

The Requirements and Rules to achieve a Certificate as a European Expert in Maintenance Management

Background

To become competent to manage and develop the maintenance activities and to run a modern cost-effective maintenance organisation, there are several areas of knowledge that has to be assimilated.

The European Federation of National Maintenance Societies, EFNMS, has developed a specification for the minimum requirements of knowledge for an Expert in Maintenance Management.

The EFNMS will also certify those individuals in Europe that can prove to be enough competent (to have the required theoretical knowledge and practical experience) to become a Certified European Expert in Maintenance Management.

The aim has been to specify the theoretical knowledge and the practical experience to be hold by a maintenance manager, thereby assuring that the maintenance activities can be organised and performed in the best possible way in each company.

The objective is a competence assurance of the maintenance activities within Europe.

This document includes:

- **the EFNMS minimum Requirements of knowledge for an Expert in Maintenance Management**
- **the Rules to be able to achieve the EFNMS Certificate as an European Expert in Maintenance Management.**

Any individual or organisation is free to use these requirements as a base for their training programmes.

All individuals have their right to apply for the EFNMS Certificate and to join the examinations of the theoretical knowledge that are arranged by a National Member Society of the EFNMS.

These requirements and rules, were accepted by the EFNMS Council on the 17th of April 1993 and amended by the EFNMS Council on the 37th of May 1998.

The EFNMS minimum Requirements of knowledge for an Expert in Maintenance Management.

1. A general approach

The specification contains the minimum requirements of the theoretical knowledge for a maintenance manager in general. Special requirements for maintenance managers in electrical, mechanical, chemical industries or others, are not covered. However, this specification aims to fulfil the intention to be enough comprehensive and include the essential and fundamental knowledge, that any expert in maintenance management has to have, regardless in which company or country he is working.

In short the requirements cover the following areas:

MANAGEMENT AND ORGANISATION

- Goal, strategies, results
- Organisation, competence
- Procurement, selling of service
- Guiding, control, analysis
- Economical control, LCC, LCP
- Material handling, logistics

RELIABILITY PERFORMANCE OF PRODUCTION PLANTS

- Definitions
- Measurements, mathematical formulas
- Requirements, control, analysis
- Design, procurement, operation
- Laws, regulations

MAINTENANCE INFORMATION SYSTEMS

- Planning, ordering, analysis
- Documentation
- Information systems
- Technical/economical analysis

MAINTENANCE METHODS AND TECHNIQUES

- Remote control, condition monitoring
- Preventive activities
- Repair techniques and methods

The required knowledge mentioned above is general for an Expert in Maintenance Management in any European Country. To be able to achieve the EFNMS Certificate the requirements also include:

MAINTENANCE TERMS IN THE ENGLISH LANGUAGE

2. Three levels of knowledge

In the detailed specification the requirements of knowledge has been described in three levels:

Level 1. Very good knowledge

For these subjects the requirements are to have a very good knowledge to be able to handle the special tasks that belong to a maintenance manager.

Level 2. Good knowledge

For these subjects the requirements are to have enough knowledge to be able to manage and develop these activities.

Level 3. Understanding

For these subjects the requirements are to have enough understanding to be able to make the right decisions and to have an insight of the total implications of the maintenance activities inside and outside a company.

3. The detailed specification

Note: The information that are given within brackets () are just examples to clarify the ideas behind the requirements in the specification, and shall not be looked upon as a total list, but just as examples. After some of the detailed text there is a sign [GK] or [U]. These signs indicates that the specified detailed knowledge has a requirement equal to *Good Knowledge* respectively *Understanding*.

3.1. Management and Organisation

Within this area it is essential to have a very good knowledge about the importance of maintenance for the economy in the company, for the achievements of the production goals and for the quality of the product, and so on.

It is important to have good knowledge of the organisation of the maintenance activities.

Therefore the following knowledge has to be obtained:

Very good knowledge in:

- How to set up a company management policy in order to be able to participate in its definition as far as maintenance is concerned.
- to describe why a policy has to be set up and what the requirements are for a policy

- to give examples on in which way the maintenance aspects are in a company management policy
- How to formulate the maintenance policy within a company.
 - to give an example of a maintenance policy
 - to describe what the requirements for a maintenance policy
 - to describe the process of the development of a maintenance policy
- How to formulate the maintenance goals.
 - to describe the general requirements for maintenance goals
 - to describe the process of the development of maintenance goals
 - to give examples of maintenance goals
 - to describe the relationship between goals and policy
- Different maintenance strategies and how to choose the right strategy.
 - to formulate different maintenance strategies
 - to describe the reasons behind the choice of a certain strategy
- How to specify the requirements for the maintenance activities.
 - to describe the different maintenance activities
 - to describe different requirements for the maintenance activities
 - to describe the process of the identification, the formulation and the communication of the requirements
- How to organize the maintenance activities, how to choose a suitable organisation and assure the right competence within the organisation.
 - to describe different types of maintenance organizations (e.g. centralized, decentralized, cooperation with the equipment supplier and/or servicing companies and integration with the production)
 - to describe the advantages and the disadvantages with the different types of organizations and the combination of them
 - to describe how to develop the competence in all the different types of organizations
- How to determine the human and material resources in order to implement the organisation.
 - to state the different types of maintenance resources (e.g. tools, material, personnel, transportation, documentation, shops)
 - to describe how to develop and optimize the maintenance resources (personnel and material), their location, quality and quantity
- How to assure (by maintenance activities) the health and safety and the right environment conditions (inside and outside the company).
 - to describe different conditions in the production equipment that may cause risks for health, safety and the environment (inside and outside the company)
 - to describe the possibility to prevent such incidents by maintenance activities, including cooperation with other departments in the company and external parties

- How to guide, control and analyse the maintenance activities.
 - to describe different methods and techniques to achieve an optimized result for the company by the maintenance activities, including the economical and safety aspects for these methods and techniques
 - to describe different general aspects that have to be taken into account for analysis
 - to describe the methods and techniques for analysing and the betterment process
 - to describe different methods to control the maintenance activities
 - to understand the different maintenance concepts (e.g. TPM, RCM, etc)
- How to develop and use key-figures for the economical control.
 - to describe how to use the key-figures in the control and development of the maintenance activities
 - to describe what the fundamental requirements are for key-figures
 - to describe the most useful key-figures for different maintenance organizations
- LCC/LCP techniques/methods.
 - to describe the methods of LCC and LCP, and when they can be used
 - to be able to make some fundamental calculations of LCC and LCP
 - to describe how to organize the work when using the concepts of LCC and LCP
 - to describe how the concepts of LCC and LCP can be used in different situations
 - to describe how to specify the LCC requirements in a procurement process [GK]
 - to describe how to verify the LCC values and the consequences if the verified result is not in accordance with the specified requirements [GK]
- Logistics support, material and store handling, methods for spare part calculations
 - to describe the different factors that will have an influence on an optimized organisation of the spare part consumption (e.g. cost for lack of spare parts, cost for storage, cost for interest, etc)
 - to describe routines and organization for an optimized logistic support of spare parts (e.g. purchasing, quality control, delivery systems inside the maintenance organization, etc)
 - to describe different ways of organizing the spare part store (e.g. centralized, decentralized, at the supplier)
 - to describe how to calculate the total amount of spare parts and how many of each type, inclusive the typical mathematical formulas for this purpose [GK]
- How to measure and analyse the results of the maintenance activities, e.g. efficiency and economy.
 - to describe different methods to measure the result of the maintenance activities, the advantages and disadvantages with the methods and their handling of the economical aspects
 - to describe what is not covered by these methods
 - to understand different economical models regarding maintenance and understand the fundamental principles regarding the economical results for a company
 - to be able to develop a model for measurement and analysis of the maintenance activities
- The maintenance activities in the development and procurement of new production equipment.
 - to be able to transfer production requirements into functional requirements (e.g. equipment dependability) and into quantitative and qualitative maintenance requirements (e.g. reliability and maintainability) and optimize the resources
 - to understand the importance for maintenance of taking part in the development phase

- to describe how the maintenance experience can be used during the design phase
- How to define the future maintenance needs of a company.
- to understand which factors that are important for the need of maintenance activities and how they might be changed in the future (e.g. new requirements regarding goals, strategies and results)
- to understand the future needs of maintenance and its influence on the actual activities in the long run (e.g. work load, type of work, quality and quantity)
- to be able to describe different future scenarios

Good knowledge in:

- How to define and implement human resources development policy.
- to describe why a human resources development policy has to be set up and what the fundamental requirements are for such a policy
- to give an example of a human resources development policy
- to describe the process of the development of a human resources development policy

Understanding in:

- Actual European standards within maintenance.
- Laws and regulations regarding labour, liability, guarantee, environment, energy, etc.
- to describe different methods to measure the fulfilment of the laws and regulations with respect to labour, liability, guarantee, environment, energy, etc.
- to describe what is not covered by these methods
- to know the different unions in the country and the agreed commitments
- The essential contribution from the maintenance activities to achieve good product quality and good production performance.
- to understand the maintenance contribution

3.2 Availability Performance of Production Plants

Within this area it is essential to have knowledge about how to guide, control and develop the availability performance activities, in order to assure the performance of the production, the quality of the products, the safety regulations and the environment conditions.

It is important to have good knowledge of all availability performance activities that shall be taken care of during the entire life cycle of a production system, e.g. during development, procurement, operation and displacement of a production equipment.

Therefore the following knowledge has to be obtained:

Very good knowledge in:

- **Reliability**

- to understand that this has to do with the number of failures and the disabled states due to maintenance activities
- to be able to define reliability
- to describe some different measures of reliability (e.g. MTBF, MTTF, etc)
- to be able to calculate the reliability
- to be able to describe the mechanism that causes the failures
- to describe the different redundancies [U]
- to be able to draw a reliability block diagram with serial and parallel systems and for active and passive redundancies [U]
- to be able to calculate the reliability probability for a serial and parallel system and for active and passive redundancies [U]
- to be aware of the different statistical distributions for failures (e.g. Exponential, Lognormal, Weibull, etc) [U]

- **Maintainability**

- to understand that this has to do with active time for maintenance
- to be able to define maintainability
- to describe some different measures of maintainability (e.g. MTTR, M, etc)
- to be able to calculate the maintainability
- to describe which time elements that are included and not included in the calculation (e.g. preparation time, functional check out, waiting for resources) [GK]
- to be able to analyse what causes the length of active maintenance times

- **Supportability**

- to understand that this has to do with waiting times for maintenance resources
- to be able to define supportability
- to describe some different measures of supportability (e.g. MLDT, MWT, etc)
- to be able to calculate the supportability
- to be able to analyse what causes the length of the waiting times

- **Availability**

- to understand that this has to do with the time of the ready state for the equipment
- to be able to define availability
- to describe the connection and differences between dependability, availability, reliability, maintainability and supportability
- to be able to calculate the availability with respect to down time, running time, operational cycles, production, calendar time, etc [GK]
- to be able to analyse what causes low availability [GK]
- to understand the influence of availability on the production [GK]

- **Improvements of the availability performance**

- to understand in which different ways it is possible to improve the availability
- to understand in which different ways it is possible to improve the reliability (e.g. the choice of components, redundancies, design, preventive maintenance, better operational use, etc)
- to understand in which different ways it is possible to improve the maintainability (e.g. design, documentation, maintenance equipment, education, etc)

- to understand in which different ways it is possible to improve the supportability (e.g. assure faster access of personnel, documentation, spare parts, maintenance equipment, transports and assure faster administrative routines, etc)

Good knowledge in:

- The mathematical and statistical formulas to be used in the specifications and for verifications.
- to be able to specify requirements regarding reliability performance (e.g. what is regarded as failures, active maintenance time, waiting time and how the availability is defined, etc)
- to describe the basic mathematical formulas within availability, reliability, maintainability and supportability
- to be able to specify how the verification will be performed
- to describe the different consequences if the verified results are different from the requirements [U]
- Human reliability
 - to describe the different types of human failures
 - to describe what causes human failures
 - to understand how human failures can be prevented and avoided
- Production safety
 - to describe the different types of incidents that the maintenance activities shall prevent (e.g. consequences on health, safety and environment)
 - to understand how to predict and prevent such consequences
 - to give examples of external parties interested in those preventions
- Risk analysis
 - to be able to define risk
 - to describe the different steps in a general risk analysis
 - to be able to calculate risks
 - to describe some different methods for risk analysis and when they can be used (e.g. FMEA and Fault-tree)[U]
 - to be able to judge on the quality of a performed risk analysis [U]

Understanding in:

- Quality assurance
 - to define quality and quality assurance
 - to mention some standards and methods for quality assurance regarding maintenance
 - to describe how the maintenance activities will have an influence on the quality assurance
- Laws and regulations (technical aspects)
 - to exemplify governmental organizations that are responsible for laws and regulations regarding maintenance
 - to exemplify organizations that are checking the application of these laws and regulations
 - to exemplify laws and regulations that have a direct influence on the maintenance activities

3.3 Maintenance Information Systems

Within this area it is essential to have knowledge about the different methods and systems that can be used in the decision making process, to be able assure that the maintenance activities are costeffective and are supporting the company profit.

It is important to have good knowledge of how to specify the system requirements and how to develop and use the information systems for planning, control, feedback analysis and improvements.

Therefore the following knowledge has to be obtained:

Very good knowledge in:

- Maintenance Management Information Systems (key-figures, guidance tables and so on).
- to describe differnt types of information systems and be able to combine these (e g the customer requirements on maintenance, the efficiency of the plant equipment and the machineries, the different contracts for the maintenance performance)
- to be able to specify the requirements for an information system

Good knowledge in:

- Maintenance Information Systems (for planning, work order, technical/economical analysis, and so on).
- to describe different types of information for maintenace activities (e g workorder, work control, planning, work preparation, spare parts, LCC/LCP, safety, risks, environment, production results, betterments, modifications, investments, etc)
- to be able to specify the requirements for information systems that will handle the above
- to describe the limits and the uncertainties that might exist in these systems
- to be able to combine, prioritize and argue regarding the use of these systems
- to be able to describe the different modules in a maintenance information system
- Technical documentation/information systems.
- to be able to specify the requirements for a documentation system and give some examples of how the different documents shall look like (e g maintenace instructions, equipment lists, drawings, spare part lists, education/personnel informations, handbooks, etc)
- to describe how to organize the work to keep the systems updated
- Technical process control systems.
- to be able to specify these systems
- to describe the limits and the uncertainties that might exist in these systems
- to be able to combine, prioritize and argue regarding the use of these systems
- to describe the relationship between the process control system and the maintenance information system

Understanding in:

- Expert systems.
 - to define and describe the principle of an expert system, inclusive the different types of such systems
 - to describe the problems regarding the use of such systems
- Basics concerning the computer support for the topics above.
 - to describe the basic ideas how to combine and prioritize the information systems mentioned above
 - to describe different ideas regarding the documentation system (e.g. paper - computerized, local - central, advantages - disadvantages, etc)
 - to be able to adapt the systems to the actual circumstances
 - to be able to indicate actual costs for these systems and the advantages to use them
 - to know the fundamental requirements regarding the security for information systems and the need of backup for computer systems
 - to describe how to use the results from these information systems
 - to describe the difficulties with these systems (e.g. collecting data, present data, etc)
 - to describe the principle concept how to handle a project regarding the implementation of a new system (e.g. the choice of system, preparation, installation, training, etc)

3.4 Maintenance Methods and Techniques

Within this area it is essential to have knowledge about the theories and methods that are used to optimise the mix between corrective maintenance, preventive maintenance (predetermined or conditions based) and modifications.

It is important to have knowledge about how to choose the right methods for the best cost effectiveness.

Therefore the following knowledge has to be obtained:

Good knowledge in:

- The theory of the failure patterns
 - to define a fault
 - to describe the different causes for a fault (e.g. specification, design, installation, operation, maintenance)
 - to understand the statistical distributions for failures
 - to be able to choose the appropriate maintenance method depending on the actual failure distribution (e.g. corrective, preventive, condition based, modification)
 - to be able to classify and take into account the different consequences of a fault
- Types of wear and tear
 - to describe the different causes of wear and tear
 - to describe the different possibilities to prevent that
- Improvement techniques (aiming at reducing failure rates and down times)

- to know and understand different methods of fault finding
- to understand different methods of improvements due to maintenance requirements
- to be able to specify, plan, control and follow up improvements
- **Preventive techniques**
 - to describe methods and techniques for preventive and condition based maintenance
 - to understand and be able to decide about the intervals between preventive maintenance actions
 - to be able to choose a suitable preventive maintenance program (e.g. activities, intervals, etc)
- **Inspection techniques**
 - to describe methods and techniques for inspection (condition based maintenance)
 - to understand and be able to decide about the intervals between inspections
 - to be able to choose a suitable inspection system
- **Condition monitoring techniques**
 - (see "Inspection techniques" above)
- **Methods of life extensions**
 - to know different methods of life extensions, and how to execute them
 - to be able to describe in a visual way how different maintenance activities will have an influence on the life time of the production equipment
- **Measurement methods**
 - to understand the principles of measurement systems with indication and presentation for the purpose of maintenance
 - to describe typical methods to measure different technical conditions
- **Control systems**
 - to be able to describe different types of condition monitoring systems (e.g. continuous, by intervals, on request, centralized or decentralized)

Understanding in:

- **Performance improvement techniques.**
 - to know and judge on the importance of different fault finding methods
 - to understand different methods of improvements due to maintenance requirements
 - to be able to specify, plan, execute and up performance improvements
- **Repair techniques.**
 - to be able to plan, execute and follow up repair work
 - to be able to give examples of repair techniques

3.5 Maintenance terms in the English language

Within the language area it is essential to have good knowledge about the maintenance terms in the English language, in order to be able to handle international maintenance management matters within Europe. (This requirement only applies to those that like to have an EFNMS European Certificate, and does not apply for a National Certificate.)

Therefore the following knowledge has to be obtained:

Good knowledge in:

- The understanding of maintenance terms in the English language.

The Rules to be able to achieve the EFNMS Certificate as a “European Expert in Maintenance Management”

1. General

An applicant has to fulfil the requirements regarding the theoretical knowledge and the practical experiences (as specified below) within one year to be able to get the EFNMS Certificate. The date of the certification will be the date when the last of the requirements is fulfilled.

2. The requirements of theoretical knowledge

2.1. An examination

2.1.1. Each National Maintenance Society that is a member of the EFNMS will, on behalf of the EFNMS, arrange written examinations of the theoretical knowledge in each societies own language. (These tests can be arranged at intervals that will suit each society.)

2.1.2. The examination has to be arranged according to national university standards

2.1.3. The examination shall include:

[A] questions that cover the subjects in the detailed specification,

[B] one maintenance article in English, from which the students shall write an abstract in their own language.

2.1.4. The complete examination of [A] above, shall last no more than 8 hours. The examination can be divided into two parts, with two different questionnaires. (E.g. one part with questions covering "Management and

Organization" + "Maintenance Information Systems" and another part covering "Reliability Performance of Production Plants" + "Maintenance Methods and Techniques".)

2.1.5. The complete examination of [A] above, give 100 points. To pass the examination a candidate has to achieve 70 points. If the examination is divided into two parts, as described in 1.1.4. above, the first part can give 55 points (to pass 40 points) and the second part 45 points (to pass 30 points.)

2.1.6. A separate examination of [B] above is allowed for 1 hour.

2.1.7. Regarding the examination of [B] above, a candidate shall prove a fully understanding of the maintenance terms in English to pass the test.

2.1.8. Present at the examination have to be the National Examiner (see 2.2.1. below), the EFNMS observer (see 2.4.2. below) and a member from the board of the National Maintenance Society.

2.2. A questionnaire preparation group for the examination

2.2.1. For the preparation of the questions in an actual examination, the National Maintenance Society has to select a group of professionals who are authorities within the area of maintenance management.

This group has to include as a minimum:

- a professor and/or a teacher from a university
- a maintenance manager from a medium or large company
- a representative from the board of the National Maintenance Society

(In some cases the same person can cover more than one of the criterias above. However, the group shall not consist of less than three people and each of them has to fulfil at least one of the criterias above, and all the mentioned criterias have to be covered by the group.)

Among the above professionals a National Examiner shall be appointed.

2.2.2. The final proposal for the questionnaire has to be sent to an EFNMS observer (see 2.2.2. below) for approval. The approval has to be done by the signature of the observer on each sheet of the questionnaire.

A questionnaire that is not approved by the EFNMS observer is not valid for the purpose of the EFNMS certification.

2.2.3. The questions for the written examinations have to be treated confidential. Nobody outside the preparation group and the EFNMS

observers shall be able to know anything about the questions prior to the actual examination.

2.3. The questionnaire

2.3.1. The examination for [A] above shall include questions that cover the subjects in the detailed specification. *All subjects under the heading "Very good knowledge" have to be covered by the questions.*

The examination for [B] above can consist of an article in English, where the maintenance management aspects are covered. To pass the examination a fully understanding of the article and the right translation of the maintenance terms has to be proved.

2.3.2. The questionnaire has to be arranged according to national university standards.

2.4. The National Examiner and the EFNMS observer

2.4.1. The National Examiner will be selected among the members of the group of professionals (defined in 2.2. I. above) and will be in charge for running the examination according to 2. I. above.

2.4.2. The selected EFNMS observer has to be a member of the EFNMS Certification Committee and belong to another National Society than the Society which conducts the examination.

The EFNMS observer shall understand the language in which the examination is done. His costs shall be paid by the Society which conducts the examination.

2.5. The evaluation of the examination

2.5.1. The evaluation of the examination has to be done by the National Examiner a member from the board of the National Society and the EFNMS observer.

2.5.2. The result has to be written down on each candidates answer form and signed by the National Examiner and the EFNMS observer (the EFNMS Examination Executor). *Unless both these signatures are present on the answer form, the examination result is not valid for the purpose of the EFNMS examination.*

2.5.3. The result of the examination is final and can not be a subject of any appeal against.

3. The requirements of practical experience

The applicant shall fulfil the following practical experiences:

At last 5 years experience in the field of maintenance, inclusive at least 2 years experience in a managing position in the field of maintenance. (At least one of these years should have occurred during the last 18 months.)

4. The EFNMS Certificate

The EFNMS will issue the Certificate (diploma), that will be signed by the EFNMS President, The National Society President and the EFNMS Examination Executor.

5. A register of Certified Experts in Maintenance Management

The EFNMS will make a register of all certified European Experts in Maintenance Management's that are certified according to these rules.

The names of the certified individuals may be published. (The names of those that not passed the test shall not be published.)

6. The certification costs

For each issued certificate the National Society has to pay 50 ECU to the EFNMS.

This amount and a sum for the administration of the National Society has to be paid by the applicant (student). (The sum for administration is to be decided by each National Society.)

7. Certificates from a National Maintenance Society

An individual who has fulfilled the requirement 2. [A] above will receive a national certificate from his (her) National Society that proves that he (she) has passed this examination.

Each national member society of the EFNMS has its right to issue a National Maintenance Society Certificate (diploma) as a "National Expert in Maintenance Management" for each national individual which has fulfilled the requirements 1., 2. [A] and 3 above. (The requirements regarding the English language and the EFNMS quality control are not included.)

The sum for administration to be paid by the applicant (student) is to be decided by each National Society