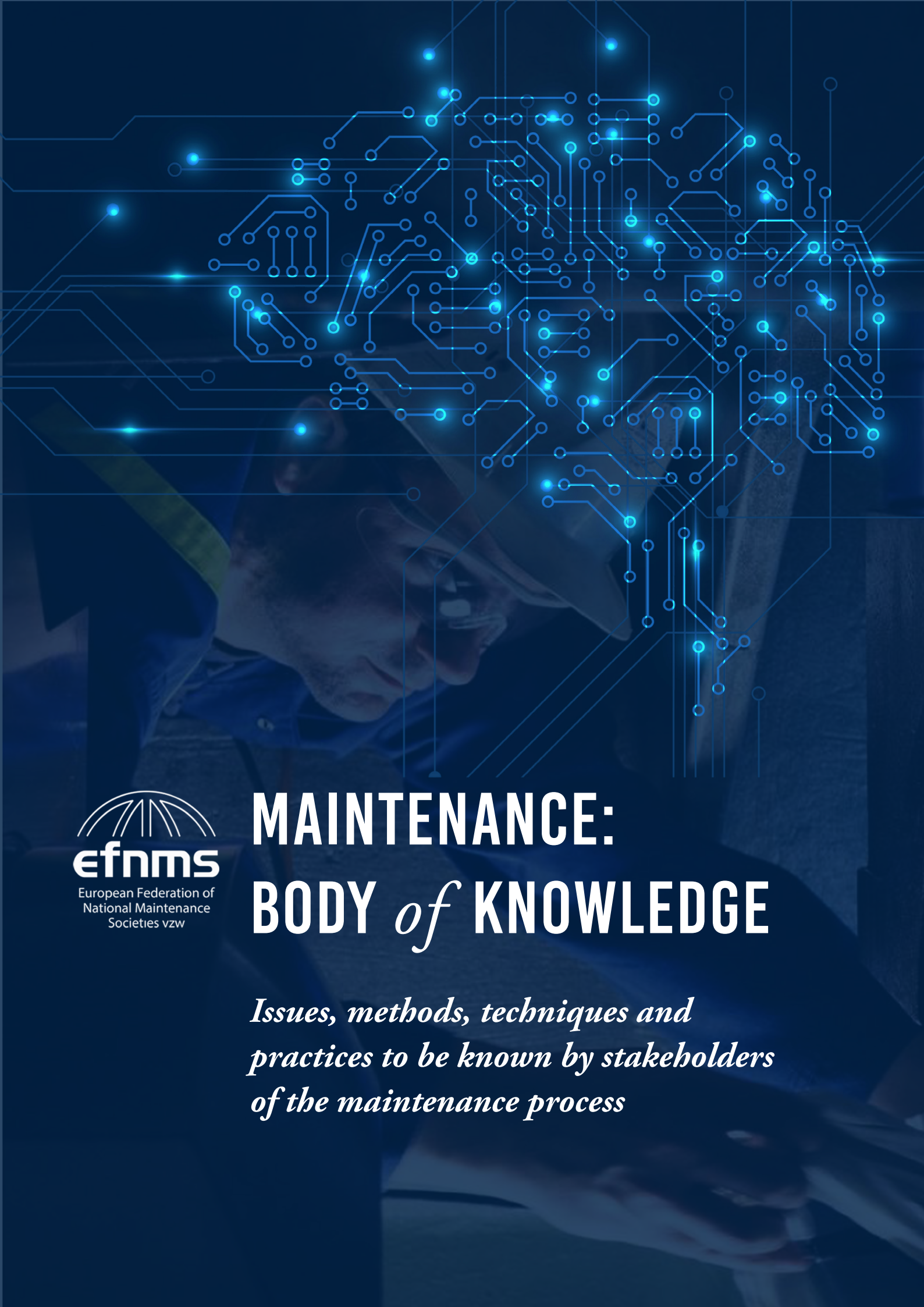

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MAINTENANCE: BODY *of* KNOWLEDGE

Issues, methods, techniques and practices to be known by stakeholders of the maintenance process

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CHAPTER 1

MAINTENANCE WITHIN PHYSICAL ASSET MANAGEMENT

BOK SUBJECTS AND ASSOCIATED MAINTENANCE PROCESSES

1. MAINTENANCE WITHIN PHYSICAL ASSET MANAGEMENT

#	MAINTENANCE SUBJECTS	EN17007's Sub-processes in close relation
1.1	**Relations between maintenance and other processes** Maintenance is one of the processes of industrial companies with a strong impact on performance. It has also strong relations with other processes (acquisition/creation, operation, modernisation, disposal, support) and with the company's strategic plan. These relations must be identified and managed, so maintenance contributes effectively to the management of assets. Business, corporate, and maintenance objectives must be consistent to properly manage assets, asset systems, and asset portfolios. Maintenance can be considered within asset management.	**MAN** - Establish the maintenance policy, strategy, and development actions. **MRQ** - Deliver maintenance requirements during item design and modification **PRV 1.** Characterise undesirable events. **PRV 2**. Use and update maintenance plans.
1.2	**Life cycle management** Management of costs over the life cycle of assets encompasses the 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.). Continuous improvement methods, such as Plan-Do-Check-Act (PDCA), apply to the maintenance process during the asset's life cycle.	**MAN** - Establish the maintenance policy, strategy, and development actions.
1.3	**Life cycle extension** 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 asset managers.	**MAN** Establish the maintenance policy, strategy, and development actions. **BUD.3** Create a budget estimate for infrequent or exceptional maintenance tasks.

#	MAINTENANCE SUBJECTS	EN17007's Sub-processes in close relation
1.4	**Replacement investments** Replacement investment is generally an optimisation problem often linked to items' life extension. Operational research techniques are used to find the best trade-off between costs and expected benefits of replacements.	**BUD. 3** Create a budget estimate for infrequent or exceptional maintenance tasks. **OPT. 5** Prioritise areas of improvement related to the budgeting of maintenance of items. **MAN.1** Establish the maintenance policy, strategy, and development actions. **MAN.4** Prepare and negotiate the budgets.
1.5	**Maintenance and investment decisions** Investment decisions often depend on the maintenance costs and unavailability factor of installed assets and on the 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 to minimise the overall cost of ownership.	**MAN.1** Establish the maintenance policy, strategy, and development actions. **MRQ** Deliver maintenance requirements during item design and modification.
1.6	**Rebuilding and reinvestment strategies** Rebuilding and reinvestment strategies depend in part on maintenance effectiveness and maintenance costs. The assets' reliability and maintainability assessed through the analysis of experience feedback are important elements in decision-making.	**MAN.1** Establish the maintenance policy, strategy, and development actions. **MRQ** Deliver maintenance requirements during item design and modification.
1.7	**Value based maintenance** This approach was introduced to quantify the economic added value of maintenance in terms of cash flow (especially through calculation of net present value). It helps to identify the value drivers and to measure and benchmark performance in order to apply best practices (e.g., equipment probability improvement, work processes, information systems, etc.).	**MAN.1** Establish the maintenance policy, strategy, and development actions. **PRV.2** Use and update maintenance plans.

#	MAINTENANCE SUBJECTS	EN17007's Sub-processes in close relation
1.8	**Integrated logistic support** Integrated logistic support (ILS) is a "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 was 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 to ensure the product can be operated and supported at an affordable cost. The expenses due to logistic support are a major contributor to the life cycle cost (LCC) of a product, and customers are now making purchase decisions based on LCC rather than initial purchase price alone.	**IMP** Improve the items. **MRQ** Deliver maintenance requirements during item design and modification.
1.9	**Uncertainty in maintenance management** Reliability data, maintenance costs of assets, and effectiveness of maintenance plans are often uncertain data. Decision-makers use stochastic techniques that evaluate uncertainty using models calculating the performance of these assets and thus make their decisions more robust.	**MAN.1** Establish the maintenance policy, strategy, and development actions. **OPT** Improve the results.
1.10	**Regulations and relations with auditing and safety organisations** Some maintenance tasks are required by regulations, and close relationships must be established with the organisations/authorities in charge of safety of the installations to perform and monitor the mandatory tasks. In addition, internal or external audits are often carried out to verify the implementation and results of maintenance; this is a strategic function. Knowledge of regulations and relevant technical standards is paramount.	**MAN.1** Establish the maintenance policy, strategy, and development actions. **MAN.6** Define, select, analyse, and communicate the information**.** **MAN.7** Define policy and strategy areas of improvement. **HSE** Ensure personal health and safety of individuals and preserve the environment in maintenance. **DTA.9** Monitor methods, technologies, regulations, standards, etc. **OPT** Improve the results.

#	MAINTENANCE SUBJECTS	EN17007's Sub-processes in close relation
1.11	**Maintenance and sustainability** Maintenance is an essential lever for sustainable development. When maintenance is involved in the design phase of assets and when these assets are designed to be maintainable and reliable, their useful life is increased. Ensuring a longer useful life and appropriate maintenance actions reflect economic, ecological, and social aspects of companies and ensure sustainability of assets. In particular, maintainability is a guarantee of sustainable development**.**	**MAN.1** Establish the maintenance policy, strategy, and development actions. **IMP.2** Define reliability, maintainability, safety and logistic support requirements. **IMP.5** Analyse and choose options and validate the solutions. **MRQ.3** Develop reliability, maintainability, and logistic support requirements. **MRQ.6** Participate in the analysis and choice of options and validate the solutions. **OPT.3** Prioritise areas of improvement related to the IMP process. **OPT.6** Prioritise and specify modifications of existing items (MRQ process). **OPT.7** Prioritise improvements for future investments (MRQ process).
1.12	**Facility management** To ensure, support, and improve the effectiveness of the organisation's core activities, actions such as cleaning operations and routine maintenance on buildings (painting, plumbing, glazing, etc.) must be carried out.	**IST** Provide the needed infrastructures.
1.13	**Maintenance and Industry 4.0** Industry 4.0 is a new concept based on digitalisation of information. It includes cyber-physical systems, the Internet of Things, cloud computing, and cognitive computing. Maintenance is directly concerned with these new technologies, as diagnosis, prognosis, and all maintenance processes based on data collection and analysis are strongly impacted. Therefore, the management process must take these new techniques into account to establish a maintenance strategy.	**MAN.1** Establish the maintenance policy, strategy, and development actions. **DTA** Manage data. **ACT.6** Perform the maintenance tasks. **TOL.5** Determine and provide a maintenance management, decision support software tools, and documentation system.