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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 20815

Oil and gas industries including lower carbon energy — Production assurance and reliability management

*Industries du pétrole, de la pétrochimie et du gaz naturel —
Assurance production et gestion de la fiabilité*

ICS: 75.180.01; 75.200

ISO/TC 67

Secretariat: **NEN**

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This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
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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 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*.

This third edition cancels and replaces the second edition (ISO 20815:2018), which has been technically revised. The main changes are as follows:

- [Clause 3](#): several new terms, definitions and abbreviations;
- [Clause 4](#): changes in [Clause 4.1](#), new [Clause 4.2.2](#), revised [Figure 5](#) and [Table 2](#);
- Main clauses and [Annex A](#): establishment and use of production assurance programme or reliability management programme will both imply conformance of this document;
- [Annex A](#): minor changes;
- [Annex B](#) and [C](#): changes to align with production assurance processes for life cycle phases in revised [Table 2](#);
- [Annex A](#) and [Annex E](#) are made normative;
- [Annex D](#): various new text and new figures;
- [Annex F](#): revised figure in [Clause F.2](#), new text in [Clauses F.3](#) and [F.4](#);
- [Annex G](#): various changes made to reflect the relationship to ISO/TS 3250:2021. Some text in the second edition (ISO 20815:2018) has been removed since the next edition of ISO/TS 3250 is planned to cover production loss categories for also midstream, downstream and petrochemical;
- [Annex H](#): some changes;
- [Annex I](#): various changes in [Clauses I.1](#), [I.7](#) to [I.10](#), [I.18](#), [I.20](#) to [I.26](#).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The oil and gas industries including petrochemical and lower carbon energy activities involve large capital expenditure (CAPEX) as well as operating expenditure (OPEX). The safety and the profitability of the associated assets are dependent upon the reliability, availability and maintainability of the systems and components that are used. Therefore, for optimal production availability to deliver affordable energy in a sustainable manner, standardized and integrated production assurance and reliability management are essential.

The concept of production assurance, introduced in this document, enables a common understanding with respect to use of reliability technology in the various life cycle phases and covers the activities implemented to achieve and maintain a performance level that is at its optimum in terms of the overall economy and, at the same time, consistent with applicable regulatory requirements and framework conditions.

The normative [Annex A](#) and [Annex E](#), and the informative annexes support this standardization concept for industry stakeholders.

Oil and gas industries including lower carbon energy — Production assurance and reliability management

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document describes the concept of production assurance within the assets and operations associated with exploration drilling, exploitation, processing and transport of petroleum, petrochemical and natural gas resources. This document covers assets and associated activities for upstream, midstream, downstream and petrochemical business categories. It focuses on production assurance of oil and gas production, processing and associated activities and covers the analysis of reliability and maintenance of the components. This includes a variety of business categories and associated systems/equipment in the oil and gas value chain. Production assurance addresses not only hydrocarbon production, but also associated activities such as drilling, pipeline installation and subsea intervention.

This document also supports production assurance and reliability management for lower carbon energy assets and associated operations, e.g., carbon capture and storage (CCS), hydrogen, ammonia, and wind energy. This document provides processes and activities, requirements and guidelines for systematic management, effective planning, execution and use of production assurance and reliability technology. This is to achieve cost-effective solutions over the life cycle of an asset development project structured around the following main elements:

- production assurance management for optimum economy of the facility through all of its life cycle phases, while also considering constraints arising from health, safety, environment, and quality;
- planning, execution and implementation of reliability technology;
- application of reliability and maintenance data;
- reliability-based technology development, design and operational improvement.

The IEC 60300-3 series addresses equipment reliability and maintenance performance in general.

This document designates 12 processes, of which seven are defined as core production assurance processes and addressed in this document. The remaining five processes are denoted as interacting processes and are outside the scope of this document. The interaction of the core production assurance processes with these interacting processes, however, is within the scope of this document as the information flow to and from these latter processes is required to ensure that production assurance requirements can be fulfilled.

This document specifies how to establish and execute the production assurance programme (PAP) and/or a reliability management programme (RMP). It is important to reflect the PAP and/or RMP in the overall project management in the project for which they apply. The PAP is generally used for an entire asset or a project by an operator. The RMP typically applies for a contractor or a vendor/manufacturer/supplier for their scope of work in a project. See [Annex A](#) for further guidance for preparing PAP and/or RMP.

This document also recommends that the listed processes and activities be initiated only if they can be considered to add value for the stakeholder (e.g. operator), but the selected process can depend on their business strategy and application area.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14224:2016, *Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment*

ISO/TS 3250:2021, *Petroleum, petrochemical and natural gas industries — Calculation and reporting production efficiency in the operating phase*

ISO 15663:2021, *Petroleum, petrochemical and natural gas industries — Life cycle costing*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

active repair time

effective time to achieve repair of an *item* (3.1.28)

Note 1 to entry: The expectation of the effective time to repair is called MART (mean active repair time).

Note 2 to entry: ISO 14224:2016 distinguishes between the terms mean active repair time (MART), mean time to repair (MTTR), mean time to restoration (MTTRes), and mean overall repairing time (MRT). See ISO 14224:2016, 3.59, 3.63, 3.64 and 3.61 for further details.

Note 3 to entry: The mean active repair time (MART) is defined as “expected active repair time” in ISO/TR 12489:2013, 3.1.34. See also ISO/TR 12489:2013, Figures 5 and 6.

[SOURCE: ISO 14224:2016, 3.2, modified — Notes 1 to 2 to entry have been adjusted, and Note 3 to entry has been added.]

3.1.2

asset

item (3.1.28), thing or entity that has potential or actual value to an organization

Note 1 to entry: Assets can be physical or non-physical.

Note 2 to entry: A grouping of assets referred to as an ‘asset system’ (see ISO 55000:2024, 3.1.6) can also be considered as an asset.

Note 3 to entry: In this document, ‘asset’ only refers to the physical assets, which are tangible assets. An organization can also operate assets that are wholly owned or partly owned through joint ventures or other arrangements. Typically, an asset is a facility or an installation, or a group of facilities. The facility corresponds to an installation category in ISO 14224:2016, Table A.1. These installations can be subdivided into plant/units, *systems* (3.1.72), equipment classes (see ISO 14224, 3.18), subunits, components, etc. as described in ISO 14224:2016, Table 2.

[SOURCE: ISO 55000:2024, 3.1.1, modified — Note 3 to entry has been added.]

3.1.3**availability**

ability to be in a state to perform as required

Note 1 to entry: For a binary item, the measure of the availability is the probability to be in up state (i.e. in a state belonging to the up state class), see [3.1.76](#).

Note 2 to entry: [Figure 1](#) shows a system that is available at time t_1 and unavailable at time t_2 .

Note 3 to entry: See ISO 14224:2016, Annex C for a more detailed description and interpretation of availability.

Note 4 to entry: *Technical availability* ([3.1.73](#)) or *operational availability* ([3.1.49](#)) can be used as derived performance measures to reflect estimate availability. Case specific definition of system availability is needed to reflect the *system* ([3.1.72](#)) being addressed.

Note 5 to entry: Further terms are given in ISO/TR 12489:2013.

Note 6 to entry: See [Figure G.1](#) for further information.

[SOURCE: IEC 60050-192:2015, 192-01-23, modified — Notes 1 to 6 to entry have been added.]

3.1.4**average availability****mean availability**

$A(t_1, t_2)$

average value of the *instantaneous availability* ([3.1.25](#)) over a given time interval (t_1, t_2)

Note 1 to entry: The average availability is the ratio between the accumulated time spent in up state and the length of the considered period of observation. For example, [Figure 1](#) shows the average availability of the system over the interval $[0, t_3]$ is equal to $(\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 + \delta_6 + \delta_8 + \delta_9)/t_3$, i.e., $1 - \delta_7/t_3$ where δ_7/t_3 is the average unavailability of the system. This formula is similar to the formula obtained for production availability calculations when only two levels, 100 % and 0 %, are considered.

Note 2 to entry: The average availability may be interpreted as the long-run proportion of time where the item is able to function. Mathematically speaking, the average availability is the mathematical expectation of the term *availability* ([3.1.3](#)), as this term does not have the mathematical property of a normal probability and cannot be handled as such.

[SOURCE: IEC 60050-192:2015, 192-08-01, modified — Notes 1 and 2 to entry have been added.]

3.1.5**barrier**

functional grouping of safeguards or controls selected to prevent a *major accident* ([3.1.39](#)) or limit the consequences

[SOURCE: ISO 17776:2016, 3.1.1, modified — Notes to entry not included.]

3.1.6**binary item**

item ([3.1.28](#)) with two classes of states

Note 1 to entry: The two classes can be *up state* ([3.1.76](#)) and *down state* ([3.1.14](#)).

EXAMPLE 1 An item that only have an up state and a down state is a binary item. Components A and B in [Figure 1](#) are binary items.

EXAMPLE 2 A system made up of two redundant binary items, A and B, has four states: S_1 (both A and B in up state), S_2 (A in up state and B in down state), S_3 (A in down state and B in up state), S_4 (both A and B in down state). If the system is able to operate as required in states S_1 , S_2 and S_3 and not able in state S_4 , it is a binary item with the up state class $\{S_1, S_2, S_3\}$ and the down class $\{S_4\}$. This is illustrated in [Figure 1](#).

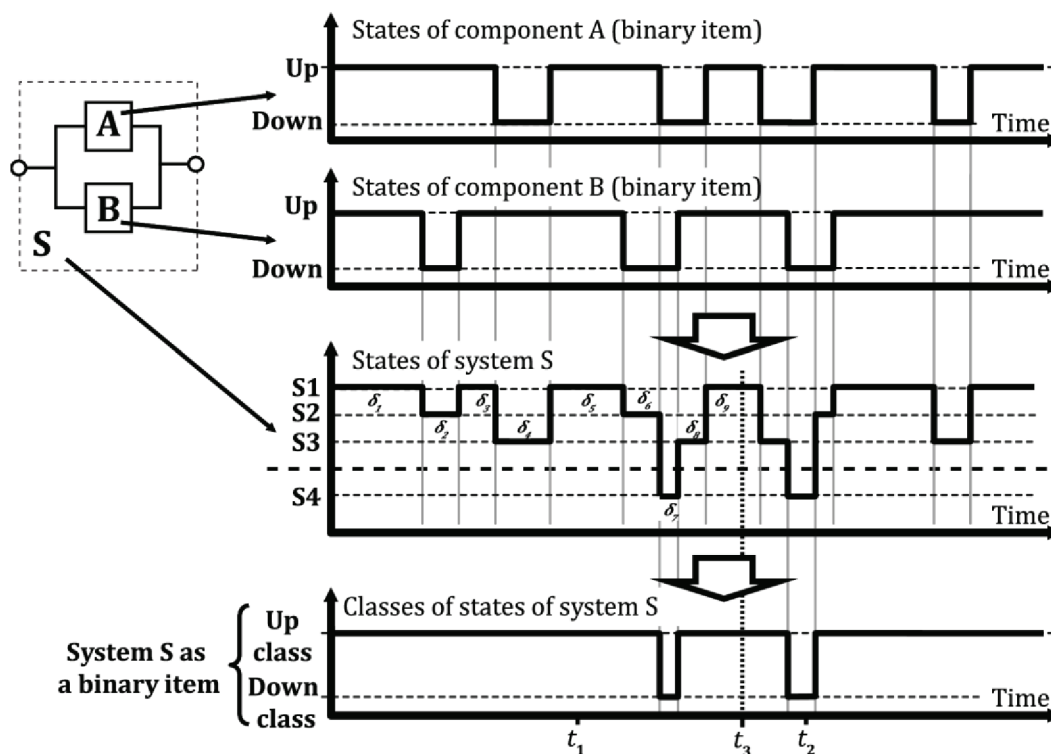


Figure 1 — Illustration of availability behaviour of an 1oo2 system

3.1.7

capital expenditure

CAPEX

investment used to purchase, install and commission an *asset* (3.1.2)

Note 1 to entry: See further information regarding estimation of CAPEX in ISO 15663:2021, C.2.

[SOURCE: ISO 15663:2021, 3.1.7]

3.1.8

common cause failure

failures of multiple *items* (3.1.28), which would otherwise be considered independent of one another, resulting from a single cause

Note 1 to entry: See also Notes to entry for common cause failures in ISO 14224:2016, 3.5.

[SOURCE: IEC 60050-192:2015, 192-03-18, modified — Note 1 to entry has been added.]

3.1.9

condition monitoring

obtaining information about physical state or operational parameters

Note 1 to entry: Condition monitoring is used to determine when preventive maintenance may be required.

Note 2 to entry: Condition monitoring may be conducted automatically during operation or at planned intervals.

Note 3 to entry: Condition monitoring is part of condition-based maintenance. See also ISO 14224:2016, Figure 6.

[SOURCE: IEC 60050-192:2015, 192-06-28, modified — Note 3 to entry has been added.]

3.1.10**corrective maintenance**

maintenance ([3.1.35](#)) carried out after fault detection to effect restoration

Note 1 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 1 to entry has been added.]

3.1.11**deliverability**

ratio of deliveries to planned deliveries over a specified period of time, when the effect of compensating elements, such as substitution from other producers and *downstream* ([3.1.16](#)) buffer storage, is included

Note 1 to entry: See [Figure G.1](#) for further information.

3.1.12**design life**

planned usage time for the total *system* ([3.1.72](#))

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.

Note 2 to entry: The design life is decided during the life cycle phase 'Define'. Design life in this document can thus mean a lifetime that can change and that can be chosen based on production assurance activities or life cycle costing.

3.1.13**demand availability**

ability of the production facility to satisfy the demand over a specified period of time

Note 1 to entry: This performance measure expressed the fraction of time or number of times the produced volume that is exported is equal to or above demand. See also [Table G.1](#).

3.1.14**down state****unavailable state****internally disabled state****internal disabled state**

state of being unable to perform as required, due to internal *fault* ([3.1.22](#)), or *preventive maintenance* ([3.1.54](#))

Note 1 to entry: This concept is related to a *binary item* ([3.1.6](#)), which can have several down states forming the down state class of the item. All the states in the down state class are considered to be equivalent with regard to the unavailability of the considered item.

Note 2 to entry: See also Notes to entry for down state in ISO 14224:2016, 3.15.

EXAMPLE In [Figure 1](#), the down state class of the system S comprises only one state $\{S_4\}$ and the system S is in down state at time t_2 .

[SOURCE: IEC 60050-192:2015, 192-02-20, modified — Notes 1 and 2 have been added.]

3.1.15**down time**

time interval during which an *item* ([3.1.28](#)) is in a *down state* ([3.1.14](#))

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 ISO 14224:2016, Table 4).

Note 2 to entry: Down time can be equipment down time (see Figure 4 and Table 4 in ISO 14224:2016), production down time (see [Figures I.1](#) and [I.2](#)) or down time for other operations (e.g. drilling). It is important to distinguish between the equipment down time itself and the down time of the plant to which the equipment belongs.

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

3.1.16

downstream

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

Note 1 to entry: See ISO 14224:2016, A.1.4 for further details.

[SOURCE: ISO 14224:2016, 3.17]

3.1.17

failure

loss of ability to perform as required

Note 1 to entry: A failure of an item is an event that results in a fault (i.e. a state) of that item. This is illustrated in [Figure 2](#) for a binary system S comprising two redundant components A and B.

[SOURCE: IEC 60050-192:2015, 192-03-01, modified — Note 1 to entry has been added.]

3.1.18

failure cause

root cause

set of circumstances that leads to *failure* ([3.1.17](#))

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 ISO 14224:2016, 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.]

3.1.19

failure data

data characterizing the occurrence of a failure event

Note 1 to entry: See also ISO 14224:2016, Table 6.

[SOURCE: ISO 14224:2016, 3.25]

3.1.20

failure mode

manner in which *failure* ([3.1.17](#)) occurs

Note 1 to entry: See also the tables in ISO 14224:2016, B.2.6, on the relevant failure modes, which define failure modes to be used for each equipment class.

[SOURCE: IEC 60050-192:2015, 192-03-17, modified — Note 1 to entry has been added.]

3.1.21

failure rate

conditional probability per unit of time that the *item* ([3.1.28](#)) fails between t and $t + dt$, provided that it has been working over $(0, t)$

Note 1 to entry: See ISO 14224:2016, C.3 for further explanation of the failure rate.

Note 2 to entry: This definition applies for the first failure of binary items ([3.1.4](#)).

Note 3 to entry: Under the assumptions that the failure rate is constant and that the item is as good as new after repairs the failure rate can be estimated as the number of failures relative to the corresponding accumulated up time divided by this accumulated up time. In this case this is the reciprocal of *MTTF* ([3.1.40](#)). In some cases, time can be replaced by units of use.

Note 4 to entry: The estimation of the failure rate can be based on operating time or calendar time.

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

3.1.22

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' (ISO 14224:2016, 3.44). The down states of items A, B and S in [Figure 2](#) are examples of faults.

Note 2 to entry: An item made of several sub-items (e.g. a system) which continues to perform as required in presence of faults of one or several sub-items is called fault tolerant.

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

[SOURCE: IEC 60050-192:2015, 192-04-01, modified — Note 2 to entry has been added.]

3.1.23

fault tolerance

attribute of an *item* ([3.1.28](#)) that makes it able to perform a required function in the presence of certain given sub-item *faults* ([3.1.22](#))

3.1.24

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 Reference [\[87\]](#).

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 Reference [\[84\]](#)).

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.]

3.1.25

instantaneous availability

$A(t)$

probability that an *item* ([3.1.28](#)) is in a state to perform as required at a given instant

[SOURCE: IEC 60050-192:2015, 192-08-01]

3.1.26

integrity

condition in which an *asset* ([3.1.2](#)) is safe and reliable for its purpose

Note 1 to entry: For some application areas, more specific terms and definitions exist. such as asset integrity (see ISO/TS 3250:2021, 3.1.2), mechanical integrity, plant integrity, safety integrity (see ISO/TR 12489:2013, 3.1.2), structural integrity (see ISO 19900:2019, 3.50), system integrity, technical integrity and well integrity (see ISO/DIS 16530-1:2025, 3.73) . These integrity terms can encompass various failure consequences (e.g., safety, environmental, production, and operation; see ISO 14224:2016, Table C.2).

Note 2 to entry: Integrity is also defined for use in pipeline integrity management for onshore gas infrastructure in EN 17649:2022, 3.7. see also DNV-ST-F101:2017 and ISO 19345-1:2019, 3.1.32.

Note 3 to entry: The integrity can be expressed mathematically by using specific performance measures as described in [Annex G](#).

[SOURCE: EN 17349:2022, 3.7, modified — Notes 1 to 3 to entry have been added.]

3.1.27

integrity management

set of processes and procedures used to proactively manage the safe, environmentally responsible and reliable service of an *asset* (3.1.2) throughout its life cycle

Note 1 to entry: The integrity management program covers a set of processes and practises used in reliability management. See e.g. ISO 19345-1:2019, 3.1.21.

3.1.28

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 document, item can also be plant/unit and installation. See ISO 14224:2016, Figure 3.

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

3.1.29

life cycle costing

process of evaluating the difference between the life cycle cost of two or more alternative options

Note 1 to entry: Life cycle costing can involve quantitative and/or qualitative assessment.

[SOURCE: ISO 15663:2021, 3.1.27]

3.1.30

life cycle phase

discrete stage in the life cycle with a specified purpose

Note 1 to entry: The different life cycle phases are further described in ISO 15663:2021, 4.5.

[SOURCE: ISO 15663:2021, 3.1.28]

3.1.31

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.]

3.1.32

lost revenue

LOSTREV

income loss that occurs when generated income are less than expected due to external or internal factors

Note 1 to entry: Production loss categories are defined in ISO/TS 3250:2021. Time loss categories are described in [Clause G.3](#).

[SOURCE: ISO 15663:2021, 3.1.29, modified — Notes 1 and 2 to entry have not been included, and new Note 1 to entry has been added.]

3.1.33

maintainability

ability to be retained in, or restored to a state to perform as required, under given conditions of use and *maintenance* ([3.1.35](#))

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 [Figure G.1](#) for further information.

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

3.1.34

maintainable item

item ([3.1.28](#)) that constitutes a part or an assembly of parts that is normally the lowest level in the equipment hierarchy during *maintenance* ([3.1.35](#))

[SOURCE: ISO 14224:2016, 3.48]

3.1.35

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

[SOURCE: IEC 60050-192:2015, 192-06-01]

3.1.36

maintenance data

data characterizing the maintenance action planned or done

Note 1 to entry: See also ISO 14224:2016, Table 8.

[SOURCE: ISO 14224:2016, 3.51]

3.1.37

maintenance management

all activities of the management that determine the maintenance 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]

3.1.38

maintenance supportability **supportability**

ability to be supported to sustain the required *availability* ([3.1.3](#)) with a defined operational profile and given logistic and maintenance resources

Note 1 to entry: Maintenance supportability of an item result from the inherent *maintainability* ([3.1.33](#)), 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 ISO 14224:2016, 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.]

3.1.39**major accident**

hazardous event that results in multiple fatalities or severe injuries; or extensive damage to structure, installation or plant; or large-scale impact on the environment

Note 1 to entry: Examples of large-scale impact on the environment are persistent and severe environmental damage that can lead to loss of commercial or recreational use, loss of natural resources over a wide area or severe environmental damage that will require extensive measures to restore beneficial uses of the environment.

Note 2 to entry: In ISO 17776:2016, a *major accident* (3.1.39) is the realization of a major accident hazard.

[SOURCE: ISO 17776:2016, 3.1.12]

3.1.40**mean time to failure****MTTF**

expected time before the *item* (3.1.28) fails

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

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

Note 3 to entry: See also ISO 14224:2016, Annex C.

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

3.1.41**midstream**

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

Note 1 to entry: See ISO 14224:2016, A.1.4 for further details.

[SOURCE: ISO 14224:2016, 3.65]

3.1.42**modification**

combination of all technical and administrative actions intended to change an *item* (3.1.28)

Note 1 to entry: In this document, the use of the term modification is primarily meant to cover major modification activities. See further details in ISO/TS 3250:2021, 8.2.2 with respect to how such major modifications are reflected in production efficiency reporting.

[SOURCE: ISO 14224:2016, 3.67, modified — Notes 1 to 3 to entry have not been included, and new Note 1 to entry has been added.]

3.1.43**multi-state item**

item (3.1.28) with more than two classes of states

Note 1 to entry: This is an extension of the binary items beyond the concepts of up and down states. This can characterize single items with degraded states or systems made up of several components in a production facility.

EXAMPLE An oil production system comprising two wells, A and B, that can be considered as binary items (see 3.1.3) has four states: S_1 (both A and B in up state), S_2 (A in up state and B in down state), S_3 (A in down state and B in up state), S_4 (both A and B in down state). If, when they are in up state, A produces 200 bpd (barrels per day) and B produces 100 bpd, then the system has four classes of production 300 bpd, $\{S_1\}$, 200 bpd, $\{S_2\}$, 100 bpd, $\{S_3\}$ and 0 bpd, $\{S_4\}$. With regards to oil production, it is a multi-state item. This is illustrated in Figure 2.

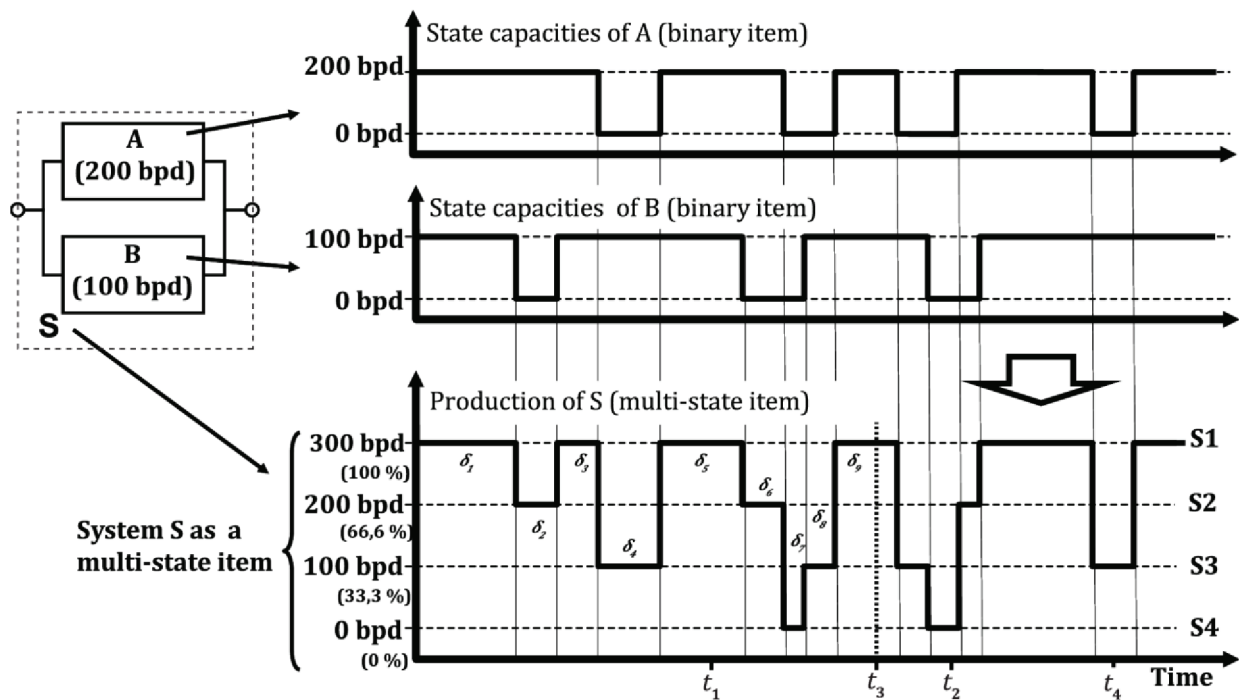


Figure 2 — Illustration of production availability behaviour of a multi-state system

3.1.44

observation period

time period during which *production performance* (3.1.59) and *reliability data* (3.1.64) are recorded

3.1.45

on-stream availability

ability of a production facility to deliver a volume above zero over a specified period of time

Note 1 to entry: This performance measure expresses the fraction of time or number of times produced volume is above zero. See also [Table G.1](#).

3.1.46

operating expenditure

OPEX

expenses used for operation and maintenance, including associated costs such as logistics and spares

Note 1 to entry: See further information regarding estimation of OPEX in ISO 15663:2021, C.3.

[SOURCE: ISO 15663:2021, 3.1.31]

3.1.47

operating state

state of performing as required

Note 1 to entry: See also ISO 14224:2016, Table 4.

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

Note 3 to entry: The state capacities of a multi-state item characterize various levels of operation and consequently, the definition of the operating state of a multi-state item depends on the situation, for example, if:

- no other requirement is given, any state with a capacity greater than zero is an operating state;
- a minimum capacity is required, it provides the limit to split the states between up and down classes;
- a given capacity is specified, then only the states with this capacity are operating states;

- no other requirement is given, any state with a capacity greater than zero is an operating state (300 bpd, 200 bpd and 100 bpd in [Figure 2](#));
- a minimum capacity is required, it provides the limit to split the states between up and down classes (300 bpd, 200 bpd in [Figure 2](#), if the minimum allowed production is 200 bpd);
- a given capacity is specified, then only the states with this capacity are operating states (200 bpd in [Figure 2](#) if and only if 200 bpd are required).

[SOURCE: IEC 60050-192:2015, 192-02-04, modified — Notes 1 and 3 to entry have been added.]

3.1.48

operating time

time interval during which an *item* ([3.1.28](#)) is in an *operating state* ([3.1.47](#))

Note 1 to entry: The accumulated times of various disjunct operating times interrupted by e.g. unplanned or planned down time is also called operating time.

Note 2 to entry: Sometimes the term ‘running time’ is used instead of ‘operating time’. Often the running time describes the active part of the operating time, see Table 4 in ISO 14224:2016. Whether rundown or start-up period is included depends on equipment, but hot-standby time is not included even though some equipment functions can be active to minimize start-up time in e.g., redundant configuration (hot standby).

Note 3 to entry: Running hours during testing is also called running hours, even though this is at test conditions.

[SOURCE: IEC 60050-192:2015, 192-02-05, modified — Notes 1 to 3 to entry have been added.]

3.1.49

operational availability

availability ([3.1.3](#)) experienced under actual conditions of operation and *maintenance* ([3.1.35](#))

Note 1 to entry: Operational availability is determined considering down time due to failures and associated mobilization time (see ISO 14224:2016, 3.66), but excluding external causes. This down time represents maintainability and maintenance supportability; see [Figure G.1](#).

Note 2 to entry: The planned down time (for preventive maintenance activities) and unplanned down time (i.e., mean active repair time (MART) plus mobilization time) for corrective maintenance are included in the operational availability calculations. When such mobilization for preparation and/or delay for repair resources is included, the unplanned down time will be mean overall repairing time (MRT). See ISO/TR 12489:2013, Figure 5.

[SOURCE: IEC 60050-192:2015, 192-08-03, modified — Note 1 to entry have been adjusted. Note to 2 to entry has been added.]

3.1.50

performance measure

quantitative expression describing the performance of an *item* ([3.1.28](#))

Note 1 to entry: In this document various performance measures are specified for *production assurance* ([3.1.55](#)) and reliability management purposes. A performance measure can be a term used as *performance requirement* ([3.1.52](#)) or *performance objective* ([3.1.51](#)).

Note 2 to entry: Recommended performance measures for time-based and volume-based production assurance are given in [Table G.1](#).

Note 3 to entry: Performance measures cover both technical and operational functions. See [D.3.4.1](#).

3.1.51

performance objective

indicative level for the desired performance

Note 1 to entry: Objectives are expressed in qualitative or quantitative terms. Objectives are not absolute requirements and may be modified based on cost or technical constraints. See further details in [Annex F](#).

3.1.52**performance requirement**

required minimum level for the performance of the *system* ([3.1.72](#))

Note 1 to entry: Requirements are normally expressed in quantitative terms, but may also be expressed in qualitative terms.

3.1.53**petrochemical**

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

Note 1 to entry: See ISO 14224:2016, A.1.4 for further details.

[SOURCE: ISO 14224:2016, 3.75]

3.1.54**preventive maintenance**

maintenance ([3.1.35](#)) carried out to mitigate degradation and reduce the probability of *failure* ([3.1.17](#))

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

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

3.1.55**production assurance**

activities implemented to achieve and maintain a performance that is at its optimum in terms of the overall economy and at the same time consistent with applicable framework conditions

Note 1 to entry: Production assurance in this document is not only limited to cover production of oil and gas. It can also be other activities such as drilling operations, downhole well intervention, subsea intervention, offshore loading operations, for which production assurance activities and reliability management are needed.

Note 2 to entry: Production assurance activities relate closely to the integrity management of the installations. See definition of integrity in [3.1.26](#).

3.1.56**production availability**

A_p

ratio of production to planned production, or any other reference level, over a specified period of time

Note 1 to entry: Production availability is an extension of the *average availability* ([3.1.4](#)) to deal with multi-state items. Reference is made to production volume, i.e., the ability to achieve the planned production or some reference level at time t , where the planned production level is defined according to user needs. The ratio between the accumulated production delivered over a given interval of time and a reference production level defined for this interval. For example, in [3.1.4](#), [Figure 1](#) shows the production availability of the system over the interval $[0, t_3]$ is equal to $[300 \cdot (\delta_1 + \delta_3 + \delta_5 + \delta_9) + 200 \cdot (\delta_2 + \delta_6) + 100 \cdot (\delta_4 + \delta_8)] / (300 \cdot t_3)$ provided the reference production level is 300 bpd at any time. By dividing by 300, this formula can also be written $[(\delta_1 + \delta_3 + \delta_5 + \delta_9) + 66,6 \% \cdot (\delta_2 + \delta_6) + 33,3 \% \cdot (\delta_4 + \delta_8)] / t_3$.

Note 2 to entry: This measure is used in conjunction with analysis of delimited systems without compensating elements such as substitution from other producers and downstream buffer storage. Battery limits need to be defined in each case.

Note 3 to entry: See [Clause G.1](#) and [Figure G.1](#) for further information.

Note 4 to entry: For offshore and onshore loading systems, some special performance measures exist when undertaking loading performance analyses, see further details of such metrics in [Clause I.26](#).

3.1.57**production efficiency**

PE

ratio of production to *production potential* ([3.1.61](#)) over a specified period of time

Note 1 to entry: For PE calculation methods, see ISO/TS 3250:2021.

Note 2 to entry: PE is normally considered as a historically reported measure, but can also be expressed as a forecast.

Note 3 to entry: With production is meant the actual production for historical reporting or forecast production for PE forecast. The actual production used for calculation of PE is not necessarily the fiscal metered production.

Note 4 to entry: Production efficiency is a term often used by operators for historic *production availability* ([3.1.56](#)) in the life cycle phase 'Operate' and is a reported measure, but in principle the same measure as predicted production availability that is a modelled measure.

Note 5 to entry: The operator will need to have a production performance system to enable report and calculation of PE data. Such systems can be part of other organization business performance systems and can be related to CMMIS. See further information in ISO/TS 3250:2021, Annex A.

[SOURCE: ISO/TS 3250:2021, 3.1.39. modified – Notes 1 and 4 to entry adjusted.]

3.1.58

production loss

difference between *production potential* ([3.1.61](#)) and actual production

Note 1 to entry: Production loss is caused by planned or unplanned activities or events. Annex A in ISO/TS 3250:2021 defines the production loss categories that shall be used in the upstream business category.

Note 2 to entry: The term production deferment is sometimes used to indicate that the oil/gas constituting the production loss is not totally lost but can be produced at a later stage. Production loss is the term used for PE calculation and reporting since the production loss is actually a loss within the time period considered.

Note 3 to entry: Examples of lost revenue elements as a result of production loss are described in ISO 15663:2021, C.4.1.

Note 4 to entry: In early life cycle phases prior to start-up of production when production availability models are used for calculations (see [Clause I.5](#)), production loss can be estimated in relation to a defined reference production volume. See further information in [Clause G.2](#).

[SOURCE: ISO/TS 3250:2021, 3.1.40, modified – Note 4 to entry has been added.]

3.1.59

production performance

capacity of a *system* ([3.1.72](#)) to meet demand for deliveries or performance

Note 1 to entry: *Production availability* ([3.1.56](#)), *deliverability* ([3.1.11](#)) or other appropriate measures can be used to express production performance.

Note 2 to entry: The use of production performance terms should specify whether it represents a predicted or historic production performance.

3.1.60

production performance analysis

systematic evaluations and calculations carried out to assess the *production performance* ([3.1.59](#))

Note 1 to entry: Various performance measures used in production performance analysis to address various parts of the hydrocarbon production chain are shown in [Table G.1](#). Such production performance analysis applies volume-based performance measures but can be complemented by also time-based performance measures. Production availability analysis is an analysis that normally covers the entire *asset* ([3.1.2](#)); see [Clause I.5](#), and the PAP will cover such analysis. If only a part of the asset is covered production unavailability analysis can be performed. [Annex D](#) provides guidance for planning and reporting such analyses.

Note 2 to entry: Loading performance analysis is a particular type of production performance analysis focussing on offshore and onshore loading operations, which e.g., use metocean data to analyse weather impact on such operations (see [Clauses I.25](#) and [I.26](#)).

3.1.61

production potential

maximum volume that can be produced through wells, plant and export installations, also considering market restrictions, within a given time period

Note 1 to entry: Production potential can vary over time.

Note 2 to entry: See more information regarding production potential in ISO/TS 3250:2021 for use when calculating *production efficiency* (3.1.53). Note that ISO/TS 3250:2021 also defines the terms well ‘production potential’ and ‘market potential’.

[SOURCE: ISO/TS 3250:2021, 3.1.43, modified – Notes 2 to 4 to entry have not been included, and new note 2 to entry has been added.]

3.1.62

redundancy

existence of more than one means for performing a *required function* (3.1.66) of an *item* (3.1.28)

Note 1 to entry: See ISO 14224:2016, C.1.2 for further details, where passive (cold), active (hot) standby and mixed redundancy are described.

Note 2 to entry: Redundancy in IEC 61508-1:2016 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”.

[SOURCE: ISO 14224:2016, 3.80]

3.1.63

reliability

ability of an *item* (3.1.28) to perform a *required function* (3.1.66) 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 may also be expressed as *survival probability* (3.1.70).

Note 2 to entry: In Figure 3, the reliability is illustrated for a system S comprising two redundant components A and B. The system is reliable all over the interval $[0, t_1]$ but has had a failure during $[0, t_2]$. See also Figure G.1 for further information.

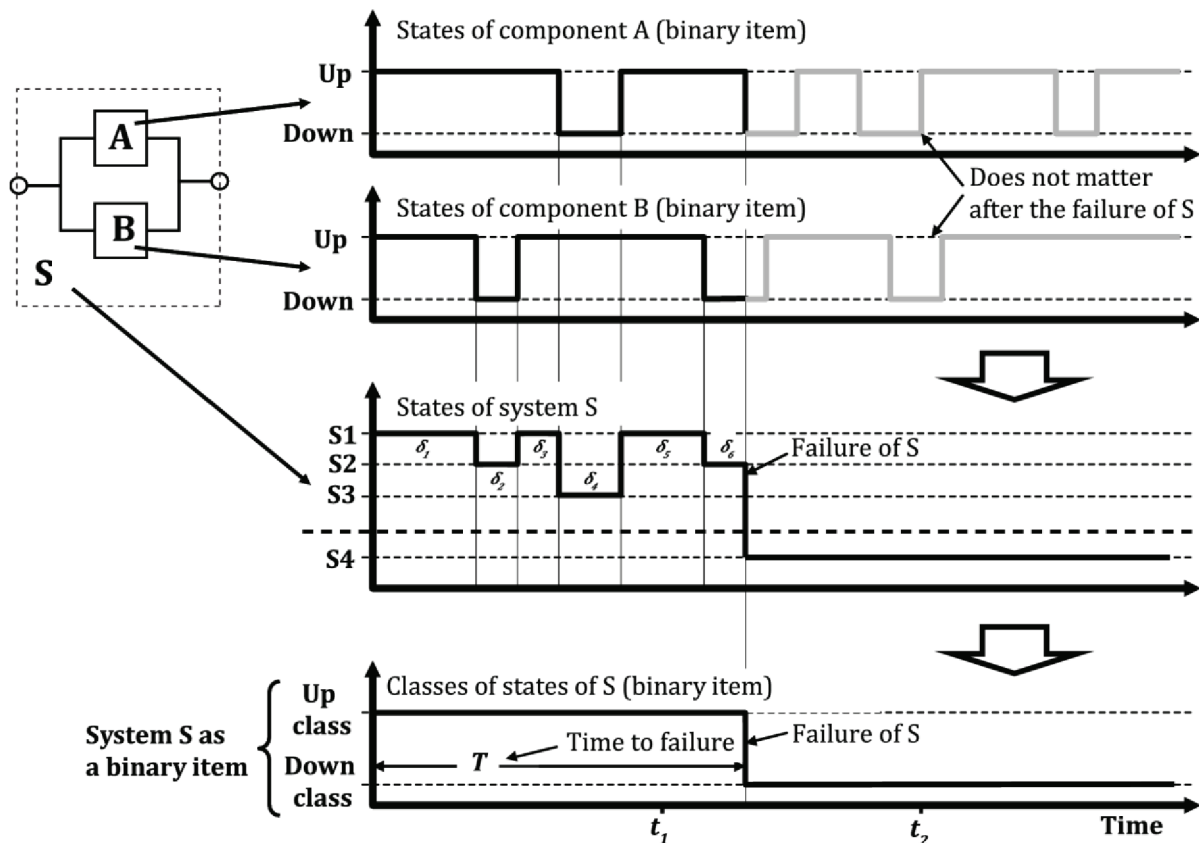


Figure 3 — Illustration of a system S comprising two redundant components A and B

[SOURCE: ISO 14224:2016, 3.81, modified — Notes 1 and 2 to entry have been added.]

3.1.64

reliability data

data for *reliability* ([3.1.63](#)), *maintainability* ([3.1.33](#)) and maintenance support performance

[SOURCE: ISO 14224:2016, 3.82]

3.1.65

reliability management

activities undertaken to achieve *reliability* ([3.1.63](#)) related *performance objectives* ([3.1.51](#)) and *performance requirements* ([3.1.52](#))

Note 1 to entry: Reliability management reflects production assurance activities on equipment and system level. In project/product development and design phases this is often called ‘reliability engineering’.

Note 2 to entry: A reliability management programme (RMP) can be used to describe such activities, see [Clause A.1](#).

3.1.66

required function

function, or combination of functions, of an *item* ([3.1.28](#)) that is considered necessary to provide a given service

[SOURCE: ISO 14224:2016, 3.83]

3.1.67

risk

combination of the probability of an event and the consequences of the event

Note 1 to entry: This definition is based on ISO/IEC Guide 51:2014, 3.9 that defines risk as combination of the probability of occurrence of harm and the severity of that harm, where the probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event and the possibility to avoid or limit the harm. ‘Harm’ has been replaced by ‘event’ in the definition to cope with production assurance purpose. It is also similar to the definition of the ‘level of risk’ given in ISO 31073:2022, 3.3.22 (i.e., “combination of consequences and their likelihood”).

Note 2 to entry: Events leading to production losses are considered within the production assurance field.

3.1.68

risk register

record of information about identified *risks* ([3.1.67](#))

Note 1 to entry: The definition is withdrawn in ISO Guide 73:2009. Project risk management requires managing identified risks as described in ISO 31000:2018 and Clause 6 in ISO/DIS 29010:2025, as well as in ISO 29001:2020. The term is used in this document regarding Process 7, see [Clause C.2](#).

[SOURCE: ISO Guide 73:2009, 3.8.2.4, withdrawn – Note 1 to entry has not been included.]

3.1.69

state capacity

state efficiency

processing ability of an item state

Note 1 to entry: The capacity of an item state is related to the amount of production the item is able to produce or process in this state. For example, in [Figure 2](#), component A has a capacity of 200 bpd.

EXAMPLE 1 A single oil production well with two states (binary item, [3.1.4](#)) has, for example, a capacity of 100 barrels per day (bpd) when it is in up state and of 0 bpd when it is in down state (see component B in [Figure 2](#)).

EXAMPLE 2 An oil production system made up of two wells, A and B, producing respectively 200 bpd and 100 bpd, has four states. This is illustrated in [Figure 2](#):

- S_1 (A and B producing) : capacity = 300 bpd;
- S_2 (A producing alone) : capacity = 200 bpd;
- S_3 (B producing alone) : capacity = 100 bpd;
- S_4 (A and B failed) : capacity = 0 bpd.

When the reference value is non-ambiguous, the capacity can be given in percentage. For example, with regard to the maximum capacity of the producing system, the capacity of S_1 is 100 %, the capacity of S_2 is 66,6 %, the capacity of S_3 is 33,3 % and the capacity of S_4 is 0 %.

3.1.70

survival probability

reliability <measure>

$R(t)$

likelihood of the continued functioning of an *item* (3.1.28)

Note 1 to entry: This likelihood is calculated by using [Formula \(1\)](#):

$$R(t) = P(T > t) \quad (1)$$

where $P(T > t)$ is the probability that the time to failure of an item, T , is greater than t , a time equal to or greater than 0.

Note 2 to entry: Reliability is illustrated in [Figure 3](#) for a system S comprising two redundant components A and B. As $T > t_1$ the system is reliable all over the interval $[0, t_1]$ and is surviving at time t_1 . As $T < t_2$ the system is not surviving at time t_2 .

3.1.71

sustainability

state of the global system, including environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs

Note 1 to entry: The environmental, social and economic aspects interact, are interdependent and are often referred to as the three dimensions of sustainability.

Note 2 to entry: Sustainability is the goal of sustainable development.

Note 3 to entry: Sustainability aspects of maintenance cover but are not limited to unnecessary maintenance, rest useful lifetime, maintenance efficiency and (re)use of materials.

[SOURCE: ISO Guide 82:2019, 3.1, modified — Note 3 to entry has been added.]

3.1.72

system

set of interrelated *items* (3.1.28) that collectively fulfil a requirement

Note 1 to entry: See a taxonomic structure of systems in ISO 14224: 2016, Table A.3 for various business categories.

[SOURCE: IEC 60050-192:2015, 192-01-03, modified — Notes to entry have not been included, and new Note 1 to entry has been added.]

3.1.73

technical availability

inherent availability

intrinsic availability

availability (3.1.3) provided by the design under ideal conditions of operation and *maintenance* (3.1.35)

Note 1 to entry: Delays associated with maintenance, such as logistic and administrative delays are excluded. This down time represents maintainability; see [Figure G.1](#).

Note 2 to entry: Only the active repair time of unplanned down time (i.e., the mean active repair time (MART) and no mobilization time for the corrective maintenance) is included in the technical availability calculations. The active repair time (MART) of critical failures detected during a periodic test will though be reflected by the 'technical availability', but not the equipment down time whilst the periodic test is performed.

Note 3 to entry: For estimation of technical availability, see ISO 14224:2016, C.2.3. For benchmarking, the technical availability is KPI 8 in ISO 14224:2016, Table E.3.

[SOURCE: IEC 60050-192:2015, 192-08-02, modified — Note 1 to entry has been adjusted, and Notes 2 and 3 to entry has been added.]

3.1.74

technology qualification

process of providing evidence that the technology will perform as required for the specified application area

Note 1 to entry: The requirements include both functional (technical and operational) and associated reliability requirements for its *design life* (3.1.12). Application area refers to the operating conditions, environment or purpose for which the technology will be used.

Note 2 to entry: See further information in [Clauses C.3](#) and [I.21](#).

3.1.75

uncertainty

inability to determine accurately what is or will be the true value of a quantity

Note 1 to entry: Uncertainty can have different meanings. It can be used as a measure of *variability* (3.1.79) 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).

Note 2 to entry: Uncertainty of input data can be relevant for availability calculations as described in this document.

Note 3 to entry: According to ISO 31000:2018, uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequences, or likelihood.

[SOURCE: ISO 14224:2016, 3.95, modified — Note 1 to entry has been adjusted, and Notes 2 and 3 to entry have been added.]

3.1.76

up state

available state

state of being able to perform as required

Note 1 to entry: This concept is related to a *binary item* (3.1.6), which can have several up states forming the up state class of the item. All the states in the up state class are considered to be equivalent with regard to the availability of the considered item.

Note 2 to entry: Up state relates to the availability performance of the item.

Note 3 to entry: See also ISO/TR 12489:2013, Figure 5.

EXAMPLE In [Figure 1](#), the up state class of the system S comprises three states $\{S_1, S_2, S_3\}$ and the system is in up state at time t_1 .

[SOURCE: IEC 60050-192:2015, 192-02-01, modified — Notes 1 to 3 to entry have been added.]

3.1.77

up time

time interval during which an *item* (3.1.28) is in an *up state* (3.1.76)

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".

[SOURCE: ISO 14224:2016, 3.97]

3.1.78

upstream

business category of the petroleum industry involving exploration and production

Note 1 to entry: See ISO 14224:2016, A.1.4 for further details.

[SOURCE: ISO 14224:2016, 3.98]

3.1.79

variability

variations in *performance measures* ([3.1.50](#)) for different time periods under defined framework conditions

Note 1 to entry: The variations can be a result of the down time pattern for equipment and systems or operating factors, such as wind, waves and access to certain repair resources.

3.2 Abbreviations

ALT	accelerated life testing
BBN	Bayesian belief network
BOP	blowout preventer
bpd	barrels per day
CAPEX	capital expenditure
CCS	carbon capture and storage
CMMIS	computerized maintenance management information system
CPD	conditional probability distributions
ESD	emergency shut down
FAT	factory acceptance test
FEED	front-end engineering and design
FID	final investment decision
FMEA	failure modes and effects analysis
FMECA	failure modes, effects and criticality analysis
FN	flow network
FNA	flow network analysis
FPSO	floating production, storage and offloading
FSMP	functional safety management plan
FT	fault tree
FTA	fault tree analysis
GHG	greenhouse gas
HALT	highly accelerated life testing
HAZOP	hazard and operability (study)

HASS	highly accelerated stress screening
HSE	health, safety and environment
ITT	invitation to tender
KPI	key performance indicator
LCC	life cycle cost
LCCMP	life cycle costing management plan
LNG	liquefied natural gases
LOSTREV	lost revenue
MART	mean active repair time
MDT	mean down time
METBF	mean elapsed time between failures
MODU	mobile offshore drilling unit
MPA	Markov process analysis
MRT	mean overall repairing time
MTTF	mean time to failure
MTTR	mean time to repair
MTTRes	mean time to restoration
MUT	mean up time
NPV	net present value
OPEX	operating expenditure
PAP	production assurance programme
PE	production efficiency
PFD	probability of failure on demand
PID	process instrumentation diagrams
PM	preventive maintenance
PN	Petri nets
PNA	Petri net analysis
POR	performance and operability review
FSMP	functional safety management plan
QA	quality assurance
QRA	quantitative risk analysis

RBD	reliability block diagram
RBI	risk-based inspection
RCA	root cause analysis
RCM	reliability-centred maintenance
RM	reliability and maintainability
RMP	reliability management programme
ROV	remote operated vehicle
SAT	site acceptance test
SEM	subsea electronic module
SIL	safety integrity level
SIMOPS	simultaneous operations
SISV	subsea intervention and support vessel
SIT	system integration test
SRA	structural reliability analysis
TNC	technology novelty category
TQP	technology qualification programme
TRL	technology readiness level

4 Production assurance and decision support

4.1 Users of this document

This document is intended for users such as the following:

- **Installations/plants/facilities:** Operating facility, e.g., HSE, engineering, construction, installation, operation and maintenance personnel.
- **Operators/owners/companies:** Reliability staff or others analysing or responsible for production assurance, reliability management and associated activities. Other stakeholders are technology developers, concept and system planners, HSE staff, technical safety, integrity management, maintenance management and professional subject-matter experts that manage and assess plant/system/equipment performance with respect to production assurance (production availability, system availability, equipment reliability, etc.).
- **Contractors:** Main contractor for engineering, procurement, construction, drilling, installation, operation, maintenance services, etc.
- **Vendors/manufacturers/suppliers:** Use of reliability management activities in technology development, technology qualification, system design to ensure product quality and improvements, etc.
- **Authorities/regulatory bodies:** These organizations can refer to this document for regulatory compliance regarding HSE, production availability, system availability, equipment reliability, maintenance and resource utilisation.

- **Consultants:** Consultancy services for supporting production assurance and reliability management, e.g., undertaking analysis of production availability, system availability, equipment reliability, or maintenance, as defined in this document.
- **Universities:** Institutions with educational roles in society and experts that might improve methods on these matters.
- **Research institutions:** Personnel that apply this document for research within a production assurance and reliability management context.

4.2 Framework conditions

4.2.1 General

The objective associated with systematic production assurance is to contribute to the alignment of design and operational decisions with corporate business objectives. Production assurance and reliability management activities also support operating and quality management; see ISO 9001:2015, ISO 29001:2020 and ISO/DIS 29010:2025).

In order to fulfil this objective, technical and operational measures as illustrated in [Figure 4](#) may be used during design or operation to influence the production performance. [Figure 4](#) shows measures that to a greater or lesser extent can have an effect on production performance. Some of these measures are purely technical and it is necessary that they will be adhered to in design; others are related purely to operation. Most of the measures have both technical and operational aspects, e.g. a bypass cannot be used in the life cycle phase ‘Operate’ unless provisions have been made for in design. In addition, there are dependencies between many of the listed measures.

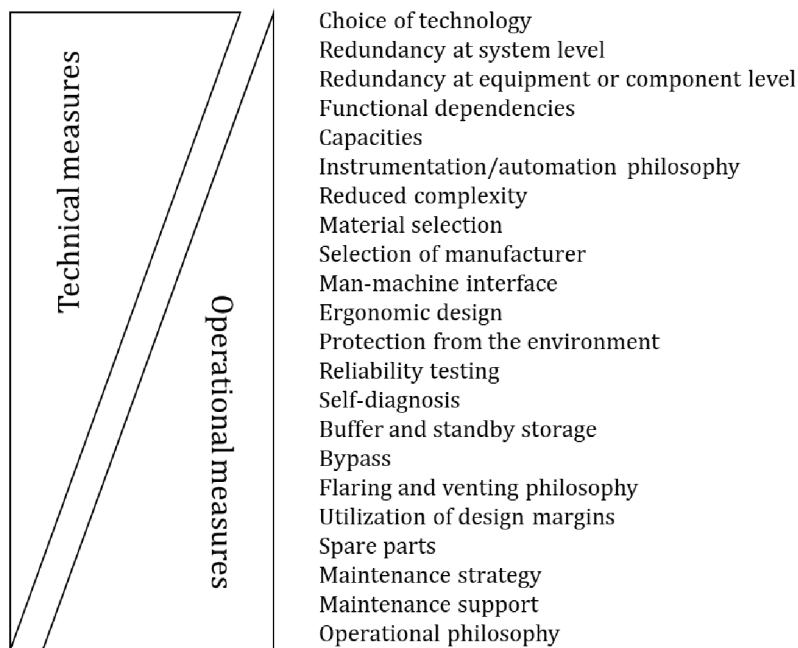


Figure 4 — Typical technical and operational measures that affect production performance

This imposes two important recommendations for production assurance to be efficient:

- production assurance should be carried out throughout all life cycle phases, but;
- production assurance should have a broad coverage of project activities focussing on value creation.

The greatest opportunity of influencing the life cycle cost of an asset and its ultimate profitability is during the ‘Select’ and ‘Define’ life cycle phases of a project (see ISO 15663:2021, Figure 3). An overview of cost and

revenue factors to be considered in conjunction with the economic optimization is shown in [Figure 5](#). These factors can be used to better prioritize and understand the production assurance activities with respect to the three main elements of life cycle costing (CAPEX, OPEX and LOSTREV). The economic decision criteria depend on company as well as the business context (e.g. concept selection, field development, system configuration) that is subject to decision.

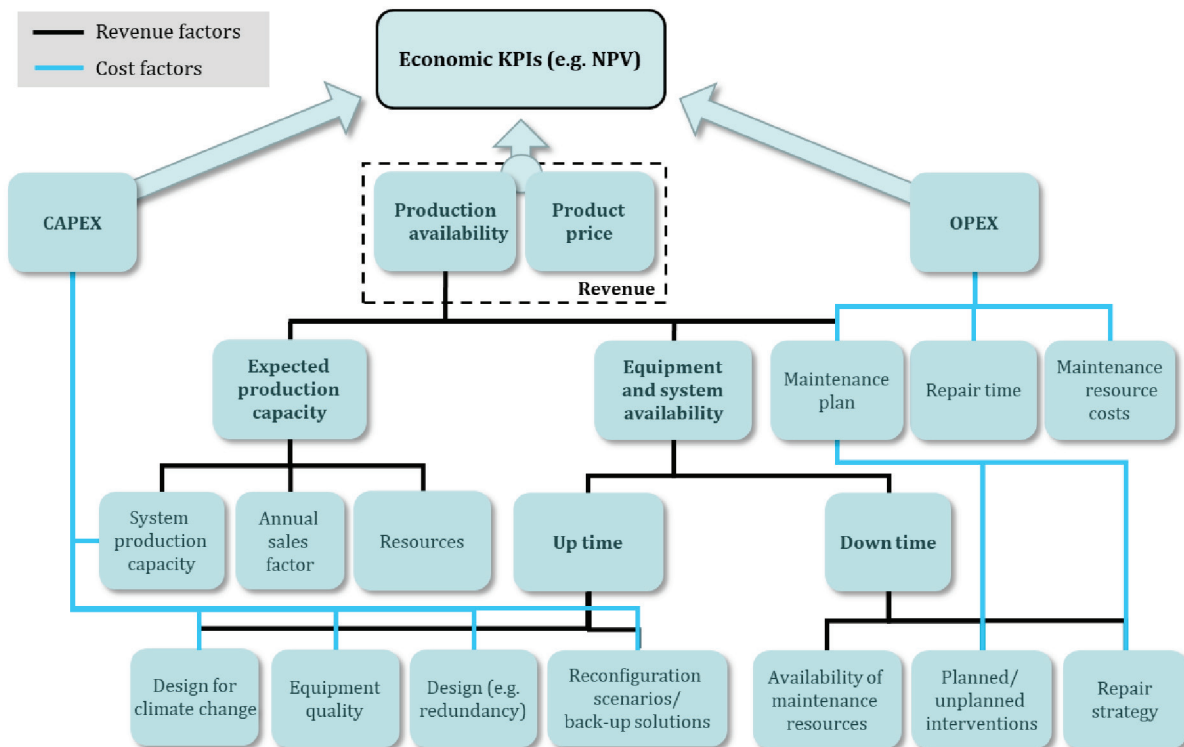


Figure 5 — Business model: Influence factors of production assurance on project economy

4.2.2 Sustainability and climate change considerations

The changing business environment for oil and gas industries including a need for lower carbon energy implies that achieving cost-effective solutions for such assets will benefit from use of requirements and guidance for production performance analysis as described in this document. Identification and decision support for mitigations and adaptations related to sustainability and climate change (as outlined in ISO Guide 82:2019 and ISO Guide 84:2020) for specific life cycle phase or throughout the life cycle of an installation can benefit from use of such analysis.

Design for climate change is also reflected in [Figure 5](#), and examples are:

- **Mitigation:** Designing for lower GHG emissions (e.g., by use of carbon capture and storage, electrification or flaring restrictions) may increase CAPEX. It may also increase OPEX, affect production availability negatively, but also potentially reduce environmental taxes.
- **Adaptation:** Taking account and minimizing effect of climate change that can result in a harsher environment (e.g., more extreme weather) with possibly increased down time and increased OPEX.

Sustainability and climate change issues shall thus be considered in planning of the production assurance and reliability management activities, as such subject matters can be a key item in the project. Based on such considerations, the PAP and/or the RMP could include analysis activities supported by this document. Energy efficiency of an asset and/or activity will affect GHG emissions but depends also on the operational framework and optimization of technical and operational solutions. Regarding selection of optimal solution for a subject matter, life cycle costing using ISO 15663:2021 should also be considered; see also Annex [I.19](#).

The climate change implications should also be considered when defining performance objectives and/or performance requirements (e.g., production availability and technical availability). See [Annex F](#) for further guidance, and ISO/TS 3250:2021 address PE targets for life cycle phase 'Operate'.

The analysis techniques for production assurance and reliability management can also be applied for lower carbon energy assets like CCS, hydrogen facilities and offshore wind energy projects. See also [Table G.1](#) that provides a list of performance measures for use in analyses, as well as when defining performance objectives and/or performance requirements.

4.3 Optimization process

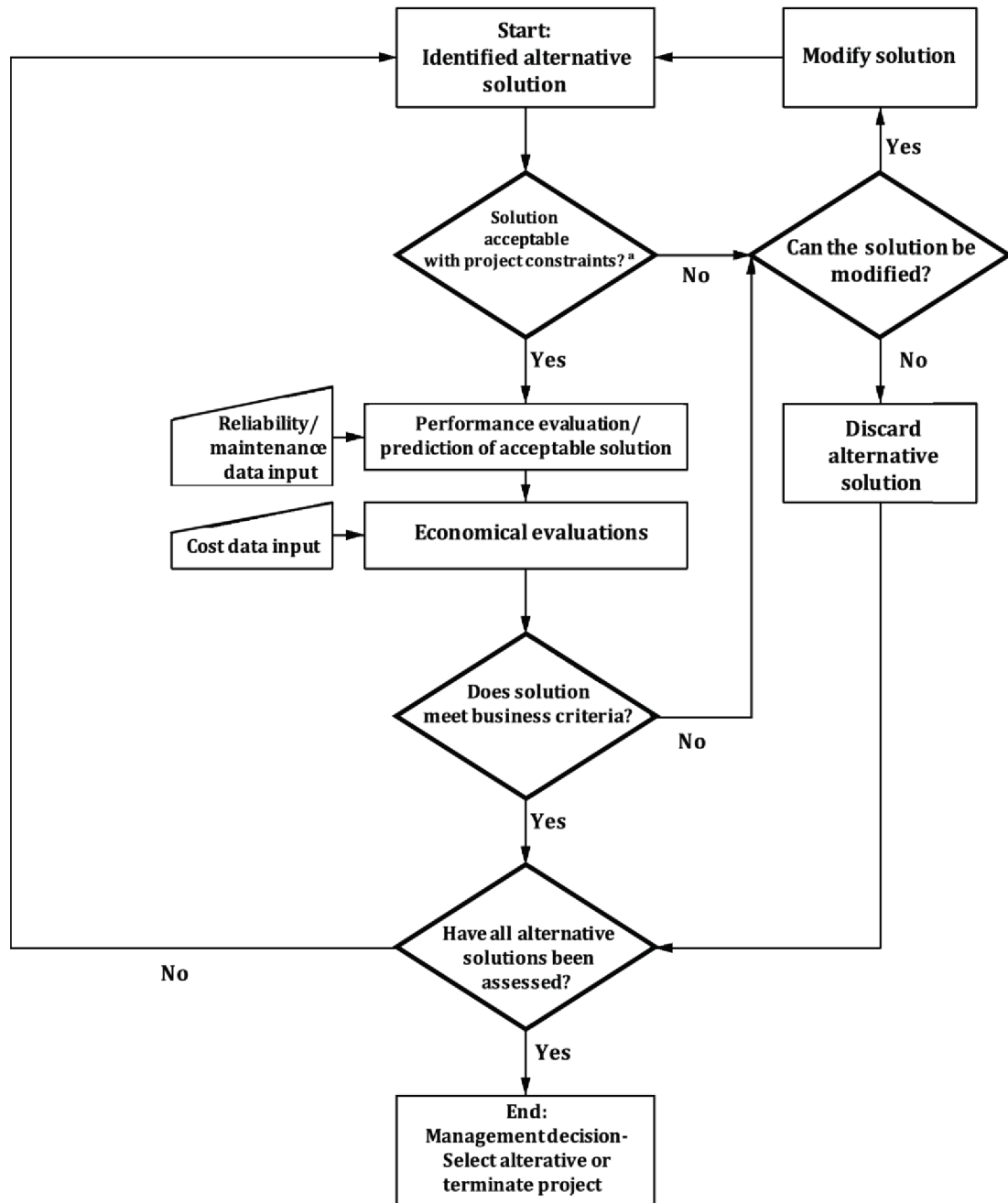
The main principle for optimization of design or selection between alternative design solutions is economic optimization within given constraints and framework conditions. The achievement of high performance is of limited importance, unless the associated costs are considered. In the use of this document the interaction with ISO 15663:2021 shall be considered when establishing the PAP or RMP, and the LCCMP may then also reflect such relationship.

Examples of constraints and framework conditions that affect the optimization process are:

- statutory health, safety and environmental regulations;
- requirements for safety equipment resulting from the risk analysis and the overall safety acceptance criteria;
- requirements to design or operation given by statutory and other regulatory bodies' regulations;
- project constraints, such as budget, implementation time, national and international agreements;
- conditions in the sales contracts;
- technical constraints;
- climate change considerations (see [4.2.2](#)).

The optimization process can be seen as a series of steps as follows (see [Figure 6](#) for an illustration).

- a) Assess the project requirements and generate designs that are capable of meeting the project requirements.
- b) Identify all statutory, regulatory and other framework requirements that apply to the project.
- c) Predict the appropriate production assurance parameters.
- d) Identify the preferred design solution based on an economical evaluation/analysis, using economic evaluation measures such as NPV, LCC or another optimization criterion.
- e) Apply the optimization process as illustrated in [Figure 6](#). For the execution of the optimization process, the production assurance and reliability management function shall be addressed by competent team members.
- f) If required, the process can be iterative, where the selected alternative is further refined, and alternative solutions are identified. The iterative process is typical for “gated” or threshold project-execution phases.
- g) Sensitivity analyses may be performed to take account of uncertainty in important input parameters.



^a Typical project constraints include HSE requirements; technical feasibility; compliance with acts, rules and regulations; economical constraints; schedule constraints.

Figure 6 — Optimization framework

4.4 Production assurance programme

4.4.1 Objectives

A production assurance programme (PAP) shall be established and serve as a management tool in the process of conforming with this document. The PAP may be either established for the various life cycle phases of a new asset development project or established for assets already in operation. As production