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PROCESS TYPES	EN17007's MAINTENANCE PROCESSES	MAINTENANCE CHAPTERS						MAINTENANCE SUBJECTS	DEFINITIONS	RELATIONS TO EN15628	STANDARDS
		Maintenance management	Maintenance within Physical Asset Management	Maintenance execution	Maintenance engineering techniques	Health, safety and environment in maintenance	Maintenance support				
MANAGEMENT	**MAN - Manage maintenance** (strategy and improvement, human resources, continuous improvement, compliance, etc.)		●					Relations between maintenance and other processes	Definition Maintenance is one of the processes of industrial companies that has a strong impact on performances. It has also strong relationships with the other processes (acquisition/creation, operation, modernisation, disposal, support processes) as well as with organizational strategic plan of the company. These relations must be identified and managed so that maintenance contributes effectively to the management of the assets.	C3: To define, manage and develop the organizational model of maintenance	• EN 17007 : Maintenance process and associated indicators • IEC 60300-3-14 Maintenance and maintenance support • NF X60-000 Maintenance function • DIN 31051 Fundamentals of maintenance. (Grundlagen der Instandhaltung)
			●					Maintenance process description – roles & responsibilities	Definition The maintenance process includes corrective maintenance, preventive maintenance and the process of improving intrinsic reliability and maintainability of equipment. It also includes all the support processes that make it possible to carry out maintenance actions on assets (management of resources, maintenance during design phase, etc.). The description of these processes and their interrelationships is useful to determine the roles and responsibilities of the stakeholders, to define indicators and to manage the entire maintenance process.	B3: To organize, manage and develop the maintenance resources: personnel, materials and equipment B4: To plan the maintenance tasks within his area of responsibility, defining and organizing the necessary resources C3: To define, manage and develop the organizational model of maintenance C5: To ensure right management and continuous improvement of maintenance	
			●					Life cycle management	Definition Management of costs over the life cycle of assets encloses total cost of acquisition, ownership and disposal of the assets. Maintenance costs are of particular concern because they have a significant impact on direct costs (direct maintenance costs) and indirect costs (availability of assets, plant safety, company image, etc.).	B8: f) To assess the reliability, availability and maintainability of asset and the lifecycle cost C4: b) To evaluate the availability, reliability, maintainability, supportability and the cost of life cycle of asset	• IEC 60300-3-3 Dependability management - Application guide - Life cycle costing
			●					Life cycle extension	Definition Maintenance is particularly concerned with the decision to extend the lifetime of assets. Indeed, the durability of assets and their renovation costs can be decisive factors in the choices made by assets managers.		• ISO 55000 : Asset management — Overview, principles and terminology • ISO 55001 : Asset management — Management systems — Requirements • ISO 55002 : Asset management — Management systems — Guidelines for the application of ISO 55001 • EN 16646 : Maintenance within Asset Management • PAS 55-1 Specification for thr optimized management of physical assets • PAS 55-2 Guidelines for the application of PASS 55-1 • PSK Condition audit in process industry • VDI 2891 : Maintenance relevant criteria for purchase of machines. (Instandhaltungskriterien bei der Beschaffung von Investionsgütern) • NF X 50-501 Maintenance - Reference conditions for items : Vocabulary of renovation and reconstruction activities
			●					Maintenance, and investment decisions	Definition Investment decisions often depend on the maintenance costs and unavailability factor of installed assets, and on estimation of the maintenance costs of future investments. Moreover, maintenance must be taken into account in the choices of the assets to be acquired and/or to be designed in order to minimize their overall cost of ownership.	B1: d) To provide within his area of responsibility, the necessary information to the maintenance manager for the definition of investment proposals relating to assets according to their status C4: a) To collaborate in the design of new assets, providing all the information and experience useful to the success of the project	

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			●					Rebuilding & Reinvestment strategies	Definition Rebuilding and reinvestment strategies depend in part on the maintenance effectiveness and maintenance costs. The assets reliability and maintainability assessed through the analysis of experience feedback are important elements for decision-making.		• UNI 11414:2011 : Maintenance Guidelines for qualification of maintenance system
			●					Relations with auditing & safety organizations	Definition A part of the maintenance tasks are required by regulations and close relationships must be established with the organizations/authorities in charge of safety of the installations to carry out and monitor the mandatory tasks. In addition, internal or external audits are often carried out to verify the implementation and results of maintenance, which is a strategic function for companies.	B5: g) To perform audits and, inspections to control the status of asset and processes C1: b) To ensure compliance with legislation, technical standards and company strategies, objectives and procedures on safety, health, environmental protection and quality	
			●					Uncertainty in maintenance management	Definition Reliability data, maintenance costs of assets and effectiveness of maintenance plans are often uncertain data. That leads decision-makers to use stochastic techniques that evaluate the uncertainties obtained on the results of models calculating the performances of these assets and thus make decisions more robust.	B5: e) To monitor performance, reliability, availability of asset and maintenance costs through the indicators C4: b) To evaluate the availability, reliability, maintainability, supportability and the cost of life cycle of asset	
			●					Maintenance and Sustainability	Definition Maintenance is an essential lever for sustainable development because when maintenance is involved in the design phase of the assets and when these assets are designed to be maintainable and reliable then their useful life is increased. A longer useful life and appropriate maintenance actions is a way to act on the economical, ecological and social aspects of companies and to ensure sustainability of the assets. In particular Maintainability is a guarantee of sustainable development.	B8: To use the engineering knowledge and the rganizational tools to improve maintenance tasks and plant efficiency in terms of availability and reliability (essential knowledge a) sustainability principles)	
			●					Maintenance and industry 4.0	Definition Industry 4.0 is a new concept based on digitalization of information. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing. Maintenance is directly concerned by these new technologies where diagnosis, prognosis and all maintenance processes based on data collection and analysis will be strongly impacted. Therefore, the management process must take into account these new techniques to establish its maintenance strategy.	A7: To use and ensure the use of the ICT systems B8: j) To use the computerized maintenance management systems and tools for data acquisition, monitoring and reporting C2: b) To ensure the proper and timely use of maintenance information systems, promoting the upgrade; the development of systems and tools necessary to meet the business requirements C5: e) To ensure the proper right and timely use of maintenance information systems, promoting the upgrade and the development of systems and tools necessary to make them consistent with the technical and management needs	

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		●						Total Productive Maintenance	Definition TPM (Total Productive Maintenance) is a method to manage maintenance activities in order to improve productivity of manufacturing processes, especially by reducing downtimes and increasing OEE (Overall Equipment Effectiveness). While RCM is essentially technical, TPM is more concerned by organization and work process. It involves operators as well as maintenance staff, starting with simple but efficient actions as 5S, then prioritizing and solving problems through teamwork.	A5: To coordinate and / or supervise on-site maintenance tasks B1: To ensure the implementation of maintenance strategies and policies C5: To ensure right management and continuous improvement of maintenance	
					●			FRACAS (Failure Reporting Analysis Corrective Action System)	Definition FRACAS methods are based upon the principles of problem solving techniques, they aim to improve the dependability of current and future designs by feedback of testing, modification and use experience. They include methods as PCDA (Plan-Do-Check-Act), DMAIC (Define Measure Analyse Improve Control), Ishikawa, KT (Kepner and Tregoe), KAISEN, 6 SIGMA, 8D (8 Disciplines), A3 (Toyota method), etc.		
		●						Value based maintenance	Definition This approach was introduced to quantify the economic added value of maintenance in terms of cash flows (especially through calculation of Net Present Value). It helps to identify the value drivers, to measure and to benchmark performances in order to apply best practices (e.g. : equipment probability improvement, work processes, information systems, …).	B5: To ensure economic efficiency and effectiveness of maintenance tasks based on a technical state of the technology B9: a) Economical thinking and acting C6 : To ensure and control the compliance with maintenance and company budget, the respect of the planned maintenance tasks and the proper condition of assets.	• EN 1325-1 Value management, value analysis, functional analysis vocabulary – value analysis and functional analysis • EN 1325-2 Value management, value analysis, functional analysis vocabulary – value management

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REALISATION	**COR - Restore the items in required state** (Diagnose the state of the faulty item) (see ACT process for tasks implementation)				●			Fault diagnosis	Definition Fault diagnosis covers the methods and techniques that make it possible to detect faults and to locate them. This includes testing for fault detection on standby items and techniques for localisation of faulty components when an item is in downstate due to failure.	A2: a) To interpret the first signs of failures and use fault diagnosis methods	• ISO 13381-1 Condition monitoring and diagnostics of machines - Prognostics - General guidelines • ISO 13379 Condition monitoring and diagnostics of machines - General guidelines on data interpretation and diagnostics techniques • NF ISO 13372 Condition monitoring and diagnostics of machines – Vocabulary • VDI 2888 Maintenance condition monitoring. (Zustandsorientierte Instandhaltung)
					●			Root Cause Analysis	Definition Root cause analysis (RCA) is a "systematic process to identify the cause of a fault, failure or undesired event, so it can be removed by design, process or procedure changes" [IEV 50(192)]. Root Cause Analysis is a method to identify the preliminary causes of an event (especially failures). Different techniques can be performed to find causes, as why-because analysis, Ishikawa diagrams, fault trees, Bayesian networks, etc. It is based on past events in order to avoid recurrence of similar situations by changing conditions, actions or organization and to improve continuously the maintenance process.	A2: b) causes and propose actions C4: g) To ensure failure analysis on critical assets, in order to identify the root causes and propose actions	• IEC 62740 Root cause Analysis
REALISATION	**PRV - Prevent undesirable events by avoiding failures and faults** (Characterize undesirable events and use and update maintenance plans) (see ACT process for tasks implementation)	●						Criticality analysis (RCM, …)	Definition RCM is a "systematic method for determining the respective maintenance tasks and associated frequencies, based on the probability and consequences of failure" [IEV 50(191)]. The method consists in identification of failure modes and there causes which are critical against objectives (availability, safety, costs, etc.), then to determine the efficient and cost effective maintenance tasks to prevent the occurrence of these failures. The data used may be derived from experience feedback analysis and used in FMECA. RCM may also initiate modifications of design or procedures to carry out improvements.	B1: b) To cooperate in the development of annual and perennial maintenance plans B5: e) To monitor performance, reliability, availability of asset and maintenance costs through the indicators C1: e) To promote process re-engineering analysis and studies for maintenance and logistics with the aim to ensure the improvement of availability, reliability and maintainability and to optimize maintenance costs C4: g) To ensure failure analysis on critical assets, in order to identify the root causes and propose actions	• IEC 60300-3-11 : Application guide – Reliability Centered Maintenance • SAE JA1011 : Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes • SAE JA1012 : A guide to RCM standard • IEC 60812 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
		●						Maintenance and risk management (RBI, …)	Definition Risk Based Inspection (RBI) is a method used to determine where inspections (generally Non Destructive Testing) must be performed to avoid serious failures. This approach applies more especially to passive items characterized by High Impact – Low Probability (HILP) failures (examples : pipes, structures, …). Reliability modeling is used to identify where and when degradation mechanisms are more likely expected in order to focus inspections on critical areas. Approaches based on expert opinion are often called Risk Informed Inspection (RII).	A1: To perform or ensure the safe execution of the maintenance plans according to business strategies B4: c) To identify the risks arising from maintenance tasks C5: c) To ensure that maintenance tasks meet or improve the safety conditions of the asset and the service levels	• CWA 15740 : Risk-Based Inspection and Maintenance Procedures for European Industry (RIMAP) (2008) • EN16991 : Risk based inspection framework • IEC 60812 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)

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REALISATION	ACT - Implement preventive and/or corrective actions on the item			●				Work preparation & scheduling	Definition Preparation of maintenance tasks consists in writing and updating the maintenance procedures which describe the actions to be performed (including safety of individuals), define the necessary resources, and estimate the workload. Scheduling consists in setting in order the tasks to be done and determining the starting and ending dates according to the constraints (production, …).	A5: To coordinate and / or supervise onsite maintenance tasks B2: To plan the maintenance tasks within his area of responsibility, defining and organizing the necessary resources C2: To define processes and tools to support maintenance tasks	• EN 17007 : Maintenance process and associated indicators • IEC 60300-3-14 Maintenance and maintenance support • NF X60-000 Maintenance function
				●				Shutdown & turnaround management	Definition Shutdowns require a special organization to secure the installation, carry out maintenance tasks according to an established schedule, organize logistic support, take into account the hazards, and carry out the necessary tests and requalification to return the equipment to the operator. All of these activities must be optimized to minimize costs and unavailability, given existing constraints.	B1: To ensure the implementation of maintenance strategies and policies C3 : To define, manage and develop the organizational model of maintenance	
					●			Condition monitoring techniques (vibration analysis, thermography, tribology, etc.)	Definition Condition monitoring techniques are part of condition based maintenance which consist of measuring "at predetermined intervals the characteristics and parameters of the physical actual state of an item" [EN13306]. They include especially vibration analysis, thermography, tribology, etc. and don't lead to unavailability of the asset.	A1: g) To apply the diagnostic techniques (failure analysis and troubleshooting techniques) and the on condition maintenance A2: a) To interpret the first signs of failures and use fault diagnosis methods B5: c) To monitor the development of abnormalities and check the performance parameters C2: c) To define criteria for the development and implementation of diagnostic systems	• ISO 13381-1 Condition monitoring and diagnostics of machines - Prognostics - General guidelines • ISO 13379 Condition monitoring and diagnostics of machines - General guidelines on data interpretation and diagnostics techniques • NF ISO 13372 Condition monitoring and diagnostics of machines – Vocabulary • VDI 2888 Maintenance condition monitoring. (Zustandsorientierte Instandhaltung) • VDI 2889 Methods and systems for condition and process monitoring in maintenance. (Einsatz wissensbasierter Diagnosemethoden und -systeme in der Instandhaltung) • PSK 5704 Condition monitoring. Vibration measurement. Acceptance test and vibration severity limits • UNI 10652:2009 Maintenance - Appraisal and evaluation of the goods condition
					●			Non Destructive Testing (ultrasonic testing, Eddy current, radiography, etc.)	Definition Non destructive testing are maintenance techniques, part of condition based maintenance, which consist of measuring, observing, or testing the relevant characteristics of an item. They include ultrasonic testing, Eddy current, radiography, gammagraphy, etc. and lead generally to unavailability of the asset.		
					●			Diagnosis & Prognosis and Predictive maintenance	Definition Predictive maintenance is a part of condition based maintenance "carried out following a forecast derived from repeated analysis or known characteristics and evaluation of the significant parameters of the degradation of the item" [EN13306]. These techniques consist of a diagnosis to evaluate the state of the items and a prognosis to estimate its evolution over time.		

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					●			Equipment health analysis	Definition Prognosis and Health Management (PHM) is a discipline which uses news technologies (especially digital electronics) to assess health of items (degradation levels) and to predict in real-time their reliability and remaining useful life. It is used in different industrial sectors such as aerospace, military systems, automobiles, etc., to improve maintenance and logistic support. That allows to carry out maintenance based on current and predicted health of the items and to be more efficient in detecting faults or degradations and in decreasing downtimes and costs.	A1: b) To perform the inspection tasks in order to highlight and prevent the item degradation A1: g) To apply the diagnostic (failure analysis and troubleshooting techniques) and the on condition maintenance A2: a) To interpret the first signs of failures and use fault diagnosis methods B8: To use the engineering knowledge and the organizational tools to improve maintenance tasks and plant efficiency in terms of availability and reliability C2: c) To define criteria for the development and	
					●			Ageing and degradation mechanism modelling	Definition Prediction of failures requires representing the failure mechanisms of items which can be done using : - "Black box" approaches based on the statistics of time to failure (distribution of useful lifetimes), - "Gray box" approaches that represent the evolution of degradation over time from measurements but without describing the physical mechanism, - "White box" approaches based on simulation of a physical model of the failure mechanism.		
					●			Remaining useful life assessment	Definition Useful life is the "time interval from a given instant until the instant when a limiting state is reached. The limiting state may be a function of failure rate, maintenance support requirement, physical condition, economics, age, obsolescence, changes in the user's requirements or other relevant factors" [EN13306]. The remaining useful life (RUL) takes into account the knowledge of the current state of an item and its estimation is a part of prognosis and health management. It provides key information in decision making by quantifying how much time is left until failure.		
				●				e-maintenance	Definition e-maintenance is a maintenance performed via computing, usually remotely, to monitor equipment and detect early degradation so that it is possible to refurbish the equipment at a convenient time.	B5: c) To monitor the development of abnormalities and check the performance parameters B8: j) To use the computerized maintenance management systems and tools for data acquisition, monitoring and reporting	
				●				Operator Based Maintenance	Definition These are the maintenance actions carried out by an operator. These actions are generally simple and can be early preventive actions to mitigate failure mechanisms or detection of symptoms leading to subsequent actions carried out by maintenance personel.	A1: b) To perform the inspection tasks in order to highlight and prevent the item degradation C5: f) To promote the use of professional skills and technical resources available	

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REALISATION				●				Remote maintenance	Definition Remote maintenance consists of maintenance actions "performed without direct physical personnel to the item". Robots can be used to perform this kind of maintenance.	A1: e) To use the machines, equipment and tools necessary for the execution of maintenance tasks A4 : To ensure the availability of materials, tools and equipment necessary for the execution of maintenance tasks C5: e) To ensure the proper right and timely use of maintenance information systems, promoting the upgrade and the development of systems and tools necessary to make them consistent with the technical and management needs	
				●				Disassembly and reassembly processes	Definition Disassembly and reassembly of items sometimes require special studies due to their accessibility and to the accessibility to their components. Computerized simulations of items' handling, storage and repair can be used to determine feasibility and to optimize maintenance times.	A2: d) To perform restoration tasks in accordance with the required methodologies and standard works A8: a)To perform properly, efficiently and effectively the assigned maintenance tasks C2: a) Evaluation of effectiveness and efficiency of the maintenance process and techniques and implementation of improvements, according to health, safety, quality and economy	
				●				Qualification of equipment	Definition Some equipment must be qualified to be put into service. They are testing to demonstrate their ability to meet the requirements and in particular those in relation to safety. Some equipment must be re-qualified after maintenance tasks.	B5: b) To verify and test the proper functionality of the asset by conducting a formal hand-over together with the physical asset owner/operating manager at the end of the work, before using it	
	IMP - Improve the items			●				Reliability & maintainability improvements	Definition when preventive maintenance does not provide good operational reliability or when maintainability is not sufficient to achieve a good level of availability, improvements of item are required in terms of reliability or maintainability. Analysis must be carried out to assess dependability characteristics and identify efficient and cost effective changes in the item design or manufacturing.	A1: c) To identify and propose actions or projects to improve reliability, availability and maintainability of assets B5: e) To monitor performance, reliability, availability of asset and maintenance costs through the indicators B8: To use the engineering knowledge and the organizational tools to improve maintenance tasks and plant efficiency in terms of availability and reliability	• IEC 60812 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA) • IEC 62308 Reliability assessment methods • IEC 61649 Weibull analysis • IEC 61703 Mathematical expressions for reliability, maintainability and maintenance support items

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SUPPORT	BUD - Budget maintenance of items	●						Replacement investments	Definition Replacement investment is generally an optimization problem often linked to life extension of items. Operational research techniques are used to find the best trade-off between costs and expected benefits of replacements.	B1: d) To provide within his area of responsibility, the necessary information to the maintenance manager for the definition of investment proposals relating to assets according to their status	
							●	Budgetary control	Definition to establish each year the maintenance budget it is necessary to identify the regular and exceptional costs. It is then necessary to know the rules of the budgetary control to follow the deviations and to signal them to the management so as to take the necessary measures	B1: a) To contribute to the development of the maintenance budget according to business objectives C5: i) i) To present and visualize, such as for maintenance budget, human resources requests of additional capital expenditures. C6: To ensure and control the compliance with maintenance and company budget, the respect of the planned maintenance tasks and the proper condition of assets	
SUPPORT	DOC - Deliver the operational documentation						●	Maintenance knowledge & best practices	Definition Maintenance improvement is based on Maintenance knowledge & best practices. That requires learning, training, benchmarking and implementation of better ways of ensuring high maintenance performance. Benchmarking makes it possible to identify best practices which must be analyzed and adapted to other context. Maintenance knowledge must be capitalized and carefully transferred within the company which requires an ad hoc organization.	B8: e) To ensure the preparation of manuals and instructions for training and continuous technical updating C3: b) To ensure the implementation of company policies for the organization, management and training of employees C3: e) To ensure the implementation of company policies for the organization, management and training of employees C5: h) To collaborate in the design of training courses and coaching of maintenance personnel to ensure continuous improvement of professional competencies	• EN 13306 Maintenance Terminology • IEC 50(191) International Electrotechnical Vocabulary - Dependability and quality of service • IEC 61703 Mathematical expressions for reliability, maintainability and maintenance support items • PSK 6201 Maintenance terms and definitions • UNI 10147:2003 Maintenance - Additional terms and definitions to EN 13306. • UNI 11063:2003 Maintenance - Definitions of ordinary and extraordinary maintenance • UNI 11082:2003 Maintenance - Specific terminology for the group transportation field • NF X 60-012 Vocabulary of components of items and their supply • NF ISO 13372 Condition monitoring and diagnostics of machines – Vocabulary • EN 15221-1 Facility Management - Part 1: Terms and definitions • NF X 50-501 Maintenance - Reference conditions for items : Vocabulary of renovation and reconstruction activities • EN 13460 Maintenance - Documents for maintenance • NF X60-200 Technical documentations associated with an item throughout its life cycle • NF X60-212 Maintenance - Handbook of instructions maintenance - Definitions and general principles for the wording and layout
							●	Maintenance documents	Definition Maintenance documentation contains different types of documents (equipment technical data, maintenance plans, maintenance procedures, spare parts catalogs, etc.) which must be managed in order to be available when required with relevant and updated information.	A1: f) To comply with the required procedures, standards and operational methods of work B4: d) To ensure the proper documentation management B8: b) To develop and update policies, tools, methodologies and technical standards for maintenance in accordance with the laws and rules on safety, health and	
							●	Maintenance standards	Definition Many maintenance standards are produced by various technical committees of standardization bodies at the national (national standardization bodies), European (CEN/TC319) and international levels (IEC/TC56, ISO/TC108, 135, 251, ...). These standards are documents, usually of voluntary application, that represent a consensus of experts on a given subject. It is important to monitor them, to participate in their development and to keep an up-to-date list in relation to the topics covered.		

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SUPPORT	DTA - Manage data						●	Maintenance data collection	Definition Observations and resulting data are needed to the maintenance improvement process. These maintenance data must be collected, which means they must be defined (what must be measured?), measured, and stored in appropriate databases. Collection of maintenance data covers data related to : preventive and corrective activities, costs, spare parts, tools, human resources, sub-contractors, safety of individuals, reliability and maintainability of equipment, global performances of systems/plants (availability, environment, quality, safety, value, …), customer/client satisfaction, etc.	B8: j) To use the computerized maintenance management systems and tools for data acquisition, monitoring and reporting C5: e) To ensure the proper right and timely use of maintenance information systems, promoting the upgrade and the development of systems and tools necessary to make them consistent with the technical and management needs	• EN 15341 Maintenance — Maintenance Key Performance Indicators • VDI 2886 Benchmarking applied to maintenance. (Benchmarking in der Instandhaltung) • VDI 2893 Selection and formation of indicators for maintenance. (Auswahl und Bildung von Kennzahlen für die Instandhaltung) • PSK 7501 Key performance indicators of maintenance for use in process industry • PSK 7502 Key performance indicators of logistics. Material function • PSK Condition audit in process industry • UNI 11134:2005 Maintenance - Maintenance ratios for the group transportation field • UNI 11178:2006 Maintenance - Maintenance ratios - Guidance for the application of UNI 10388 in the field of the infrastructures of the group transportation on railways • UNI 11069:2003 Maintenance - Maintenance ratios for the vehicles in service on road, with limited distances to be covered and frequent stops
							●	Performance Indicators & Dashboards	Definition Maintenance Key performance Indicators (KPI) are measured characteristics related to an item or a maintenance activity to support management in achieving maintenance excellence. The use of sets of associated, consistent and complementary indicators (dashboard) providing synthetic and global information allows developing strategies to meet the maintenance objectives. KPI can be focused on the past (lagging indicators) or on the future (leading indicators) and dashboards must gather these two categories. Definition and collection of indicators is the first step for a maintenance improvement process.	B1: f) To provide essential key performance indicators of maintenance process B5: e) To monitor performance, reliability, availability of asset and maintenance costs through the indicators C6: c) To verify technical and economic performance through the use of key performance indicators	
					●			Big data for maintenance and asset management	Definition Nowadays, the information digitalization techniques coming from industry 4.0 (Internet of things, cloud computing, data lakes, cognitive computing, etc.) make it possible to treat a big volume of data and to increase efficiency of diagnosis and prognosis. Condition based and predictive maintenance will benefit from these new opportunities.	B8: j) To use the computerized maintenance management systems and tools for data acquisition, monitoring and reporting C2: b) To ensure the proper and timely use of maintenance information systems, promoting the upgrade; the development of systems and tools necessary to meet the business requirements C5: e) To ensure the proper right and timely use of maintenance information systems, promoting the upgrade and the development of systems and tools necessary to make them consistent with the technical and management needs	
SUPPORT	HSE - Ensure personal health and safety to individuals and preserve environment in maintenance					●		Occupational diseases and accidents	Definition Maintenance occupations cause a higher proportion of occupational accidents and diseases than the average value. It is then essential to identify dangers and investigate and address the risks associated with maintenance activities.	A3: To perform or ensure the proper execution according to rules and procedures relating to safety, health and environmental protection B3: c) To manage employees and ensure compliance with legislation, technical standards and company procedures on safety, health and environment	• OSHAS 18001 Occupational Health and safety management systems - requirements • OSHAS 18002 Occupational Health and safety management systems - Guidelines for implementation of OSHA 18001 • ILO-OSH-2001 Guidelines on occupational safety and health management systems • MASE Guideline for improvement of health and safety at work • IEC 61508 Functional safety of electrical/electronic/ programmable electronic safety-related systems • IEC 61511 Functional safety – Safety instrumented systems for the process industry sector • UNI 10449:2008 Maintenance - Criteria to prepare and to manage the permit to work
						●		Risk assessment in maintenance	Definition Risks analyzes related to health and safety of maintenance personnel must be carried out systematically during the preparation of maintenance tasks. More generally they must also be carried out to identify and to prevent risks in the workplace, especially in workshops, warehouses and all areas where maintenance activities are carried out.		

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						●		Good practices in safety	Definition In the field of safety, good practices must be identified and shared in order to reduce accidents and occupational diseases. The pooling of good practices, both to prevent risks and to reduce their consequences must be undertaken systematically and as widely as possible.		
						●		Good practices in environment preservation	Definition In the field of environment preservation, good practices must be identified and shared in order to reduce pollution and damages to the environment. The pooling of good practices, both to prevent risks and to reduce their consequences must be undertaken systematically and as widely as possible.		
SUPPORT	IST - Provide the needed infrastructures				●			Maintenance of real estates	Definition Wharehouses, workshops, offices are infrastructures that require constant maintenance to ensure that the installations function properly and to prevent unforeseen expenses. In particular, emergency items and infrastructures must be maintained according to given regulations.		• CEN/TS 15331 : Criteria for design, management and control of maintenance services for buildings • UNI 11257:2007 : Maintenance of buildings - Criteria for the drafting of plan and programme of maintenance of buildings – Guidelines • UNI 10604:1997 : Maintenance. Criteria for design, management and control of the maintenance services of building • UNI 10831-1:1999 Maintenance of buildings - Documentation and basic information for maintenance services of projects approved and executed - Structure, contents and levels of documentation • UNI 10951:2001 Systems of information for the maintenance management of buildings - Guidelines • EN 15221-1 Facility Management - Part 1: Terms and definitions • EN 15221-2 Facility Management - Part 2: Guidance on how to prepare Facility Management agreements
		●						Facility management	Definition To ensure, support and improve the effectiveness of the organization's core activities, actions as cleaning operations, routine maintenance on buildings (painting, plumbing, glazing, etc.) must be carried out.		
SUPPORT	MRQ - Deliver maintenance requirements during items design and modification	●						RAMS management during design	Definition Reliability, Availability, Maintainability and Safety (RAMS) is a generic term to encompass analysis performed in the early stages of an industrial or building project. It covers reliability analysis (failure modes, effects and criticality analysis, human error analysis, etc.), safety analysis (preliminary hazard analysis, probabilistic safety assessment, sneak analysis, vulnerability analysis, etc.), preliminary definition of maintenance (preventive and corrective actions), maintainability and supportability analysis (accessibility, repairs, spare parts, tools, etc.). RAMS is rather the implementation of methods than a single method but it results in global trade-offs between allocation of reliability, maintainability and logistic support to meet the dependability and safety requirements.	A1: c) To identify and propose actions or projects to improve reliability, availability and maintainability of assets B8: d) To promote the continuous improvement of reliability, availability, maintainability and safety performance of assets C1: e) To promote process re-engineering analysis and studies for maintenance and logistics with the aim to ensure the improvement of availability, reliability and maintainability and to optimize maintenance costs C4: a) To collaborate in the design of new assets, providing all the information and experience useful to the success of the project	• IEC 60300-3-10 : Application Guide : Maintainability • IEC 60706-2 : Maintainability of equipment – Maintainability requirements and studies during the design phase • IEC 60706-3 : Maintainability of equipment –Verification of maintainability and collection, analysis and presentation of maintainability data • IEC 60706-5 : Guide on maintainability of equipment - Diagnostic testing

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		Maintenance management	Maintenance within Physical Asset Management	Maintenance execution	Maintenance engineering techniques	Health, safety and environment in maintenance	Maintenance support				
		●						Maintainability studies	Definition Maintainability studies must be carried out during the design and development phase. In conjunction with reliability studies they are used to guide design decisions and predict the item maintainability. Maintainability studies cover many factors as accessibility, interchangeability modularity, ability to tolerate the fault, ability to detect degradations, ability to be safe for maintenance personnel, testability, etc.		
		●						Design out maintenance	Definition Design Out Maintenance consists of eliminating the need for maintenance during the design phase of an item. That can be done though over-sizing of items or any other solution which makes it possible to avoid critical degradation mechanisms or the consequences of these mechanisms. It can also results in determination of ways to detect hidden failures.		
		●						Integrated Logistic Support	Definition "Management process to co-ordinate the provision of all materials and resources required to meet the needs for the operation and maintenance." [IEV 50(192)] ILS is a method introduced by the US Army (MIL-STD1388) to consider the activities and resources required to operate and maintain a product in service. It covers maintenance actions, manpower, training, spare parts provisioning, technical documentation, packaging and handling, storage and transportation, support equipment (tools, test and monitoring equipment, software) and disposal. Logistic Support Analysis (LSA) must be performed iteratively throughout the design process in order to ensure that the product can be operated and supported at an affordable cost. Indeed, the expenses due to logistic support are a major contributor to the life cycle cost (LCC) of a product and increasingly customers are making purchase decisions based on life cycle cost rather than initial purchase price alone.	A4: To ensure the availability of materials, tools and equipment necessary for the execution of maintenance tasks B6: a) To define the request for technical materials and ensure the logistics operations B8: i) To perform analysis and studies for the reengineering of maintenance and logistics processes to improve quality and reduce maintenance costs C1: e) To promote process re-engineering analysis and studies for maintenance and logistics with the aim to ensure the improvement of availability, reliability and maintainability and to optimize maintenance costs C2: To define processes and tools to support maintenance tasks	• IEC 60300-3-12 : Integrated logistic support
SUPPORT	**OPT - Improve the results**	●						Lean Maintenance	Definition The objective of Lean maintenance is to link different methods as TPM, RCM, Kaizen, etc. in order to improve productivity and quality and to reduce the amount of inputs and wastes. The use of CMMS (computerized maintenance management system) or EAM (Enterprise Asset Management) is strongly advised. Lean maintenance is rather principles than a formalized method.	B1: To ensure the implementation of maintenance strategies and policies C1: To define and develop maintenance policies according to company strategies	
		●						Decision making in maintenance	Definition Decision in maintenance must often consider multiple criteria leading to complex choices. Decision making techniques can be used to aggregate criteria, to evaluate the costs and benefits of the alternatives and to synthesize the opinions of experts.		

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		●						Benchmarking	Definition When KPIs have been collected, the second step is to compare their values to a point of reference. Benchmarking is a process which consists of comparing KPIs between different but similar items, possibly belonging to different companies. Reference targets are taken from the items having the best performances. Benchmarking helps maintenance decision makers to find the opportunities for improvement that will give competitive advantages. Methods can be used to take into account differences between items in order to provide adjusted and realistic targets.	B1: f) To provide essential key performance indicators of maintenance process B5: e) To monitor performance, reliability, availability of asset and maintenance costs through the indicators C6: c) To verify technical and economic performance through the use of key performance indicators	• EN 15341 Maintenance — Maintenance Key Performance Indicators • VDI 2886 Benchmarking applied to maintenance. (Benchmarking in der Instandhaltung) • VDI 2893 Selection and formation of indicators for maintenance. (Auswahl und Bildung von Kennzahlen für die Instandhaltung)
		●						Maintenance process diagnosis & audits	Definition Audits and diagnostics consist of methodical and formal examination of the maintenance process carried out to identify the strengths and weaknesses, determine objectives and targets to be reached and plan improvement actions. Results from benchmarking and questionnaires covering all the different maintenance/ maintenance support sub-processes can be used for this purpose.	C3: a) To identify the most appropriate organizational model to achieve corporate strategic objectives in terms of effectiveness and efficiency C5: d) To ensure the process of re-engineering and continuous improvement of maintenance	
					●			Modelling and simulation of maintenance strategies	Definition Maintenance decisions to control risks and to increase competitiveness can be based on quantitative information provided by modeling and simulation. Computational models make it possible to assess the performances of different maintenance strategies taking into account operating and environmental conditions of the system. Models must represent the causal chain leading to the malfunctioning of a system in order to estimate the costs of maintenance and downtime. In particular modeling can include degradation mechanisms, symptoms, failure modes, preventive and corrective maintenance tasks and maintenance logistic support.	B5: f) To carry out reliability studies and technical analysis to improve the availability of asset B8: d) To promote the continuous improvement of reliability, availability, maintainability and safety performance of assets B8: i) To perform analysis and studies for the reengineering of maintenance and logistics processes to improve quality and reduce maintenance costs C3: a) To identify the most appropriate organizational model to achieve corporate strategic objectives in terms of effectiveness and efficiency	
		●						Customer satisfaction surveys	Definition An effective customer satisfaction survey program allows measuring customer perceptions of how well the requested performances are meet. In addition to the measurement of objective performances, perception of how customer's problem is understood is an important factor. Different techniques can be used to collect customer satisfaction (face to face, questionnaires, automatic notifications, etc.) and to analyze the results.	B7: b) To present different solution options to the customers or physical asset owner/operating manager	
							●	Best practices identification	Definition Identification and measurement of KPI and comparison to points of reference, for example, through benchmarking or modeling and simulation, provide directions for improvement. Then the last and essential step of the improvement process is to propose and to implement actions. Identification of best practices with questionnaires, interviews, etc., especially from the best organizations identified through benchmarking, and adjustment of these practices to the company can be used to carry out appropriate improvement actions.	C1; f) To follow the development of the relationships with technical organizations, institutes and associations for the issues concerning the area of maintenance	

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							●	Tools for expert evaluation	Definition Expert judgments are very often useful when decisions have to be taken without available quantitative data. Various methods and tools exist for assessing and combining expert opinions. They allow elicitation of quantities and uncertainties, frequencies, probabilities, etc. and can provide consensus expected to be better than individual judgments.	B8: f) To assess the reliability, availability and maintainability of asset and the lifecycle cost C4: To ensure the levels of availability, reliability, maintainability, upportability, safety and quality required for the entire useful life of assets	
					●			Human error analysis	Definition Methods may be used to assess the probability of a human error during the completion of a maintenance task and to reduce this probability. They consider human factors having a significant effect on performance and may use cognitive models of human behavior to understand how and why humans make mistakes in order to propose prevention actions.	A2: b) causes and propose actions C4: g) To ensure failure analysis on critical assets, in order to identify the root causes and propose actions	
SUPPORT	RES - Provide internal human resources						●	Education & training in maintenance, E-learning in maintenance	Definition This subject contains all the pedagogical resources that allow the initial education and the continuous training in maintenance methods, techniques and practices as well as all the support knowledges which are required at the different levels of responsibility.	A5: f) To take care, within the limits of his responsibility, of training, coaching and professional development of personnel B3: f) To support human resource by assistance in recruiting, assessment and training of staff B3: g) To execute training and education for staff B8: e) To ensure the preparation of manuals and instructions for training and continuous technical updating C3: b) To ensure the implementation of company policies for the organization, management and training of employees C3: e) To define needs and proposals for recruitment plans, training of the employees and for the development of the	
							●	Competences, qualification and Certification of maintenance personnel	Definition Work profiles require different levels of competence and some require qualification or certification from maintenance personnel. It is necessary to establish the relationships between the positions and the requirements in terms of competence, qualification and certification.		• CEN/TR 15628 Maintenance - Qualification of Maintenance personnel • UNI 11420:2011 Maintenance - Qualification of maintenance personnel
				●				Relations between Operation and Maintenance staff	Definition Maintenance and operation are two processes, generally carried out by separate teams, but having strong inter-relationships. There is a need for communication and meeting facilities within companies to effectively coordinate these two teams.	A5: g) To verify that collaborating personnel is able to meet the minimum requirements for the assigned tasks B7: To communicate to all necessary parnters like staff, contractors, suppliers C5: a) Professional leadership, communication techniques and management of working groups	

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SUPPORT	**SER - Provide external maintenance services**			●				Contracting & outsourcing & insourcing	Definition Maintenance is often outsourced and the division between tasks to be carried out internally and externally must be established. Then competent companies must be selected and maintenance contracts drawn up to help the parties to manage their relations so that the tasks are carried out in accordance with the expectations.	B6: To participate in the technical aspects of contracts and procurement process and manage the performance of the contractor C7: To define strategies, policies and criteria for performance management of contractors and for the definition of maintenance materials requirements	• EN 13269 Maintenance - Guideline on preparation of maintenance contracts • IEC 60300-3-16 Application guide – Guidelines for specification of maintenance support services • EN 15221-2 Facility Management - Part 2: Guidance on how to prepare Facility Management agreements • UNI 10144:2006 Classification of maintenance services • UNI 10145:2007 Definition of evaluation factors of services maintenance firms • UNI 10146:2007 Criteria to prepare a contract for supplying maintenance finalized services • UNI 11126:2004 Telemaintenance - Criteria for the suitability of the items and for the definition of the related service • UNI 10148:2007 Maintenance - Management of a maintenance contract • UNI 10685:2007 Maintenance - Criteria to prepare a maintenance global service • UNI 11136:2004 Global service for maintenance of buildings - Guidelines • NF X60-008 Industrial maintenance - Maintenance outsourcing draft guide - Pre-contractual approach • NF X60-100 Maintenance – Preconditions to the maintenance contracts – Inventories and evaluation for the states of items • PSK Maintenance in industry. Service agreement.
SUPPORT	**SPP - Deliver spare parts**						●	Spare part management	Definition Corrective and preventive maintenance task often require spare parts and materials to maintain and restore assets. The management of these items consists of defining the necessary spare parts and materials and their optimum quantities, ordering, receiving and storing these items at defined locations, providing the items to maintenance personnel when required and monitoring the stock in order to satisfy the needs at minimum cost.	A4: b) To ensure the availability of materials and equipment required for corrective maintenance in accordance with corporate procedures B6: a) To define the request for technical materials and ensure the logistics operations B8: i) To perform analysis and studies for the reengineering of maintenance and logistics processes to improve quality and reduce maintenance costs C1: e) To promote process re-engineering analysis and	• NF X 60-012 Vocabulary of components of items and their supply • IEC 62550 Spare parts provisionning • VDI 2892 Management of maintenance spare parts. (Ersatzteilwesen der Instandhaltung)
							●	Obsolescence management	Definition Obsolescence is "the inability of an item to be maintained due to the unavailability on the market of the necessary resources at acceptable technical and/or economic conditions" [EN13306]. This situation must be managed by maintenace personnel in charge of logistic support and selection of maintenance tasks by detecting, priotizing and mitigating obsolescent items.		• IEC 62402 Application guide – Obsolescence management

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SUPPORT	TOL - Deliver the tools, support equipment and information system						●	Maintenance Information Systems	Definition It is a tool to manage all the information needed for maintenance. In particular, the information system manages information concerning assets, maintenance activities (corrective, preventive, etc.), safety of individuals, maintenance resources (spare parts, documentation, tools, personnel, ...), budgets, purchases, performance indicators, collection of feedback experience, etc.	A1: g) To apply the diagnostic techniques (failure analysis and troubleshooting techniques) and the on condition maintenance A4: c) To perform the preparation and regulation of machines, instrumentation and equipment necessary for the work A7: To use and ensure the use of the ICT systems B8: j) To use the computerized maintenance management systems and tools for data acquisition, monitoring and	• UNI 10584:1997 Maintenance. Systems of information of maintenance • UNI 10951:2001 Systems of information for the maintenance management of buildings - Guidelines
							●	Instrumentation & Wireless techniques	Definition Instrumentation techniques are progressing and they make it possible monitoring and diagnosing better and better the equipment and predicting their future behaviors. These means lead to evolution and effectiveness increase of condition based maintenance techniques, and more particularly of predictive maintenance tasks.		
							●	Visualization for maintenance diagnosis	Definition The maintenance diagnosis requires the use of signals or images visualization techniques to compare them with references. These techniques make it possible to reveal deviations and to deduce the level of severity of the degradations or failures observed.		
							●	Traceability	Definition Traceability is an important characteristic for maintenance since it allows the causal chain between events to be established and thus to understand the phenomena, the situations and their root causes. The traceability of components is also sometimes necessary to better manage risks and ensure a high level of reliability.		
					●			Augmented reality techniques	Definition Augmented Reality allows superimposing information about an item or a document. This enables maintenance personnel to have up-to-date technical documentation, safety information, lists of operations to be performed, diagnostic tools, etc., while they carry out maintenance tasks on an item.	A1: e) e) To use the machines, equipment and tools necessary for the execution of maintenance tasks A2: d) To perform restoration tasks in accordance with the required methodologies and standard works A6: a) To perform properly, efficiently and effectively the assigned maintenance tasks	
					●			Robotics and remote handling	Definition Special constraints (safety, accessibility, precision, etc.) lead to use robot or remote handling to carry out maintenance tasks. Many industrial sectors as space, aeronautics, energy, medical, etc., use these techniques.		

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					●			Maintenance tasks modelling and simulation	Definition CAD (Computer Aided Design) models can be used to test maintenance tasks in order to optimize disassembly, repairs, assembly, handling, etc., to decrease time to restoration and costs and to increase safety. These simulation tools are also useful to help trainees learning maintenance procedures through interactive exercises.	B5: f) To carry out reliability studies and technical analysis to improve the availability of asset B8: d) To promote the continuous improvement of reliability, availability, maintainability and safety performance of assets B8: i) To perform analysis and studies for the reengineering of maintenance and logistics processes to improve quality and reduce maintenance costs	

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