INTERNATIONAL STANDARD

ISO 20815

First edition
2008-06-01

Corrected version
2009-06-15

Petroleum, petrochemical and natural gas industries — Production assurance and reliability management

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

Reference number
ISO 20815:2008(E)

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 20815 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This corrected version of ISO 20815:2008 incorporates the following corrections:

— 3.1.13 "$(t + \Delta t)$" modified to "$[t, (t + \Delta t)]$";

— 3.1.46, Equation (1) symbols and definitions modified;

— Clause G.2, Equation (G.2) symbols and definitions modified.

Introduction

The petroleum and natural gas industries involve large capital investment costs as well as operational expenditures. The profitability of these industries is dependent upon the reliability, availability and maintainability of the systems and components that are used. Therefore, for optimal production availability in the oil and gas business, a standardized, integrated reliability approach is required.

The concept of production assurance, introduced in this International Standard, 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 and framework conditions.

Annexes A through I are for information only.

Petroleum, petrochemical and natural gas industries — Production assurance and reliability management

1 Scope

This International Standard introduces the concept of production assurance within the systems and operations associated with exploration drilling, exploitation, processing and transport of petroleum, petrochemical and natural gas resources. This International Standard covers upstream (including subsea), midstream and downstream facilities and activities. 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.

It 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, quality and human factors;

— planning, execution and implementation of reliability technology;

— application of reliability and maintenance data;

— reliability-based design and operation improvement.

For standards on equipment reliability and maintenance performance in general, see the IEC 60300-3 series.

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

This International Standard recommends that the listed processes and activities be initiated only if they can be considered to add value.

The only requirements mandated by this International Standard are the establishment and execution of the production-assurance programme (PAP).

2 Normative references

The following referenced documents are indispensable for the application 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 14224:2006, *Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
availability
ability of an item to be in a state to perform a required function under given conditions at a given instant of time, or in average over a given time interval, assuming that the required external resources are provided

See Figure G.1 for further information.

3.1.2
common cause failure
failures of different items resulting from the same direct cause, occurring within a relatively short time, where these failures are not consequences of each other

3.1.3
corrective maintenance
maintenance that is carried out after a fault recognition and intended to put an item into a state in which it can perform a required function

See IEC 60050-191:1990, Figure 191-10 [2], for more specific information.

3.1.4
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 buffer storage, is included

See Figure G.1 for further information.

3.1.5
design life
planned usage time for the total system

NOTE Design life should not be confused with **MTTF** (3.1.25), which is comprised of several items that may be allowed to fail within the design life of the system as long as repair or replacement is feasible.

3.1.6
down state
internal disabled state of an item characterized either by a fault or by a possible inability to perform a required function during preventive maintenance [2]

NOTE This state is related to availability performance.

3.1.7
downtime
time interval during which an item is in a non-working state [2]

NOTE The downtime includes all the delays between the item failure and the restoration of its service. Downtime can be either planned or unplanned.

3.1.8
downstream
business process, most commonly in the petroleum industry, associated with post-production activities

EXAMPLES Refining, transportation and marketing of petroleum products.

3.1.9
failure
termination of the ability of an item to perform a required function

NOTE 1 After failure, the item has a fault.

NOTE 2 "Failure" is an event, as distinguished from "fault", which is a state.

3.1.10
failure cause
root cause
circumstances during design, manufacture or use that have led to a failure [2]

NOTE Generic failure cause codes applicable for equipment failures are defined in ISO 14224:2006, B.2.3.

3.1.11
failure data
data characterizing the occurrence of a failure event

3.1.12
failure mode
effect by which a failure is observed on the failed item

NOTE Failure-mode codes are defined for some equipment classes in ISO 14224:2006, B.2.6.

3.1.13
failure rate

limit, if this exists, of the ratio of the conditional probability that the instant of time, T, of a failure of an item falls within a given time interval, $[t, (t + \Delta t)]$ and the length of this interval, Δt, when Δt tends to zero, given that the item is in an up state at the beginning of the time interval

See ISO 14224:2006, Clause C.3 for further explanation of the failure rate.

NOTE 1 In this definition, t may also denote the time to failure or the time to first failure.

NOTE 2 A practical interpretation of failure rate is the number of failures relative to the corresponding operational time. In some cases, time can be replaced by units of use. In most cases, the reciprocal of **MTTF** (3.1.25) can be used as the predictor for the failure rate, i.e. the average number of failures per unit of time in the long run if the units are replaced by an identical unit at failure.

NOTE 3 The failure rate can be based on operational time or calendar time.

3.1.14
fault
state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources [2]

NOTE A fault is often a result of a failure of the item itself but the state can exist without a failure.

3.1.15
fault tolerance
attribute of an item that makes it able to perform a required function in the presence of certain given sub-item faults [2]

3.1.16
item
any part, component, device, subsystem, functional unit, equipment or system that can be individually considered [2]

3.1.17
logistic delay
accumulated time during which maintenance cannot be carried out due to the necessity to acquire maintenance resources, excluding any administrative delay [29]

NOTE Logistic delays can be due to, for example, travelling to unattended installations; pending arrival of spare parts, specialist, test equipment and information; or delays due to unsuitable environmental conditions (e.g. waiting on weather).

3.1.18
lost revenue
LOSTREV
total cost of lost or deferred production due to downtime

3.1.19
maintainable item
item that constitutes a part, or an assembly of parts, that is normally the lowest level in the equipment hierarchy during maintenance

See ISO 14224:2006, Annex A, for examples of maintainable items for a variety of equipment.

3.1.20
maintenance
combination of all technical and administrative actions, including supervisory actions, intended to retain an item in, or restore it to, a state in which it can perform a required function [2]

3.1.21
maintenance data
data characterizing the maintenance action planned or done

3.1.22
maintainability
⟨general⟩ ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources [2]

See Figure G.1 for further information.

3.1.23
maintenance support performance
ability of a maintenance organization, under given conditions, to provide upon demand, the resources required to maintain an item, under a given maintenance policy [2]

NOTE The given conditions are related to the item itself and to the conditions under which the item is used and maintained.

3.1.24
mean time between failures
MTBF
expectation of the time between failures [2]

NOTE The MTBF of an item can be longer or shorter than the design life of the system.

3.1.25
mean time to failure
MTTF
expectation of the time to failure [2]

NOTE The MTTF of an item can be longer or shorter than the design life of the system.

3.1.26
mean time to repair
MTTR
expectation of the time to restoration [2]

3.1.27
midstream
business category involving the processing, storage and transportation sectors of the petroleum industry

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

3.1.28
modification
combination of all technical and administrative actions intended to change an item [2]

3.1.29
observation period
time period during which production performance and reliability data are recorded

3.1.30
operating state
state when an item is performing a required function [2]

3.1.31
operating time
time interval during which an item is in an operating state [2]

3.1.32
performance objectives
indicative level for the desired performance

NOTE Objectives are expressed in qualitative or quantitative terms. Objectives are not absolute requirements and may be modified based on cost or technical constraints.

3.1.33
performance requirements
required minimum level for the performance of a system

NOTE Requirements are normally quantitative but may also be qualitative.

3.1.34
petrochemicals
business category producing the chemicals derived from petroleum and used as feedstock for the manufacture of a variety of plastics and other related products

EXAMPLES Methanol, polypropylene.

3.1.35
preventive maintenance
maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item [2]

3.1.36
production-performance analysis
systematic evaluations and calculations carried out to assess the production performance of a system

NOTE The term should be used primarily for analysis of total systems, but may also be used for analysis of production unavailability of a partial system.

3.1.37
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

3.1.38
production availability
ratio of production to planned production, or any other reference level, over a specified period of time

NOTE This measure is used in connection 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.

See Figure G.1 for further information.

3.1.39
production performance
capacity of a system to meet demand for deliveries or performance

NOTE 1 Production availability, deliverability or other appropriate measures can be used to express production performance.

NOTE 2 The use of production-performance terms should specify whether it represents a predicted or historic production performance.

3.1.40
redundancy
existence of more than one means for performing a required function [2]

3.1.41
reliability
ability of an item to perform a required function under given conditions for a given time interval [2]

NOTE 1 The term “reliability” is also used as a measure of reliability performance and may also be expressed as a probability.

NOTE 2 See Figure G.1 for further information.

3.1.42
reliability data
data for reliability, maintainability and maintenance support performance

NOTE Reliability and maintainability (RM) data is the term applied by ISO 14224:2006.

3.1.43
required function
function, or combination of functions, of an item that is considered necessary to provide a given service [2]

3.1.44
risk
combination of the probability of an event and the consequences of the event [20]

3.1.45
risk register
tool to log, follow up and close out relevant risks

NOTE Each entry in the risk register should typically include

— description of the risk,

— description of the action(s),

— responsible party,

— due date,

— action status.

3.1.46
survival probability
$R(t)$
likelihood of the continued functioning of an item, as given by Equation (1):

$$R(t) = \mathrm{Pr}(T > t) \quad (1)$$

where Pr is the probability that T, the time to failure of an item, is greater than t, a time equal to or greater than 0

3.1.47
up state
state of an item characterized by the fact it can perform a required function, assuming that the external resources, if required, are provided [2]

NOTE This relates to availability performance.

3.1.48
upstream
business category of the petroleum industry involving exploration and production

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

3.1.49
uptime
time interval during which an item is in the up state [2]

3.1.50
variability
variations in performance measures for different time periods under defined framework conditions

NOTE The variations can be a result of the downtime pattern for equipment and systems or operating factors, such as wind, waves and access to certain repair resources.

3.2 Abbreviations

BOP	blowout preventer
CAPEX	capital expenditures
ESD	emergency shut down
FMEA	failure modes and effects analysis
FMECA	failure modes, effects and criticality analysis
FNA	flow-network analysis
FTA	fault-tree analysis
GTL	gas to liquid
HAZID	hazard identification

HAZOP	hazard and operability study
HSE	health, safety, environment
LCC	life-cycle cost
LNG	liquefied natural gases
LOSTREV	lost revenue
LPG	liquefied petroleum gases
MPA	Markov process analysis
MTBF	mean time between failure
MTTF	mean time to failure
MTTR	mean time to repair
OPEX	operational expenditure
PAP	production-assurance programme
PNA	petri net analysis
POR	performance and operability review
RBD	reliability block diagram
RBI	risk-based inspection
RCM	reliability-centred maintenance
ROV	remote operated vehicle
SIMOPS	simultaneous operations
SRA	structural-reliability analysis
QA	quality assurance

4 Production assurance and decision support

4.1 Framework conditions

The objective associated with systematic production assurance is to contribute to the alignment of design and operational decisions with corporate business objectives.

In order to fulfil this objective, technical and operational measures as indicated in Figure 1 may be used during design or operation to change the production performance. Figure 1 shows 21 factors that to a greater or lesser degree can have an effect on production performance. Some of these factors are purely technical and it is necessary that they be adhered to in design; others are related purely to operation. Most of the factors have both technical and operational aspects, e.g. a bypass cannot be used in the operational phase unless provisions have been made for it in the design phase. In addition, there are dependencies between many of the listed factors.

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

— Production assurance should be carried out throughout all project design and operational phases.

— Production assurance should have a broad coverage of project activities.

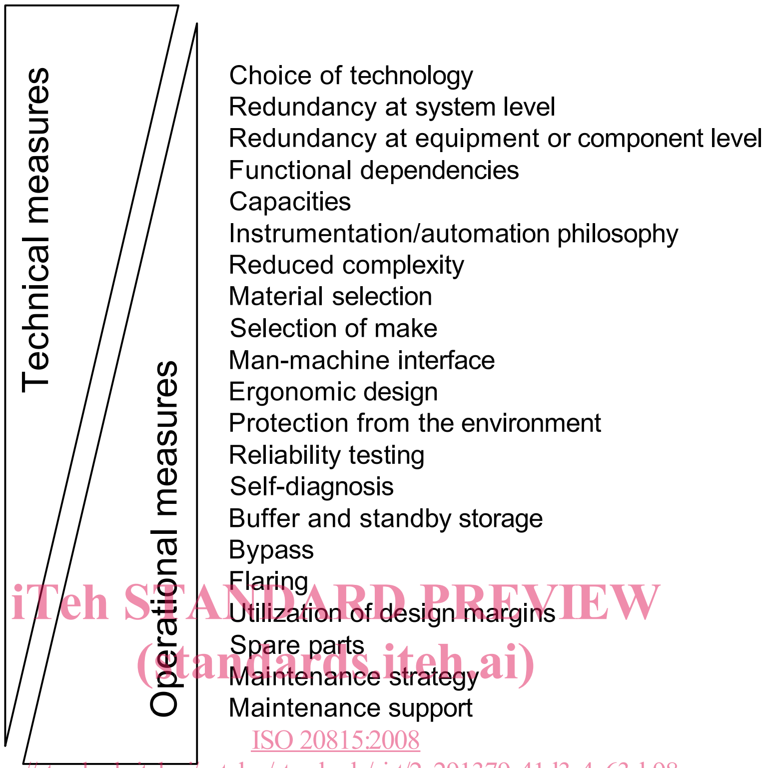

Figure 1 — Design and operational measures that affect production performance

4.2 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. This International Standard can, therefore, be considered together with ISO 15663 (all parts).

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.