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Vzdrževanje - Vzdrževalni inženiring - Zahteve

Maintenance - Maintenance engineering - Requirements

Instandhaltung - Instandhaltungsengineering - Anforderungen

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English Version

Maintenance - Maintenance engineering - Requirements

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (prEN 17666:2021) has been prepared by Technical Committee CEN/TC 319 “Maintenance”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

Introduction

Maintenance engineering is a discipline applying competencies, methods, techniques and tools to develop and support maintenance in order to ensure that an item is able to perform its required functions in a safe, sustainable and cost-effective manner throughout the life cycle.

The prime objective of maintenance engineering is to contribute to the achievement of overall stakeholder requirements through optimized and cost-effective maintenance as part of physical asset management. The scale or scope of maintenance engineering varies depending on the complexity of the physical asset, its technical condition, the organization, and its degree of authority to influence design and maintenance.

The benefits of the contributions from maintenance engineering include, but are not limited to:

— achievement of maintainability and availability goals by influencing design;

— risk analysis related to maintenance;

— application of sustainability principles;

— achieved required integrity and safety level;

— achieved required performance and technical condition;

— improved life extension decisions;

— improved maintenance support performance;

— reduced environmental footprint by saving energy and raw materials consumption;

— improved competitiveness and output value.

This standard is generic and provides guidance on the methodology to achieve maintenance engineering objectives. The intended users of this standard are personnel involved in design, procurement, construction, commissioning, operation, improvement, maintenance and disposal/transition or decommissioning of physical assets. No specific structure or size of organization is assumed so that maintenance engineering effort should be tailored to suit specific applications and organisational requirements.

While maintenance engineering has the most impact when applied during the concept stage and design of a physical item, this standard is applicable to maintenance engineering in all life cycle stages, and for different scenarios, for example

— manufacturer producing one equipment and then maintaining it.

— transfer of property at commissioning to a buyer who will be in charge of maintenance.

— transfer of property at commissioning followed by a warranty period. The seller is responsible during the warranty and the buyer thereafter.

— maintenance service (sub) contract by the seller to the buyer or to a third party.

This standard is part of a group of standards published by CEN/TC 319 giving guidance on maintenance, see Annex B and the committee site on www.cen.eu: https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6300&cs=1A64AA79FCFDE906561AFDA09269B3123

1 Scope

This document describes the generic requirements, criteria and contents of maintenance engineering. This includes guidance on methods and techniques which are used to sustain the required functions of items at any stage of their life cycle.

This document gives guidance on how maintenance engineering can contribute to the assurance of required integrity, safety, reliability, maintainability and availability to achieve a sustainable balance between performance, risk and costs.

This document does not give guidance on how to set up systems and infrastructure to support the maintenance engineering function.

This document refers to standards that further describe detailed methods and techniques.

NOTE The overall maintenance process and management is covered by other CEN/TC 319 standards EN 17007 [10] and prEN (WG 8).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13306:2017, *Maintenance - Maintenance terminology*

EN 15628, *Maintenance - Qualification of maintenance personnel*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN 13306:2017, EN 15628 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
maintenance
combination of all technical, administrative and managerial actions during the *life cycle* (3.13) of an *item* (3.7) intended to retain it in, or restore it to, a state in which it can perform the *required function* (3.8)

Note 1 to entry: Technical maintenance actions include observation and analyses of the item state (e.g. inspection, monitoring, testing, diagnosis, prognosis, etc.) and active maintenance actions (e.g. repair, refurbishment).

Note 2 to entry: See also the definitions of improvement and modification in EN 13306 [2].

[SOURCE: EN 13306:2017, 2.1]

3.2
operation
combination of all technical, administrative and managerial actions, other than maintenance actions, that results in the item being in use

Note 1 to entry: Maintenance actions carried out by operators are not included in operation.

Note 2 to entry: In this document, operational and operations are used as synonyms.

[SOURCE: EN 13306:2017, 2.9]

3.3
engineering
branch of science and technology concerned with the design, building, use and disposal of engines, machines and structures

3.4
maintenance engineering
engineering (3.3) discipline applying *competencies* (3.10), methods, techniques and tools to develop and support *maintenance* (3.1) in order to assure that an *item* (3.7) is able to perform its *required functions* (3.8) in a safe, sustainable and *cost-effective* (3.6) manner throughout the *life cycle* (3.13)

3.5
maintenance management
all activities of the management that determine the *maintenance* (3.1) requirements, objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics

[SOURCE: EN 13306:2017, 2.2]

3.6
cost-effective
balance of cost, risk, opportunity and performance taking into account stakeholder objectives

Note 1 to entry: Performance covers quality, short and long term.

3.7
item
part, component, device, subsystem, functional unit, equipment or system that can be individually described and considered

Note 1 to entry: A number of items e.g. a population of items, or a sample, may itself be considered as an item.

Note 2 to entry: An item may consist of hardware, software or both.

Note 3 to entry: Software consists of programs, procedures, rules, documentation and data of an information processing system.

Note 4 to entry: Services is included.

Note 5 to entry: Systems may include people.

[SOURCE: EN 13306:2017, modified — Note 4 and 5 to entry are added]

3.8
required function
function, combination of functions, or a total combination of functions of an item which are considered necessary to fulfil a given requirement

Note 1 to entry: "Necessary to fulfil a given requirement" may also include asset value preservation.

Note 2 to entry: The given requirement may be expressed or implied and may in some cases be below the original design specifications.

Note 3 to entry: The required function, by implication, also covers what the item shall not do.

[SOURCE: EN 13306:2017, 2.6]

3.9
physical asset
item (3.7) that has potential or actual value to an organization

Note 1 to entry: Examples of physical assets are components, machines, plants, buildings, infrastructures, etc. Physical asset and technical system are often used as synonyms.

[SOURCE: EN 13306:2017, 3.2, modified — Added the last sentence in the note.]

3.10
competence

proven ability to use knowledge, *skills* (3.11), and personal, social and/or methodological abilities, in work or study situations and in professional and personal development

Note 1 to entry: Competence is described in the terms of responsibility and autonomy.

[SOURCE: EN 15628:2014, 3.1]

3.11
skills
ability to apply knowledge and use know-how to complete tasks and resolve problems

Note 1 to entry: Skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, tools and instruments).

3.12
criticality
<of a failure mode> numerical index of the severity of a failure or a fault combined with the probability or frequency of its occurrence

Note 1 to entry: The numerical index in this context may be defined, for example, as an area in the frequency of failure occurrence - severity matrix diagram (see Annex E in EN 13306:2017).

3.13
life cycle
series of stages through which an item goes, from its conception to disposal

EXAMPLE: A typical system lifecycle consists of acquisition, operation, maintenance, modernisation, decommissioning and/or disposal

Note 1 to entry: The stages identified will vary with the application. Reuse and recycle follows disposal.

[SOURCE: EN 13306:2017, 4.18]

3.14
life cycle cost
sum of the costs generated during the *life cycle* (3.13) of the *item* (3.7)

Note 1 to entry: For a user or an owner of an item, the total life cycle cost may include only those costs pertaining to acquisition, operation, maintenance and disposal.

[SOURCE: EN 13306:2017, 11.1]

3.15
indicator
quantitative or qualitative measure of a characteristic or a set of characteristics of a phenomenon or performance of activities, according to defined criteria or a given formula or questionnaire

Note 1 to entry: The indicators are a tool for development and implementation of a strategy for monitoring progress towards the goals outlined in the strategy.

[SOURCE: EN 15341:2019, 3.3]

3.16
key performance indicator
KPI
indicator (3.15) considered significant

[SOURCE: EN 15341:2019, 34]

3.17
maintenance plan
structured and documented set of tasks that include the activities, procedures, resources and the time scale required to carry out *maintenance* (3.1)

[SOURCE: EN-ISO 41011:2018, 2.5]

3.18
dependability
ability to perform as and when required

Note 1 to entry: Dependability includes *availability* (3.22), safety, security, durability, economics and their influencing factors (reliability, *maintainability* (3.21), *supportability* (3.19), conditions of use and operators influence).

Note 2 to entry: Dependability is used as a collective term for the time-related quality characteristics of an item.

[SOURCE: EN 13306:2017, 2.7, modified — In Note 1 to entry "maintenance support performance" is replaced by "supportability"]

3.19
supportability
ability to be supported to sustain the required availability with a defined operational profile and given logistic and maintenance resources

Note 1 to entry: Supportability of an item results from the inherent maintainability, combined with factors external to the item that affect the relative ease of providing the required maintenance and logistic support.

[SOURCE: IEC 60050-192:2015, 192-01-31]

3.20
integrated logistics support
ILS

management process to determine and coordinate the provision of all materials and resources required to meet the needs for operation and maintenance

Note 1 to entry: ILS is a process to determine the optimal maintenance support. ILS integrates logistics support analysis and the development of resources, see Annex A.

[SOURCE: IEC 60050-192: 2015, 192-01-30, modified — Note 1 to entry added]

3.21
maintainability
ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a *required function* (3.8), when *maintenance* (3.1) is performed under given conditions and using stated procedures and resources

Note 1 to entry: Maintainability may be quantified using appropriate measures or indicators and is then referred to as maintainability performance.

[SOURCE: EN 13306:2017, 4.5]

3.22
availability
ability of an item to be in a state to perform as and when required, under given conditions, assuming that the necessary external resources are provided

Note 1 to entry: Required external resources, other than maintenance resources, do not affect the availability of the item although the item may not be available from the user's viewpoint.

Note 2 to entry: This ability depends on the combined aspects of the reliability, maintainability of the item, the maintenance supportability and the maintenance actions carried out on the item.

Note 3 to entry: Availability may be quantified using appropriate measures or indicators and is then referred to as availability performance (see EN 13306:2017, 4.9).

Note 4 to entry: There are several types of availability, for example: *achieved availability* (3.23), *operational availability* (3.24) and *inherent availability* (3.25).

[SOURCE: EN 13306:2017, 4.7, modified — Note 4 to entry added]

3.23
achieved availability
probability than an item when used under stated conditions in an ideal support environment will operate in a satisfactorily at any point in time

3.24
operational availability
availability (3.22) experienced under actual conditions of operation and maintenance

Note 1 to entry: Operational availability is determined considering down time due to failures and associated delays, but excluding external causes.

[SOURCE: IEC 60050-192: 2015, 192-08-03]

3.25
inherent availability
availability (3.22) provided by the design under ideal conditions of operation and maintenance

Note 1 to entry: Delays associated with maintenance, such as logistic and administrative delays, are excluded.

[SOURCE: IEC 60050-192: 2015, 192-08-02]

3.26
process
set of interrelated or interacting activities that use inputs to deliver an intended result

Note 1 to entry: Whether the "intended result" of a process is called output, product or service depends on the context of the reference.

Note 2 to entry: Inputs to a process are generally the outputs of other processes and outputs of a process are generally the inputs to other processes.

Note 3 to entry: Two or more interrelated and interacting processes in series can also be referred to as a process.

Note 4 to entry: Processes in an organization are generally planned and carried out under controlled conditions to add value.

Note 5 to entry: A process where the conformity of the resulting output cannot be readily or economically validated is frequently referred to as a “special process”.

[SOURCE: EN ISO 9000:2015, 3.4.1 and EN 17007:2017, 3.12, modified — Note 6 to entry in the original definition from EN ISO 9000:2015 has been deleted.]

3.27
technique
way that a method is realized or implemented

[SOURCE: ISO/IEC 16500-8:1999, 3.25]

3.28
tool
hand-held item used to carry out operations in construction works

[SOURCE: ISO 6707-1:2017, 35.3.2]

3.29
predictive maintenance
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

[SOURCE: EN 13306:2017, 7.4]

3.30
stakeholder
person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity

[SOURCE: EN ISO 50001:2018, 3.1.5]

4 Symbols and abbreviations

For the purpose of this document, the following symbols and abbreviations apply.

AI	Artificial intelligence
CAPEX	Capital expense
CE	European conformity (Conformité Européene)
CBM	Condition based maintenance
CM	Corrective maintenance
FMEA	Failure modes and effects analysis
FMECA	Failure modes, effects and criticality analysis
HAZOP	Hazards and operability analysis
ICT	Information and communication technologies
ILS	Integrated logistics support
IEC	International electrotechnical commission (https://www.iec.ch/)
KPI	Key performance Indicator

LCA	Life cycle assessment
LCC	Life cycle costs
LCP	Life cycle profit
LORA	Level of repair analysis
PM	Preventive maintenance
PdM	Predictive maintenance
RAM	Reliability, availability and maintainability
RBI	Risk based inspection
RCA	Root cause analysis
RCM	Reliability centred maintenance
TTM	Total maintenance time

5 Maintenance engineering elements

5.1 Principles and objectives

5.1.1 General

Results from maintenance engineering shall be traceable and auditable.

The contribution of maintenance engineering depends on the detail of the solution and level within the asset hierarchy (single asset, asset system or asset portfolio) as shown in Figure 1.