotation, frequency, and amplitude – Explain sensors for vibration – Explain the differences between vibration and resonance	**A maintenance electrician should be able to:** – Use manuals for vibration instruments to measure vibrations in planned activities – Analyse vibration and resonance in practice and evaluate measuring data in trend analyses to form measures	**A maintenance electrician should be able to:** – Manage to work with vibration analyses using relevant instruments and descriptions to perform the maintenance work
5.1.7 Tribology	**A maintenance electrician should be able to:** – Describe the fundamentals of friction and lubrication	**A maintenance electrician should be able to:** – Carry out tribological tasks	**A maintenance electrician should be able to:** – Have a basic knowledge and skills in mechanical design to understand friction and tribology

References

--

Automation electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.1.1 Mechanics	**An automation electrician should be able to:** – Explain the basics in movement, mass, force, moment of inertia, kinetic energy, friction – Explain basic physical principles for mechanical parts and components	**An automation electrician should be able to:** – Carry out work in the mechanical area based on the relations between the mechanical factors and based on that be capable to carry out simple calculations	**An automation electrician should be able to:** – Manage to handle mechanical systems, both on paper and in reality

Qualifications for Maintenance Mechanics, Electricians & Automation electricians (EQF level 4)

5.1.2 Mechanical parts and components	**An automation electrician should be able to:** – Explain how mechanical system is designed, including safety and functional sketches.	**An automation electrician should be able to:** – Capable to dismount and mounting in correct order by following drawings, and manuals - Carry out mechanical measuring	**An automation electrician should be able to:** – Manage to work with mechanical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.1.3 Hydraulics and pneumatics	**An automation electrician should be able to:** – Explain what is significant with hydraulic systems, including environmental aspects and risks – Explain dirt in compressed air – Explain how to grease compressed air and when it is needed – Describe basic pneumatic symbols and render symbols and how to read functions on drawings – Describe different types of valves and their specific functions	**An automation electrician should be able to:** – Understand how to handle pressurized hydraulic systems – Understand how the hydraulic system is designed to follow control signals and functions – Carry out both installation work and troubleshooting of pneumatics – Capable to use compressed air as support in the work in a safe way and as working media in automation – Connect air-based component and electricity correctly	**An automation electrician should be able to:** – Capable to work in a safe way in hydraulic systems – Manage to handle hydraulic systems, both on paper and in reality – Manage to work with pneumatic items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work – Using pneumatics in automation systems, as a part of the control system
5.1.4 Bearings	**An automation electrician should be able to:** – Explain friction, vibration, greasing in direct and rolling bearings and preventive maintenance with changes in noise, vibration, temperature, clean handling, and lubrication	**An automation electrician should be able to:** – Carry out bearing exchange including control of functions	**An automation electrician should be able to:** – Manage to work with bearing items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.1.5 Welding and soldering	**An automation electrician should be able to:** - Mention the rules and regulations for welding including license requirements – Describe principles for soldering	**An automation electrician should be able to:** – Carry out soldering and other connecting methods	**An automation electrician should be able to:** – Manage to work with different connecting methods
5.1.6 Vibration	**An automation electrician should be able to:** – Explain basics in acceleration, rotation, frequency, and amplitude	**An automation electrician should be able to:** – Use manuals for vibration instruments to measure vibrations in planned activities	**An automation electrician should be able to:**

	– Explain sensors for vibration – Explain the differences between vibration and resonance	– Analyse vibration and resonance in practice and evaluate measuring data in trend analyses to form measures	– Manage to work with vibration analyses using relevant instruments and descriptions to perform the maintenance work
5.1.7 Tribology	**An automation electrician should be able to:** – Describe the fundamentals of friction and lubrication	**An automation electrician should be able to:** – Carry out tribological tasks	**An automation electrician should be able to:** – Have a basic knowledge and skills in mechanical design to understand friction and tribology

References

--

5.2. Electrics

Overview

– Good knowledge in general electrics

Maintenance mechanic

Subject	Knowledge	Skills	Responsibility and autonomy
5.2.1 Electrics	**A maintenance mechanic should be able to:** – Describe resistance, impedance, currant, voltage and frequency and their relationships – Describe single phase and three phase circuits including areas, currants, voltage, and groundings	**A maintenance mechanic should be able to:** – Use and read electrical drawings including symbols – Count resistance, currant and voltage and verify the results with measuring instrument	**A maintenance mechanic should be able to:** – Use electrical formulas for effect and energy to measure in an installation
5.2.2 Electro techniques	**A maintenance mechanic should be able to:** – Explain distribution of energy with different voltage, currents, transformers groundings, safety etc.	**A maintenance mechanic should be able to:** – Manage to handle electrical power in a safe way and measure volt and ampere in a live system on a safe way	**A maintenance mechanic should be able to:** – Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.2.3 Electrical safety	**A maintenance mechanic should be able to:**	**A maintenance mechanic should be able to:**	**A maintenance practitioner should be able to:**

	– Describe the risks with high voltage and high currant – Explain how to use of Earth leakage circuit breaker and good connection to earth wires	– Perform risk analysis and work safely in electrical installations – Understand the basic safety in electrical installations and how to work safely	– Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.2.4 Power distribution	**A maintenance mechanic should be able to:** – Not applicable	**A maintenance mechanic should be able to:** – Not applicable	**A maintenance mechanic should be able to:** – Not applicable

References

--

Maintenance electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.2.1 Electrics	**A maintenance electrician should be able to:** – Describe resistance, impedance, currant, voltage and frequency and their relationships – Describe single phase and three phase circuits including areas, currants, voltage, and groundings – Describe electrical drawings including symbols – Explain how to perform electrical measuring with relevant instruments	**A maintenance electrician should be able to:** – Use and read electrical drawings including symbols – Perform measurements in electrical installations – Count resistance, currant and voltage and verify the results with measuring instrument – Perform measurements using multimeters to ensure the correct connection for the equipment	**A maintenance electrician should be able to:** – Use electrical formulas for effect and energy to measure in an installation
5.2.2 Electro techniques	**A maintenance electrician should be able to:** – Explain distribution of energy with different voltage, currents, transformers groundings, safety etc. – Explain electrical symbols in various international standards and understand the design of drawings in relation to actual installations – Explain how an asynchronous motor work and how it is designed	**A maintenance electrician should be able to:** – Use and read electrical drawings for buildings and electrical charts for machinery – Recognise and understand the differences between direct and indirect grounded systems – Understand the differences between 4 and 5 parts system	**A maintenance electrician should be able to:** – Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

	– Explain how to distribute electricity to the factory, to machinery cabinet and in machinery installation – Explain three-face motors in system design including safety	– Manage to handle electrical power in a safe way and measure volt and ampere in a live system on a safe way – Be capable to use measuring instruments to verify DC and AC circuits	
5.2.3 Electrical safety	**A maintenance electrician should be able to:** – Describe the risks with high voltage and high currant – Explain the differences and how to use earthing and neutral leaders and separate signal earthling – Explain how to use of Earth leakage circuit breaker and good connection to earth wires – Mention the details in advanced safety standards and how these influence maintenance PL (Performance Level) for standard EN/ISO 13849-1 and SIL (Safety Integrity Level) for standard EN/IEC 62061 – Mention how to design safety systems for machines such as safety stops, gates and to hands operation etc.	**A maintenance electrician should be able to:** – Connect breakers and safety devices in four and five-part systems – Measure and analyse incorrect values in safety systems – Perform risk analysis and work safely in electrical installations – Understand the basic safety in electrical installations and how to work safely – Troubleshoot shortcomings in machine and production safety systems for improvements and to avoid disturbance in production	**A maintenance practitioner should be able to:** – Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.2.4 Power distribution	**A maintenance electrician should be able to:** – Mention how to handle electrical distribution over 1.000 volts and who is permitted to do it	**A maintenance electrician should be able to:** – Act correct according to the risk level concerning high voltage and currant	**A maintenance electrician should be able to:** – Know how to avoid risks whilst working in high voltage constructions, including grounding of active parts

References

--

Automation electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.2.1 Electrics	**An automation electrician should be able to:**	**An automation electrician should be able to:**	**An automation electrician should be able to:**

	– Describe resistance, impedance, current, voltage and frequency and their relationships – Describe single phase and three phase circuits including areas, currants, voltage, and groundings – Describe electrical drawings including symbols – Explain how to perform electrical measuring with relevant instruments	– Use and read electrical drawings including symbols – Perform measurements in electrical installations – Count resistance, currant and voltage and verify the results with measuring instrument – Perform measurements using multimeters to ensure the correct connection for the equipment	– Use electrical formulas for effect and energy to measure in an installation
5.2.2 Electro techniques	**An automation electrician should be able to:** – Explain distribution of energy with different voltage, currents, transformers groundings, safety etc. – Explain electrical symbols in various international standards and understand the design of drawings in relation to actual installations – Explain how an asynchronous motor work and how it is designed – Explain how to distribute electricity to the factory, to machinery cabinet and in machinery installation – Explain three-face motors in system design including safety	**An automation electrician should be able to:** – Use and read electrical drawings for buildings and electrical charts for machinery – Recognise and understand the differences between direct and indirect grounded systems – Understand the differences between 4 and 5 parts system – Manage to handle electrical power in a safe way and measure volt and ampere in a live system on a safe way – Be capable to use measuring instruments to verify DC and AC circuits	**An automation electrician should be able to:** – Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.2.3 Electrical safety	**An automation electrician should be able to:** – Describe the risks with high voltage and high currant – Explain the differences and how to use earthing and neutral leaders and separate signal earthling – Explain how to use of Earth leakage circuit breaker and good connection to earth wires	**An automation electrician should be able to:** – Connect breakers and safety devices in four and five-part systems – Measure and analyse incorrect values in safety systems – Perform risk analysis and work safely in electrical installations	**An automation electrician should be able to:** – Manage to work with electrical items using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

	– Mention the details in advanced safety standards and how these influence maintenance PL (Performance Level) for standard EN/ISO 13849-1 and SIL (Safety Integrity Level) for standard EN/IEC 62061 – Mention how to design safety systems for machines such as safety stops, gates and to hands operation etc.	– Understand the basic safety in electrical installations and how to work safely – Troubleshoot shortcomings in machine and production safety systems for improvements and to avoid disturbance in production	
5.2.4 Power distribution	**An automation electrician should be able to:** – Mention how to handle electrical distribution over 1.000 volts and who is permitted to do it	**An automation electrician should be able to:** – Act correct according to the risk level concerning high voltage and currant	**An automation electrician should be able to:** – Know how to avoid risks whilst working in high voltage constructions, including grounding of active parts

References

--

5.3. Automation

Overview

– Good knowledge in automation system

Maintenance mechanic

Subject	Knowledge	Skills	Responsibility and autonomy
5.3.1 Automation	**A maintenance mechanic should be able to:** – Explain the principles for common sensors and actuators, relays, vales, contactors in PLC/PC systems	**A maintenance mechanic should be able to:** – Connect common sensors, pneumatic valves, and relays	**A maintenance mechanic should be able to:** – Manage to work with automation systems using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.3.2 Programming	**A maintenance mechanic should be able to:** – Explain in detail how control programs in PLC/PC are designed	**A maintenance mechanic should be able to:** – Follow the machine program on the operation panel (OP) for troubleshooting	
5.3.3 Electronics	**A maintenance mechanic should be able to:**	**A maintenance mechanic should be able to:**	

	– Explain basic electronics and power	– Prove capability to handle electronics in maintenance work	

References

--

Maintenance electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.3.1 Automation	**A maintenance electrician should be able to:** – Explain common principles in automation with primary, higher, and lower systems, primary and secondary systems, signal exchange and physical blocks in the total systems including Industry 4.0 – Explain the principles for common sensors and actuators, relays, vales, contactors in PLC/PC systems – Explain how control programs in PLC/PC are designed	**A maintenance electrician should be able to:** – Use and read both horizontal and vertical designed electronic automation drawings, including common symbols and fault descriptions to analyse functions in the machines – Carry out troubleshooting and maintenance of automated systems, including risk assessments – Connect common sensors, pneumatic valves, and relays	**A maintenance electrician should be able to:** – Manage to work with automation systems using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.3.2 Programming	**A maintenance electrician should be able to:** – Explain in detail how control programs in PLC/PC are designed – Explain how to build up logical steps in a process from beginning to the end of a lapse – Mention the principles for common sensors for pressure, volume, levels in PID systems – Mention the basics in how to build up and troubleshoot automation systems	**A maintenance electrician should be able to:** – Follow the machine program on the operation panel (OP) for troubleshooting – Analyse In- and Outputs in PLC / PC systems and identify the circuits in the cabinet, program lists and on drawings	
5.3.3 Electronics	**A maintenance electrician should be able to:** – Explain basic electronics and power design to measure volume, length, weight, pH value, temperature etc.	**A maintenance electrician should be able to:** – Prove capability to handle electronics in maintenance work	

	– Mention the basics in methods to work logical from fault description to find it by drawings and program description to troubleshoot in equipment	– Handling methods for logical troubleshooting of electronic items	

References

--

Automation electrician

Subject	Knowledge	Skills	Responsibility and autonomy
5.3.1 Automation	**An automation electrician should be able to:** – Explain common principles in automation with primary, higher, and lower systems, primary and secondary systems, signal exchange and physical blocks in the total systems including Industry 40 – Explain the principles for common sensors and actuators, relays, vales, contactors in PLC/PC systems – Explain how control programs in PLC/PC are designed – Explain the basic principles in PID control – Explain the principle for robot technics according to construction and function	**An automation electrician should be able to:** – Use and read both horizontal and vertical designed electronic automation drawings, including common symbols and fault descriptions to analyse functions in the machines – Carry out troubleshooting and maintenance of automated systems, including risk assessments – Connect common sensors, pneumatic valves, and relays – Practically handle PID system – Handle the basic functions of the robot when performing maintenance work	**An automation electrician should be able to:** – Manage to work with automation systems using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.3.2 Programming	**An automation electrician should be able to:** – Explain in detail how control programs in PLC/PC are designed – Explain how to build up logical steps in a process from beginning to the end of a lapse – Explain the principles for common sensors for pressure, volume, levels in PID systems	**An automation electrician should be able to:** – Follow the machine program on the operation panel (OP) for troubleshooting – Analyse In- and Outputs in PLC / PC systems and identify the circuits in the cabinet, program lists and on drawings – Exchange and calibrate sensors in PID system	

	– Explain the basics in how to build up and troubleshoot automation systems		
5.3.3 Electronics	**An automation electrician should be able to:** – Explain basic electronics and power design to measure volume, length, weight, pH value, temperature etc. – Explain the basics in methods to work logical from fault description to find it by drawings and program description to troubleshoot in equipment	**An automation electrician should be able to:** – Prove capability to handle electronics in maintenance work – Handling methods for logical troubleshooting of electronic items	

References

--

5.4. Material technology

Overview

– Good knowledge in material technology

Subject	Knowledge	Skills	Responsibility and autonomy
5.4.1 Material technology	**A maintenance practitioner should be able to:** – Mention material properties for using steel, copper, aluminium, plastics, and ceramics	**A maintenance practitioner should be able to:** – Choose and use right kind of material when performing the maintenance work	**A maintenance practitioner should be able to:** – Manage to work with different material and using relevant tools, descriptions, drawings, and manuals to perform the maintenance work
5.4.2 Non-destructive Testing	**A maintenance practitioner should be able to:** – Mention the five most common methods in NDT and how to use them in the basic levels	**A maintenance practitioner should be able to:** – Support specialists in the work with NDT	**A maintenance practitioner should be able to:** – Manage to work with different methods and using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

5.4.3 Heat treatment	**A maintenance practitioner should be able to:** – Mention the principles of heat treatment	**A maintenance practitioner should be able to:** – Analyse and assess when undesirable heat treatment has happened	**A maintenance practitioner should be able to:** – Manage to work with heat treatment as a method and using relevant tools, descriptions, drawings, and manuals to perform the maintenance work

References

--

5.5. Design and modification

Overview

– Understanding in the general requirements for design

Subject	Knowledge	Skills	Responsibility and autonomy
5.5.1 Design requirements	**A maintenance practitioner should be able to:** – Mention the general requirements for design of industrial items – Explain the differences between modification of items and exchange of components	**A maintenance practitioner should be able to:** – Carry out ideas to transfer production requirements into functional requirements	**A maintenance practitioner should be able to:** – Work for improvements in: ▪ Production requirement ▪ Maintenance plan ▪ Facility plan ▪ Future requirements – Maintain progress for the company
5.5.2 LCC/LCP techniques/methods	**A maintenance practitioner should be able to:** – Mention the main use of LCC/LCP and the relation to long term economy	**A maintenance practitioner should be able to:** – Use the LCC/LCP method to verify and motivate the best purchase of an item or a system	**A maintenance practitioner should be able to:** – Support with material to follow up the figures of LCC and LCP in the company
5.5.3 Modification	**A maintenance practitioner should be able to:** – Mention the reason to make modifications in equipment	**A maintenance practitioner should be able to:** – Carry out modification and improvement in production equipment	**A maintenance practitioner should be able to:** – Perform the maintenance to increase a more efficient 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

Subject	Knowledge	Skills	Responsibility and autonomy
5.6.1 Maintenance services for buildings	**A maintenance practitioner should be able to:** - Explain the industrial buildings system in relation to the production equipment and actual maintenance - Water, sewage, heating, ventilation - Mention the basics in how the property system functions and are related to each other - Describe the basic routines in emergency situations, evacuations etc. - Explain how the pollutions is spread in air and water and how to practically handle it	**A maintenance practitioner should be able to:** - Capable to read drawings and manuals for building installations to follow each system - Practically act to support emergency routines and to not disturb conditions - Handling the production equipment in relation to the building systems to minimize the impact of the property	**A maintenance practitioner should be able to:** - Participate and carry out the process to avoid harder load on the buildings system parts

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

- Good knowledge in documentation handling

Subject	Knowledge	Skills	Responsibility and autonomy
6.1.1 Maintenance documents	**A maintenance practitioner should be able to:** - Mention how to follow documentation to organize the maintenance work with the most relevant tools, test equipment and how to check them - Mention how to work according to inspection plans - Explain the principle for valid documentation and changing routines for new versions	**A maintenance practitioner should be able to:** - Follow given documentation and report deviations - Apply tools and inspection equipment correctly according to the documentation	**A maintenance practitioner should be able to:** - Follow needed maintenance document including the validity and actuality of the document
6.1.2 Technical documentation and maintenance manuals	**A maintenance practitioner should be able to:** - Explain the management of technical information documents and how to use the documentation	**A maintenance practitioner should be able to:** - Use electrical, mechanical pneumatic, electronic, hydraulic schemes, building drawings and maintenance manuals when performing the work	**A maintenance practitioner should be able to:** - Follow and use different standards in maintenance document
6.1.3 Documentation systems	**A maintenance practitioner should be able to:** - Mention how documentation in a business can be designed, updated and stored	**A maintenance practitioner should be able to:** - Use technical documentation when performing the maintenance work	**A maintenance practitioner should be able to:** - Use the 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

- Good knowledge in information and data management

Subject	Knowledge	Skills	Responsibility and autonomy
6.2.1 Maintenance information systems	**A maintenance practitioner should be able to:** – Explain common systems for maintenance information including CMMS	**A maintenance practitioner should be able to:** – Use the Maintenance Information Systems for manage and performing maintenance tasks including reporting performed work	**A maintenance practitioner should be able to:** – Use Maintenance Information System including CMMS if such system is in use
6.2.2 Information handling systems	**A maintenance practitioner should be able to:** – Mention how to use the information handling systems for maintenance tasks	**A maintenance practitioner should be able to:** – Use the information handling systems for maintenance tasks	
6.2.3 Maintenance data collection	– Not applicable	– Not applicable	– Not applicable
6.2.4 Data evaluation	– Not applicable	– Not applicable	– Not applicable
6.2.5 Data monitoring	– Not applicable	– Not applicable	– Not applicable
6.2.6 Computerized Maintenance Management Systems (CMMS)	**A maintenance practitioner should be able to:** – Explain the structure and the modules in the CMMS – Describe how to use the CMMS for maintenance tasks	**A maintenance practitioner should be able to:** – Use the CMMS for manage and carry out maintenance tasks including reporting performed work	**A maintenance practitioner should be able to:** – Handle the working condition in CMMS and carry out the given maintenance task
6.2.7 Technical process control systems	**A maintenance practitioner should be able to:** – Mention how systems and functions are designed in program-, control and regulation mechanisms in mechatronic systems, program simple devices (in cooperation with	**A maintenance practitioner should be able to:** – Use technical process control systems for troubleshooting and solving problems	**A maintenance practitioner should be able to:** – Use various technical PC and PLC process control system

	developers), and simulate the program sequence before start-up	− Follow, test, and maintain hardware and software solutions for networked mechatronic systems and suggest improvements − Monitor system conditions with suitable measuring and visualization tools	

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

Overview

− Understanding in needed resources regarding infrastructures, Human Resources, external maintenance services and material, tools and equipment

Subject	Knowledge	Skills	Responsibility and autonomy
6.3.1 Infrastructure	**A maintenance practitioner should be able to:** − Mention in brief how the infrastructure in and round the property is designed	**A maintenance practitioner should be able to:** − Not applicable	**A maintenance practitioner should be able to:** − Not applicable
6.3.2 Human resources	**A maintenance practitioner should be able to:** − Mention how to plan manning for maintenance work − Mention how to handle Human Resources in the working team	**A maintenance practitioner should be able to:** − Participate in the maintenance team	**A maintenance practitioner should be able to:** − Follow the HR policy for maintenance
6.3.3 External maintenance services	− Not applicable		

6.3.4 Material, tools and equipment	**A maintenance practitioner should be able to:** – Mention how to plan and handle own and common tools and equipment – Mention common requirements for handling materials, tools, and equipment	**A maintenance practitioner should be able to:** – Handle the material, tools and equipment and their location, quality, and quantity to be ready for use	**A maintenance practitioner should be able to:** – Plan basic material, tools, and equipment for maintenance and keep them in good condition
6.3.5 Remote maintenance	– Not applicable	– Not applicable	– Not applicable
6.3.6 Contracting, outsourcing and insourcing	– Not applicable	– Not applicable	– Not applicable

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

– Good knowledge in maintenance logistics

Subject	Knowledge	Skills	Responsibility and autonomy

6.4.1 Spare parts management	**A maintenance practitioner should be able to:** – Mention how to build up and maintain spare parts in an organization – Mention the key factors regarding spare parts management	**A maintenance practitioner should be able to:** – Use existing system for spare parts management and give account for transactions	**A maintenance practitioner should be able to:** – Manage spare part handling and routines for purchase and delivery adapted for planned maintenance
6.4.2 Spare part calculations	– Not applicable	– Not applicable	– Not applicable
6.4.3 Material and store handling	– Not applicable	– Not applicable	– Not applicable
6.4.4 Logistics support	**A maintenance practitioner should be able to:** – Mention routines and organization for an optimized logistic support	**A maintenance practitioner should be able to:** – Carry out logistic support of necessary suppliance in the maintenance work	**A maintenance practitioner should be able to:** – Keep a total system for handling spare parts in the store including quality and meeting ageing problem
6.4.5 Spare part handling	**A maintenance practitioner should be able to:** – Mention how to handle spare parts in an organization and methods to find parts on the Internet – Mention different factors that will have an influence on spare part consumption	**A maintenance practitioner should be able to:** – Use the spare part store according to routines and instructions about the spare part handling	

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

– Understanding in procurement of maintenance parts and services

Subject	Knowledge	Skills	Responsibility and autonomy

6.5.1 Procurement	**A maintenance practitioner should be able to:** − Mention how the organization is build up for procurement in a company and how to specify in technical terms the requirements	**A maintenance practitioner should be able to:** − Propose or recommend regarding procurement issues with the procurement department	**A maintenance practitioner should be able to:** − Handle the legal aspects of procurement
6.5.2 Replacement investments	− Not applicable	− Not applicable	− Not applicable

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

− Understanding in Risk Based Maintenance

Subject	Knowledge	Skills	Responsibility and autonomy
6.6.1 Risk assessment in maintenance	**A maintenance practitioner should be able to:** − Mention how to perform risk analysis and how to assess them in maintenance	**A maintenance practitioner should be able to:** − Carry out risk analysis and prevent risks within maintenance − Judge the quality on performed risk analysis before the job start	**A maintenance practitioner should be able to:** − Manage risk prevention related to production and to maintenance
6.6.2 Methods for risk analysis	**A maintenance practitioner should be able to:** − Mention main methods for analysing of risks	**A maintenance practitioner should be able to:** − Apply and carry out different methods for risk analysis	
6.6.3 Monitor risk management	− Not applicable	− Not applicable	− Not applicable

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).

Qualifications for Maintenance Mechanics, Electricians & Automation electricians (EQF level 4)

7. Basic knowledge

7.1. Maintenance terminology

Overview

- Very good knowledge in maintenance terminology

Subject	Knowledge	Skills	Responsibility and autonomy
7.1.1 General terminology	**A maintenance practitioner should be able to:** - Mention in brief the main key words related to maintenance	**A maintenance practitioner should be able to:** - Use right maintenance terminology related to the task	**A maintenance practitioner should be able to:** - Use the standard in normal work including vocabulary and concepts
7.1.2 Availability	**A maintenance practitioner should be able to:** - Mention how reliability has to do with the time of the ready state for the equipment - Define availability in brief - Mention the connection and differences between dependability, availability, reliability, maintainability, and supportability		
7.1.3 Reliability	**A maintenance practitioner should be able to:** - Mention how reliability has to do with the number of failures and the disabled states due to maintenance activities - Define reliability in brief - Mention different measures of reliability (MTBF and MTTF) - Mention different types of redundancies		
7.1.4 Maintainability	**A maintenance practitioner should be able to:** - Mention how reliability has to do with active time for maintenance - Define maintainability in brief		

	– Mention different measures of maintainability (MRT and M) – Mention reasons that can causes the length of active maintenance times – Mention different ways to improve the maintainability (e.g. design, documentation, maintenance equipment, education)		
7.1.5 Maintenance Supportability	**A maintenance practitioner should be able to:** – Mention how reliability has to do with waiting times for maintenance resources – Define supportability in brief – Mention reasons that can causes the length of the waiting times – Mention different ways to improve the supportability (e.g. assure faster access of personnel, documentation, spare parts, maintenance equipment, transports and assure faster administrative routines)		

References

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

Subject	Knowledge	Skills	Responsibility and autonomy
7.2.1 Mathematics	**A maintenance practitioner should be able to:**	**A maintenance practitioner should be able to:**	**A maintenance practitioner should be able to:**

	– Explain the four mathematical methods	– Calculate the four mathematical methods	– Use mathematics, physics, chemistry, and statistics in daily work
7.2.2 Physics	**A maintenance practitioner should be able to:** – Explain basic physic methods	**A maintenance practitioner should be able to:** – Understand and calculate the physics	
7.2.3 Chemistry	**A maintenance practitioner should be able to:** – Explain basic chemistry	**A maintenance practitioner should be able to:** – Work with a quality adapted way when handling chemistry products	
7.2.4 Statistical methods	**A maintenance practitioner should be able to:** – Explain basics in statistics	**A maintenance practitioner should be able to:** – Calculate simplified statistic material	

References

--

7.3. Maintenance standards

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	**A maintenance practitioner should be able to:** – Name in brief the standard EN 13269:2016 Guideline on preparation of maintenance contracts	**A maintenance practitioner should be able to:** – Use the standard EN 13269:2016 Guideline on preparation of maintenance contracts	**A maintenance practitioner should be able to:** – Use the standard in normal work including vocabulary and concepts
7.3.2 EN 13306:2017 Maintenance Terminology	**A maintenance practitioner should be able to:** – Mention the standard EN 13306:2017 Maintenance Terminology	**A maintenance practitioner should be able to:** – Use the standard EN 13306:2017 Maintenance Terminology	
7.3.3 EN 13460:2009	**A maintenance practitioner should be able to:**	**A maintenance practitioner should be able to:**	

Maintenance Documentation	– Name in brief the standard EN 13460:2009 Maintenance Documentation	– 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	**A maintenance practitioner should be able to:** – Name in brief the standard EN 15331:2011 Criteria for design, management, and control of maintenance services for buildings	**A maintenance practitioner 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	**A maintenance practitioner should be able to:** – Name in brief the standard EN 15341:2019 Maintenance Key Performance Indicators	**A maintenance practitioner should be able to:** – Use the standard EN 15341:2019 Maintenance Key Performance Indicators	
7.3.6 EN 15628:2014 Qualifications of maintenance personnel	**A maintenance practitioner should be able to:** – Name in brief the standard EN 15628:2014 Qualifications of maintenance personnel	**A maintenance practitioner 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	**A maintenance practitioner should be able to:** – Name in brief the standard EN 16646:2014 Maintenance within physical asset management	**A maintenance practitioner 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	**A maintenance practitioner should be able to:** – Name the standard EN 16991:2018 Risk-based inspection framework	**A maintenance practitioner should be able to:** – Use the standard EN 16991:2018 Risk-based inspection framework	
7.3.9 EN 17007:2017 Maintenance process and	**A maintenance practitioner should be able to:** – Name in brief the standard EN 17007:2017Maintenance process and associated indicators	**A maintenance practitioner should be able to:** – Use the standard EN 17007:2017Maintenance process and associated indicators	

associated indicators			

References

--

7.4. Technical English

Overview

- Understanding in technical English

Subject	Knowledge	Skills	Responsibility and autonomy
7.4.1 Maintenance technical English	- Not Applicable	- Not Applicable	- Not Applicable

References

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