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Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment

Industries du pétrole, de la pétrochimie et du gaz naturel — Collecte et échange de données de fiabilité et de maintenance des équipements



Reference number
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Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **2**

3 Terms and definitions **2**

4 Abbreviated terms **18**

5 Application **20**
5.1 Equipment coverage 20
5.2 Time periods 20
5.3 Users of this International Standard 20
5.4 Limitations 21
5.5 Exchange of RM data 22

6 Benefits of RM data collection and exchange **23**

7 Quality of data **25**
7.1 Obtaining quality data 25
7.1.1 Definition of data quality 25
7.1.2 Planning measures 25
7.1.3 Verification of quality 26
7.1.4 Limitations and problems 27
7.2 Data collection process 27
7.2.1 Data sources 27
7.2.2 Data collection methods 28
7.2.3 Organization and training 28

8 Equipment boundary, taxonomy and time definitions **29**
8.1 Boundary description 29
8.2 Taxonomy 30
8.3 Timeline issues 32
8.3.1 Surveillance and operating period 32
8.3.2 Data collection periods 33
8.3.3 Maintenance times 34

9 Recommended data for equipment, failures and maintenance **35**
9.1 Data categories 35
9.2 Data format 35
9.3 Database structure 36
9.3.1 Description 36
9.3.2 Logical structure 36
9.3.3 Database architecture 37
9.4 Equipment data 38
9.5 Failure data 40
9.6 Maintenance data 42
9.6.1 General 42
9.6.2 Maintenance categories 42
9.6.3 Reporting maintenance data 43

Annex A (informative) **Equipment-class attributes** **46**

Annex B (normative) **Interpretation and notation of failure and maintenance parameters** **176**

Annex C (informative) **Guide to interpretation and calculation of derived reliability and maintenance parameters** **205**

Annex D (informative) **Typical requirements for data** **229**

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Annex E (informative) **Key performance indicators (KPIs) and benchmarking** **238**
Annex F (informative) **Classification and definition of safety critical failures** **251**
Bibliography **260**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries.*

This third edition cancels and replaces the second edition (ISO 14224:2006), which has been technically revised. The main changes are:

— Clause 3 — several new definitions;

— Clauses 8 and 9 — changes in some figures and tables;

— Annex A — new equipment classes;

— Annex B — associated new and aligned failure modes;

— Annex C — some changes and new subclauses, e.g. C.3.4 and C.7;

— Annex D — new subclause D.5;

— Annex E — new KPIs;

— Annex F — alignment with ISO/TR 12489:2013.

This corrected version of ISO 14224:2016 incorporates various editorial corrections.

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Introduction

This International Standard has been prepared based on the previous edition (ISO 14224:2006), experience gained through its use, and know-how and best practices shared through the international development process.

In the petroleum, petrochemical and natural gas industries, great attention is being paid to safety, availability, reliability and maintainability of equipment. The industry annual cost of equipment unavailability is very large, although many plant owners have improved the availability of their operating facilities by addressing this challenge. A stronger emphasis has recently been put on cost-effective design and maintenance for new plants and existing installations among more industrial parties. In this respect, data on failures, failure mechanisms and maintenance related to these industrial facilities and its operations have become more important. It is necessary that this information is used by, and communicated between, the various parties and its disciplines, within the same company or between companies. Various analysis methodologies are used to estimate the risk of hazards to people and environment, or to analyse plant or system performance. For such analyses to be effective and decisive, equipment reliability and maintenance (RM) data are vital.

These analyses require a clear understanding of the equipment's technical characteristics, its operating and environmental conditions, its potential failures and its maintenance activities. It can be necessary to have data covering several years of operation before sufficient data have been accumulated to give confident analysis results and relevant decision support. It is necessary, therefore, to view data collection as a long-term activity, planned and executed with appropriate goals in mind. At the same time, clarity as to the causes of failures is key to prioritizing and implementing corrective actions that result in sustainable improvements in availability, leading to improved profitability and safety.

Data collection is an investment. Data standardization, when combined with enhanced data-management systems that allow electronic collection and transfer of data, can result in improved quality of data for reliability and maintenance. A cost-effective way of optimizing data requirements is through industry co-operation. To make it possible to collect, exchange and analyse data based on common viewpoints, a standard is required. Standardization of data collection practices facilitates the exchange of information between relevant parties e.g. plants, owners, manufacturers and contractors throughout the world.

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Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment

1 Scope

This International Standard provides a comprehensive basis for the collection of reliability and maintenance (RM) data in a standard format for equipment in all facilities and operations within the petroleum, natural gas and petrochemical industries during the operational life cycle of equipment. It describes data collection principles and associated terms and definitions that constitute a "reliability language" that can be useful for communicating operational experience. The failure modes defined in the normative part of this International Standard can be used as a "reliability thesaurus" for various quantitative as well as qualitative applications. This International Standard also describes data quality control and assurance practices to provide guidance for the user.

Standardization of data collection practices facilitates the exchange of information between parties, e.g. plants, owners, manufacturers and contractors. This International Standard establishes requirements that any in-house or commercially available RM data system is required to meet when designed for RM data exchange. Examples, guidelines and principles for the exchange and merging of such RM data are addressed. This International Standard also provides a framework and guidelines for establishing performance objectives and requirements for equipment reliability and availability performance.

Annex A contains a summary of equipment that is covered by this International Standard.

This International Standard defines a minimum amount of data that is required to be collected, and it focuses on two main issues:

— data requirements for the categories of data to be collected for use in various analysis methodologies;

— standardized data format to facilitate the exchange of reliability and maintenance data between plants, owners, manufacturers and contractors.

The following main categories of data are to be collected:

a) equipment data, e.g. equipment taxonomy, equipment attributes;

b) failure data, e.g. failure cause, failure consequence;

c) maintenance data, e.g. maintenance action, resources used, maintenance consequence, down time.

NOTE Clause 9 gives further details on data content and data format.

The main areas where such data are used are the following:

1) reliability, e.g. failure events and failure mechanisms;

2) availability/efficiency, e.g. equipment availability, system availability, plant production availability;

3) maintenance, e.g. corrective and preventive maintenance, maintenance plan, maintenance supportability;

4) safety and environment, e.g. equipment failures with adverse consequences for safety and/or environment.

This International Standard does not apply to the following:

i. data on (direct) cost issues;

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ii. data from laboratory testing and manufacturing (e.g. accelerated lifetime testing), see also 5.2;

iii. complete equipment data sheets (only data seen relevant for assessing the reliability performance are included);

iv. additional on-service data that an operator, on an individual basis, can consider useful for operation and maintenance;

v. methods for analysing and applying RM data (however, principles for how to calculate some basic reliability and maintenance parameters are included in the annexes).

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.

ISO 20815:2008, *Petroleum, petrochemical and natural gas industries — Production assurance and reliability management*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Some derived RM parameters, which can be calculated from collected RM data covered by this International Standard, are contained in Annex C. References to Annex C are given as deemed appropriate.

3.1
active maintenance time
duration of a maintenance action, excluding logistic delay

Note 1 to entry: Technical delays are included in the active maintenance time.

Note 2 to entry: See Figure 4 and Annex C for a more detailed description and interpretation of maintenance times. See also ISO/TR 12489:2013, Figure 5.

Note 3 to entry: A maintenance action can be carried out while the item is performing a required function.

[SOURCE: IEC 60050-192:2015, 192-07-04, modified – Notes 2 and 3 to entry have been added.]

3.2
active repair time
effective time to achieve repair of an item

Note 1 to entry: See also ISO/TR 12489:2013, Figures 5 and 6.

Note 2 to entry: See also definition of “mean active repair time (MART)” in ISO/TR 12489:2013, 3.1.34, that is defined as “expected active repair time”.

3.3
availability
ability to be in a state to perform as required

Note 1 to entry: See Annex C for a more detailed description and interpretation of availability.

Note 2 to entry: Further terms are given in ISO/TR 12489:2013.

[SOURCE: IEC 60050-192:2015, 192-01-23, modified – Notes 1 and 2 to entry have been added.]

3.4
boundary
interface between an item and its surroundings

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3.5
common cause failures
failures of multiple items, which would otherwise be considered independent of one another, resulting from a single cause

Note 1 to entry: Common cause failures can also be common mode failures.

Note 2 to entry: The potential for common cause failures reduces the effectiveness of system redundancy.

Note 3 to entry: It is generally accepted that the failures occur simultaneously or within a short time of each other.

Note 4 to entry: Components that fail due to a shared cause normally fail in the same functional mode. The term common mode is therefore sometimes used. It is, however, not considered to be a precise term for communicating the characteristics that describe a common cause failure.

Note 5 to entry: See also ISO/TR 12489:2013, 3.2.14 and 5.4.2.

Note 6 to entry: See also C.1.6

[SOURCE: IEC 60050-192:2015, 192-03-18, modified – Notes 3-6 to entry have been added.]

3.6
common mode failures
failures of different items characterized by the same failure mode

Note 1 to entry: Common mode failures can have different causes.

Note 2 to entry: Common mode failures can also be common cause failures (3.5).

Note 3 to entry: The potential for common mode failures reduces the effectiveness of system redundancy.

[SOURCE: IEC 60050-192:2015, 192-03-19, modified]

3.7
condition-based maintenance
CBM
preventive maintenance based on the assessment of physical condition

Note 1 to entry: The condition assessment can be by operator observation, conducted according to a schedule, or by condition monitoring of system parameters.

[SOURCE: IEC 60050-192:2015, 192-06-07, modified]

3.8
corrective maintenance
maintenance carried out after fault detection to effect restoration

Note 1 to entry: Corrective maintenance of software invariably involves some modification

Note 2 to entry: See also ISO/TR 12489:2013, Figures 5 and 6, which illustrate terms used for quantifying corrective maintenance.

[SOURCE: IEC 60050-192:2015, 192-06-06, modified – Note 2 to entry has been added.]

3.9
critical failure
failure of an equipment unit that causes an immediate cessation of the ability to perform a required function

Note 1 to entry: Includes failures requiring immediate action towards cessation of performing the function, even though actual operation can continue for a short period of time. A critical failure results in an unscheduled repair.

Note 2 to entry: See also definition of “critical dangerous failure” and “critical safe failure” in ISO/TR 12489:2013, 3.2.4 and 3.2.7, respectively.

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3.10
cycle
operation and subsequent release/reset

[SOURCE: IEC 60050-444:2002, 444-02-11]

3.11
degraded failure
failure that does not cease the fundamental function(s), but compromises one or several functions

Note 1 to entry: The failure can be gradual, partial or both. The function can be compromised by any combination of reduced, increased or erratic outputs. An immediate repair can normally be delayed but, in time, such failures can develop into a critical failure if corrective actions are not taken.

3.12
demand
activation of the function (includes functional, operational and test activation)

Note 1 to entry: See C.1.3 for a more detailed description.

Note 2 to entry: Annex F.3 gives a list of safety critical equipment which are subject to periodic testing.

Note 3 to entry: See also relevant definitions in ISO/TR 12489:2013: "mean time to demand (MTTD)" is defined in 3.1.38, "failure due to demand" is defined in 3.2.13, and "demand mode of operation safety system" is defined in 3.3.1.

3.13
design life
planned usage time for the total system

Note 1 to entry: It is important not to confuse design life with the 'mean time to failure' (MTTF), which is comprised of several items that might be allowed to fail within the design life of the system as long as repair or replacement is feasible.

[SOURCE: ISO 20815:2008, 3.1.5]

3.14
detection method
method or activity by which a failure is discovered

Note 1 to entry: A categorization of detection methods (e.g. periodic testing or continuous condition monitoring) is shown in Table B.4.

3.15
down state
unavailable state
internally disabled state
internal disabled state
<of an item> state of being unable to perform as required, due to internal fault, or preventive maintenance

Note 1 to entry: Down state relates to unavailability of the item.

Note 2 to entry: The adjectives "down" or "unavailable" designate an item in a down state.

Note 3 to entry: See also Table 4 and Figure 4.

Note 4 to entry: See also ISO/TR 12489:2013, Figures 5 and 6.

[SOURCE: IEC 60050-192:2015, 192-02-20, modified – Notes 3 and 4 to entry have been added.]

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3.16
down time
time interval during which an item is in a down state

Note 1 to entry: The down time includes all the delays between the item failure and the restoration of its service. Down time can be either planned or unplanned (see Table 4).

Note 2 to entry: Mean downtime is in IEC 60050-192, 192-08-10, defined as the 'expectation of the down time'.

[SOURCE: IEC 60050-192:2015, 192-02-21, modified - Notes 1 and 2 to entry have been added.]

3.17
downstream
business category most commonly used in the petroleum industry to describe post-production processes

EXAMPLE Refining, transportation and marketing of petroleum products

Note 1 to entry: See also A.1.4 for further details.

3.18
equipment class
class of similar type of equipment units (e.g. all pumps)

Note 1 to entry: Annex A contains equipment-specific data for the equipment covered in this International Standard.

3.19
equipment data
technical, operational and environmental parameters characterizing the design and use of an equipment unit

3.20
equipment type
particular feature of the design which is significantly different from the other design(s) within the same equipment class

3.21
equipment unit
specific equipment within an equipment class as defined by its boundary

Note 1 to entry: Equipment unit is given at level 6 of the equipment taxonomy classification with taxonomic levels shown in Figure 3.

3.22
error
discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition

Note 1 to entry: An error within a system can be caused by failure of one or more of its components, or by the activation of a systematic fault.

Note 2 to entry: An error can be caused by a faulty item, e.g. a computing error made by faulty computer equipment.

Note 3 to entry: In this International Standard, error is also specifically used for software and human errors.

[SOURCE: IEC 60050-192:2015, 192-03-02, modified – Notes 2 and 3 to entry have been added.]

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3.23
failure
<of an item> loss of ability to perform as required

Note 1 to entry: A failure of an item is an event that results in a fault of that item: see fault (3.22).

Note 2 to entry: A failure of an item is an event, as distinct from a fault of an item, which is a state [source: ISO/TR 12489:2013].

Note 3 to entry: This concept as defined does not apply to items consisting of software only.

Note 4 to entry: See Table B.1, and also F.2 and F.3.

[SOURCE: IEC 60050-192:2015, 192-03-01, modified – Notes 2 through 4 to entry have been added.]

3.24
failure cause
root cause
set of circumstances that leads to failure

Note 1 to entry: A failure cause can originate during specification, design, manufacture, installation, operation or maintenance of an item.

Note 2 to entry: See also B.2.3 and Table B.3, which define failure causes for all equipment classes.

[SOURCE: IEC 60050-192:2015, 192-03-11, modified – Note 2 to entry has been added.]

3.25
failure data
data characterizing the occurrence of a failure event

Note 1 to entry: See also Table 6.

3.26
failure due to demand
failure occurring on demand

Note 1 to entry: See further details in ISO/TR 12489:2013, 3.2.13.

[SOURCE: ISO/TR 12489:2013, modified – Note 1 to entry has been added.]

3.27
failure frequency
unconditional failure intensity; conditional probability per unit of time that the item fails between t and $t + \mathrm{d}t$, provided that it was working at time 0

Note 1 to entry: Another term used for failure frequency is “rate of occurrence”.

Note 2 to entry: See also ISO/TR 12489:2013, 3.1.22 and 3.1.23.

[SOURCE: ISO/TR 12489:2013, modified – Notes 1 and 2 to entry have been added.]

3.28
failure impact
effect of a failure on an equipment’s function(s) or on the plant

Note 1 to entry: On the equipment level, failure impact can be classified in three classes (critical, degraded, incipient); see definitions of “critical failure” (3.9), “degraded failure” (3.11) and “incipient failure” (3.40). Classification of failure impact on taxonomy levels 3 to 5 (see Figure 3) is shown in Table 3.

Note 2 to entry: Classification of failure impact on taxonomy levels 4 and 5 (see Figure 3) is shown in Table 3. See also C.1.10.

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3.29
failure mechanism
process that leads to failure

Note 1 to entry: The process can be physical, chemical, logical, or a combination thereof.

Note 2 to entry: See also B.2.2 and Table B.2, which define failure causes for all equipment classes.

[SOURCE: IEC 60050-192:2015, 192-03-12, modified – Note 2 to entry has been added.]

3.30
failure mode
manner in which failure occurs

Note 1 to entry: See also the tables in B.2.6, on the relevant failure modes which defines failure modes to be used for each equipment class

Note 2 to entry: Analysis might require data collection to be established on different taxonomy levels, see Table 3.

[SOURCE: IEC 60050-192:2015, 192-03-17, modified – Notes 1 and 2 to entry have been added.]

3.31
failure on demand
failure likely to be observed when a demand occurs

Note 1 to entry: Failure on demand includes the failures occurred before the demand and the failures due to the demand.

Note 2 to entry: See also C.6 on testing for hidden failures in safety systems.

Note 3 to entry: See also definition on *failure due to demand* (3.26).

Note 4 to entry: See ISO/TR 12489:2013, 3.1.15 for definition of the probability of failure on demand (PFD).

Note 5 to entry: Different failure modes are used to reflect failure on demand (see the tables in B.2.6).

[SOURCE: ISO/TR 12489:2013, modified – Notes 1 through 5 to entry have been added.]

3.32
failure rate
conditional probability per unit of time that the item fails between t and $t + \mathrm{d}t$, provided that it has been working over $[0, t]$

Note 1 to entry: See also definition of failure rate in ISO/TR 12489:2013, 3.1.18.

Note 2 to entry: See also definition of failure rate in IEC 60050-192:2015, 192-05-06 (instantaneous failure rate).

[SOURCE: ISO/TR 12489:2013, modified – Notes 1 and 2 to entry have been added.]

3.33
fault
inability to perform as required, due to an internal state

Note 1 to entry: A fault of an item results from a failure, either of the item itself, or from a deficiency in an earlier stage of the life cycle, such as specification, design, manufacture or maintenance. See *latent fault* (3.44).

Note 2 to entry: A fault is often a result of a failure of the item itself but the state can exist without a failure (see ISO 20815:2008, 3.1.14).

Note 3 to entry: See also ISO/TR 12489:2013, 3.2.2.

[SOURCE: IEC 60050-192:2015, 192-04-01, modified – Notes 2 and 3 to entry have been added.]

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3.34
generic reliability data
reliability data covering families of similar equipment

Note 1 to entry: See Annex D.5 and Table D.5.

3.35
hidden failure
failure that is not immediately evident to operations and maintenance personnel

Note 1 to entry: Equipment failures that occurred at an earlier point of time, but were first observed at demand, fall into this category. Such failures are first revealed when the relevant functionality is tested (activated).

Note 2 to entry: See definition with notes to entry in ISO/TR 12489:2013, 3.2.11.

Note 3 to entry: See also *latent fault* (3.44).

3.36
human error
discrepancy between the human action taken or omitted and that intended

EXAMPLE Performing an incorrect action; omitting a required action.

Note 1 to entry: Discrepancy with intention is considered essential in determining human error (see [303]).

Note 2 to entry: The term "human error" is often attributed in hindsight to a human decision, action or inaction considered to be an initiator or contributory cause of a negative outcome such as loss or harm.

Note 3 to entry: In human reliability assessment human error is defined as any member of a set of human actions or activities that exceeds some limit of acceptability, this being an out of tolerance action or failure to act where the limits of performance are defined by the system (see [298]).

Note 4 to entry: See also IEC 62508:2010 for further details.

Note 5 to entry: See also ISO/TR 12489:2013, 5.5.2.

[SOURCE: IEC 60050-192:2015, 192-03-14, modified – Notes 1 through 5 to entry have been added.]

3.37
human fatigue
loss of physiological and psychological function as a result of extended wakefulness, heavy work, excessive stimulation, illness or stress

Note 1 to entry: Human fatigue can be related to some of the failure causes in Table B.3, e.g. operating error.

[SOURCE: Moore-Ede M.:2009, modified – Note 1 to entry has been added.]

3.38
idle state
non-operating up state during non-required time

Note 1 to entry: The adjective "idle" designates an item in an idle state.

Note 2 to entry: In some applications, an item in an idle state has some functioning subsystems, and is therefore considered to be operating.

Note 3 to entry: The non-operating time comprises the idle time, the stand-by time and the externally disabled time

[SOURCE: IEC 60050-192:2015, 192-02-14, modified – Note 3 to entry has been added.]

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3.39
idle time
time interval for which the item is in an idle state

[SOURCE: IEC 60050-192:2015, 192-02-15]

3.40
incipient failure
imperfection in the state or condition of an item so that a degraded or critical failure might (or might not) eventually be the expected result if corrective actions are not taken

Note 1 to entry: The recording of incipient failure requires some criteria for when a fault of this nature requires registration as opposed to a state/condition where no corrective actions are required.

3.41
indenture level
level of subdivision of an item from the point of view of maintenance action

3.42
integrity
ability of a barrier to function as required when needed

Note 1 to entry: See 3.1.2 in ISO/TR 12489:2013 for definition of safety integrity.

Note 2 to entry: There are different definitions of integrity: plant, asset, system, pipeline, well (see ISO 16530-1:—, 2.73), mechanical, safety (see ISO/TR 12489:2013, 3.1.2), structural and technical.

3.43
item
subject being considered

Note 1 to entry: The item can be an individual part, component, device, functional unit, equipment, subsystem, or system.

Note 2 to entry: The item may consist of hardware, software, people or any combination thereof.

Note 3 to entry: In this International Standard, the common term “item” is used on all taxonomy levels 6 to 9 in Figure 3. See also 3.30, which defines a specific item level.

[SOURCE: IEC 60050-192:2015, 192-01-01, modified – Note 3 to entry has been added.]

3.44
latent fault
undetected fault
<of an item> fault that has not become apparent

Note 1 to entry: A latent fault can eventually be revealed by preventive maintenance or by a system failure.

[SOURCE: IEC 60050-192:2015, 192-04-08, modified]

3.45
life cycle
series of identifiable stages through which an item goes, from its conception to disposal

Note 1 to entry: See 5.2 for the purpose of data collection.

Note 2 to entry: See also ISO 20815:2008, Table 2 for the purpose of production assurance.

[SOURCE: IEC 60050-192:2015, 192-01-09, modified – Notes 1-2 to entry have been added.]

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3.46
logistic delay
delay, excluding administrative delay, incurred for the provision of resources needed for a maintenance action to proceed or continue

Note 1 to entry: Logistic delays can be due to, for example, travelling to unattended installations, pending arrival of spare parts, specialists, test equipment and information, and delays due to unsuitable environmental conditions (e.g. waiting on weather).

Note 2 to entry: See also ISO/TR 12489:2013, Figure 5.

[SOURCE: IEC 60050-192:2015, 192-07-13, modified – Notes 1 and 2 to entry have been added.]

3.47
maintainability
<of an item> ability to be retained in, or restored to a state to perform as required, under given conditions of use and maintenance

Note 1 to entry: Given conditions would include aspects that affect maintainability, such as: location for maintenance, accessibility, maintenance procedures and maintenance resources.

Note 2 to entry: Maintainability can be quantified using appropriate measures. See IEC 60050-192:2015, 192-07-Maintainability and maintenance support: measures.

Note 3 to entry: See Annex C for a more detailed definition and interpretation of maintainability.

[SOURCE: IEC 60050-192:2015, 192-01-27, modified – Note 3 to entry has been added.]

3.48
maintainable item
item that constitutes a part or an assembly of parts that is normally the lowest level in the equipment hierarchy during maintenance

3.49
maintenance
combination of all technical and management actions intended to retain an item in, or restore it to, a state in which it can perform as required

Note 1 to entry: See also definition of "maintenance" in ISO/TR 12489:2013, 3.4.1.

[SOURCE: IEC 60050-192:2015, 192-06-01, modified – Note 1 to entry has been added.]

3.50
maintenance concept
definition of the maintenance objectives, line of maintenance, indenture levels, maintenance levels, maintenance support, and their interrelationships

Note 1 to entry: The maintenance policy provides the basis for maintenance planning, determining supportability requirements, and developing logistic support.

Note 2 to entry: See also ISO/TR 12489:2013, 3.4.2.

[SOURCE: IEC 60050-192:2015, 192-06-02, modified – Note 2 to entry has been added.]

3.51
maintenance data
data characterizing the maintenance action planned or done

Note 1 to entry: Refers to the type of data dealt with in this International Standard.

Note 2 to entry: See also 9.6.3, Table 8.

Note 3 to entry: See also ISO/TR 12489:2013, Clause 3.

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3.52
maintenance impact
effect of the maintenance on the plant or equipment's function(s)

Note 1 to entry: On the equipment level, two classes of impact are defined: critical and non-critical. On plant level, three classes are defined: total, partial or zero impact.

3.53
maintenance man-hours
accumulated duration of the individual maintenance times used by all maintenance personnel for a given type of maintenance action or over a given time interval

Note 1 to entry: Maintenance man-hours are expressed in units of hours.

Note 2 to entry: As several people can work at the same time, man-hours are not directly related to other parameters like the "mean time to repair" and "mean down time".

3.54
maintenance plan
structured and documented set of tasks that include the activities, procedures, resources and the time scale required to carry out maintenance

Note 1 to entry: See also ISO/TR 12489:2013, 3.4.6.

[SOURCE: EN 13306:2010, 2.5, modified – Note 1 to entry has been added.]

3.55
maintenance record
part of maintenance documentation that contains all failures, faults and maintenance information relating to an item

Note 1 to entry: This record can also include maintenance costs, item availability or up time and any other data where relevant.

3.56
maintenance supportability
supportability
<of an item> 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 (3.47), combined with factors external to the item that affect the relative ease of providing the required maintenance and logistic support.

Note 2 to entry: See Annex C for further details regarding the interpretation of maintainability.

[SOURCE: IEC 60050-192:2015, 192-01-31, modified – Note 2 to entry has been added.]

3.57
mean cycles to failure
MCTF
expected number of cycles before the item fails

Note 1 to entry: See also C.3.4.

Note 2 to entry: Refer to definition of *cycle* (3.10).

3.58
mean number of cycles
expected number of cycles per time unit

Note 1 to entry: See also C.3.4.

Note 2 to entry: Refer to definition of *cycle* (3.10).

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3.59
mean active repair time
MART
expected active repair time

Note 1 to entry: The MART is the expected effective time to repair.

Note 2 to entry: See also definition of active repair time

[SOURCE: ISO/TR 12489:2013, 3.1.34, modified – Note 2 to entry has been added.]

3.60
mean elapsed time between failures
METBF
expected elapsed time between successive failures of a repairable item

Note 1 to entry: See further details in ISO/TR 12489:2013, 3.1.30.

Note 2 to entry: IEC 60050-192:2015, 192-05-13 defines mean operating time between failures (abbreviated by MTBF or MOTBF) as "expectation of the duration of the operating time between failures".

Note 3 to entry: See also Annex C.

3.61
mean overall repairing time
MRT
expected time to achieve the following actions:

- the time spent before starting the repair; and,
- the effective time to repair; and,
- the time before the item is made available to be put back into operation

Note 1 to entry: See ISO/TR 12489:2013, Figures 5 to 7.

[SOURCE: ISO/TR 12489:2013, 3.1.33]

3.62
mean time to failure
MTTF
expected time before the item fails

Note 1 to entry: See further details in ISO/TR 12489:2013, 3.1.29.

Note 2 to entry: IEC 60050-192:2015, 192-05-11, defines MTTF as "expectation of the operating time to failure".

Note 3 to entry: See also Annex C.

[SOURCE: ISO/TR 12489:2013, 3.1.29, modified – Notes 1 through 3 to entry have been added.]

3.63
mean time to repair
MTTR
expected time to achieve the repair of a failed item

Note 1 to entry: See further details in ISO/TR 12489:2013, 3.1.31.

Note 2 to entry: IEC 60050-192:2015 defines the term as "expectation of the time to restoration".

Note 3 to entry: See also definition of 'mean time to restoration' in ISO/TR 12489:2013, 3.1.32.

Note 4 to entry: In actual life the detection time is either 0 (immediately revealed failures) or unknown (failures detected by tests). Only MRT and MART can be collected.

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Note 5 to entry: See also C.5.5.2.

3.64
mean time to restoration
MTTRes
expected time to achieve the following actions:

a) the time to detect the failure; and,

b) the time spent before starting the repair; and,

c) the effective time to repair; and,

d) the time before the component is made available to be put back into operation

Note 1 to entry: See further details in ISO/TR 12489:2013, 3.1.32.

Note 2 to entry: See also ISO/TR 12489:2013, Figures 5 to 7.

Note 3 to entry: See also definition of "mean overall repairing time" and "mean active repair time" in ISO/TR 12489:2013, 3.1.33 and 3.1.34, respectively.

Note 4 to entry: Mean time to restoration is abbreviated as MTTR in IEC 60050-192:2015, 192-07-23.

[SOURCE: ISO/TR 12489:2013, 3.1.32, modified – Notes 1 through 4 to entry have been added.]

3.65
midstream
business category involving the processing, storage and transportation sectors of the petroleum industry

EXAMPLE Transportation pipelines, terminals, gas processing and treatment, LNG, LPG and GTL.

Note 1 to entry: See also A.1.4 for further details.

3.66
mobilization time
time to get all necessary resources available to execute maintenance

Note 1 to entry: Time spent before starting the maintenance is dependent on access to resources e.g. spare parts, tools, personnel, subsea intervention and support vessels.

Note 2 to entry: See also ISO/TR 12489:2013, Figure 5 and Figure 7.

3.67
modification
combination of all technical and administrative actions intended to change an item

Note 1 to entry: Modification is not normally a part of maintenance, but is frequently performed by maintenance personnel.

Note 2 to entry: Care is needed in the collection and analysis of RM data to distinguish between maintenance due to failures and maintenance due to equipment modification.

Note 3 to entry: See also Table B.5.

3.68
non-critical failure
failure of an equipment unit that does not cause an immediate cessation of the ability to perform its required function

Note 1 to entry: Non-critical failures can be categorized as "degraded" or "incipient" (see separate definitions on degraded failure and incipient failure).

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Note 2 to entry: The term “critical” does not have the same meaning in ISO/TR 12489:2013 as in this International Standard; see further details in F.4.1.

3.69
operating state
<of an item> state of performing as required

Note 1 to entry: See also Table 4.

Note 2 to entry: In some applications, an item in an idle state is considered to be operating.

[SOURCE: IEC 60050-192:2015, 192-02-04, modified – Note 1 to entry has been added.]

3.70
operating time
time interval during which an item is in an operating state

Note 1 to entry: The duration of operating time can be expressed in units appropriate to the item concerned, e.g. calendar time, operating cycles, distance covered, and the units should always be clearly stated.

Note 2 to entry: Operating time includes actual operation of the equipment or the equipment being available for performing its required function.

Note 3 to entry: See also Table 4.

Note 4 to entry: The point in time of start-up time can differentiate depending on item subject to data collection, and could start from time of installation, time of commissioning, or time of start of service/production/injection.

[SOURCE: IEC 60050-192:2015, 192-02-05, modified – Note 1 to entry has been amended and notes 2 through 4 to entry have been added.]

3.71
opportunity maintenance
maintenance of an item that is deferred or advanced in time and is performed when an unplanned opportunity becomes available

3.72
performance objective
indicative level for the desired performance

Note 1 to entry: See further details in ISO 20815:2008, 3.1.32 and Annex F.

[SOURCE: ISO 20815:2008, 3.1.32, modified – Note 1 to entry has been added.]

3.73
performance requirement
required minimum level for the performance of a system

Note 1 to entry: Requirements are normally quantitative but can also be qualitative.

[SOURCE: ISO 20815:2008, 3.1.33, modified]

3.74
periodic test
proof test
planned operation performed at constant time intervals in order to detect the potential hidden failures which can have occurred in the meantime

Note 1 to entry: The unsafe hidden failures of a safety system which are not detected by the diagnostic tests can be detected by periodic tests. Such tests are named “proof tests” in the standards dealing with functional safety (e.g. IEC 61508-4:2010, 3.8.5).

Note 2 to entry: See ISO/TR 12489:2013, 3.4.8, 3.4.9 and 3.4.10 for further details.

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[SOURCE: ISO/TR 12489:2013, 3.4.8, modified – Note 2 to entry has been added.]

3.75
petrochemical
business category producing chemicals derived from petroleum and used as feedstock for the manufacture of a variety of plastics and other related products

EXAMPLE Methanol and polypropylene.

Note 1 to entry: See A.1.4 for further details.

3.76
planned maintenance
scheduled maintenance
planned preventive maintenance
maintenance carried out in accordance with a specified time schedule

Note 1 to entry: Scheduled maintenance can identify the need for some corrective maintenance action.

[SOURCE: IEC 60050-192:2015, 192-06-12, modified]

3.77
predictive maintenance
PdM
maintenance based on the prediction of the future condition of an item estimated or calculated from a defined set of historic data and known future operational parameters

Note 1 to entry: See 9.6, Table B.4 and B.5, and also Table E.3.

3.78
preventive maintenance
PM
maintenance carried out to mitigate degradation and reduce the probability of failure

Note 1 to entry: See also condition-based maintenance, and planned (scheduled) maintenance.

[SOURCE: IEC 60050-192:2015, 192-06-05]

3.79
random failure
failure, occurring in a random way

[SOURCE: ISO/TR 12489:2013]

3.80
redundancy
existence of more than one means for performing a required function of an item

Note 1 to entry: See C.1.2 for further details, where passive (cold), active (hot) standby and mixed redundancy are described.

Note 2 to entry: Redundancy in IEC 61508 is called “fault tolerance”.

Note 3 to entry: IEC 60050-192:2015, 192-10-02 defines redundancy as “provision of more than one means for performing a function”.

3.81
reliability
ability of an item to perform a required function under given conditions for a given time interval

Note 1 to entry: The term “reliability” is also used as a measure of reliability performance and can also be defined as a probability; see ISO/TR 12489:2013, 3.1.8.

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Note 2 to entry: See also Annex C.

Note 3 to entry: IEC 60050-192:2015, 192-01-24 defines reliability as "ability to perform as required, without failure, for a given time interval, under given conditions".

Note 4 to entry: The examples of equipment specific data in Annex A list technical and operational conditions that can cause differences in equipment reliability performance.

3.82
reliability data
data for reliability, maintainability and maintenance support performance

[SOURCE: ISO 20815:2008, 3.1.42]

3.83
required function
function or combination of functions of an item that is considered necessary to provide a given service

3.84
safety critical equipment
equipment and items of permanent, temporary and portable equipment playing an important role in safety systems/functions

3.85
safety critical failure
critical dangerous failures that are undetected

EXAMPLE Failures revealed by periodic tests.

Note 1 to entry: Critical dangerous failures are in ISO/TR 12489:2013, 3.2.4 defined as "dangerous failure leading to the complete inhibition of the safety action (i.e., leading to a dangerous situation for the protected system)".

Note 2 to entry: See also Annex F, and specifically F.4.1. regarding the indicator "failure fraction".

[SOURCE: ISO/TR 12489:2013, notes 1 and 2 to entry have been added.]

3.86
safety system
system which is used to implement one or more safety functions

Note 1 to entry: Safety function is in ISO/TR 12489:2013, 3.1.6 defined as "function which is intended to achieve or maintain a safe state, in respect of a specific hazardous event'.

Note 2 to entry: Systems with safety functions are defined in ISO/TR 12489:2013, Annex A. These systems are also cross-related in Table A.3.

[SOURCE: ISO/TR 12489:2013, 3.1.7, modified – Notes 1 and 2 to entry have been added.]

3.87
software error
erroneous result produced by the use of software product

EXAMPLE Bad code in a computer program resulting in an error.

Note 1 to entry: See Table B.2 for list of relevant equipment failure mechanisms.

Note 2 to entry: See also ISO/TR 12489:2013, B.3, and Note 5 to entry 3.2.17 (Systematic failure) in ISO/TR 12489:2013.

Note 3 to entry: See also definition of "error" (3.22).

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3.88
subunit
assembly of items that provides a specific function that is required for the equipment unit within the main boundary to achieve its intended performance

3.89
surveillance period
interval of time (calendar time) between the start date and end date of RM data collection

Note 1 to entry: See Annex C for further details.

Note 2 to entry: Surveillance time in data collection is a part of the total accumulated operating time (see definition of operating time).

3.90
systematic failure
failure that consistently occurs under particular conditions of handling, storage or use

Note 1 to entry: See also Annex F.

Note 2 to entry: See also further details in ISO/TR 12489:2013, 3.2.17.

Note 3 to entry: Reliability data covers random and systematic failures as described in ISO/TR 12489:2013, Figure B.5.

[SOURCE: ISO/TR 12489:2013, 3.2.17, modified – Notes to entry 1 to 3 have been added.]

3.91
tag number
unique code that identifies the equipment function and its physical location

Note 1 to entry: See Annex C for more detailed definitions and interpretations.

Note 2 to entry: Normally includes the system for which it belongs. The systems covered are shown in Table A.3.

Note 3 to entry: Also entitled "functional location" in some CMMIS.

Note 4 to entry: The equipment is allocated to a tag for only so long as it occupies that function and location. See also footnote b in Table 5.

3.92
taxonomy
systematic classification of items into generic groups based on factors possibly common to several of the items

3.93
trip
shutdown of machinery from normal operating condition to full stop

Note 1 to entry: Trip: The shutdown is activated automatically by the control/monitoring system:

- real trip The shutdown is effectuated as a result of a monitored (or calculated) value in the control system exceeding a pre-set limit;
- spurious trip Unexpected shutdown resulting from failure(s) in the control/monitoring system or error(s) imposed on the control/monitoring system originating from the environment or people.

Note 2 to entry: See also ISO/TR 12489:2013, 3.4.14.

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3.94
turnaround
revision shutdown
planned event wherein an entire process unit is taken off stream for revamp or renewal

Note 1 to entry: See also ISO 20815:2008, Table G.1.

3.95
uncertainty
<of a quantity> inability to determine accurately what is or will be the true value of a quantity

Note 1 to entry: Uncertainty can have different meanings within reliability data collection and exchange. It can be used as a measure of variability within a population, which is a type of uncertainty often referred to as stochastic (or aleatory) uncertainty. Uncertainty can also have a subjective meaning (epistemic uncertainties).

3.96
up state
available state
<of an item> state of being able to perform as required

Note 1 to entry: Up state relates to the availability performance of the item.

Note 2 to entry: See also ISO/TR 12489:2013, Figure 5.

[SOURCE: IEC 60050-192:2015, 192-02-01, modified – Notes 1 and 2 to entry have been added.]

3.97
up time
time interval during which an item is in an up state

Note 1 to entry: See also ISO/TR 12489:2013, Figure 3.

Note 2 to entry: Mean up time is defined in IEC 60050-192:2015 as “expectation of the up time”.

3.98
upstream
business category of the petroleum industry involving exploration and production

EXAMPLE Offshore oil/gas production facility, drilling rig, intervention vessel.

Note 1 to entry: See also A.1.4 for further details.

4 Abbreviated terms

NOTE Some specific abbreviations used for equipment types (e.g. BOP) and units (e.g. kW) are not included in this clause, but covered within each clause/sub-clause where they are used. There are also some abbreviations used in the document (see e.g. Table D.1), which are not included in this clause.

CAPEX	capital expenditure
CBM	condition-based maintenance
CDF	cumulative distribution function
CM	condition monitoring
CMMIS	computerized maintenance-management information system
DHSV	downhole safety valve
ESD	emergency shutdown

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