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Petroleum, petrochemical and natural gas industries — Calculation and reporting production efficiency in the operating phase

Industries du pétrole, de la pétrochimie et du gaz naturel — Calcul et rapport d'efficacité de la production dans la phase d'exploitation

PROOF/ÉPREUVE

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Foreword

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

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 petroleum, petrochemical and natural gas industries involve large capital expenditure as well as operating expenditure. Revenue loss caused by production loss will affect the profitability of such industry and for a specific plant operatorship.

Production efficiency (PE) is a term often used by operators for historic production availability in the operating phase. PE is a reported measure, and it can be compared with the predicted (or targeted) production availability made during a project development stage. Furthermore, PE is forecasted and tracked during the operating phase to allow tracking of performance. ISO 20815:2018 addresses production assurance activities including analytical methods for predicting production availability, and also includes a production loss categorization.

This document supports this production loss categorization with a harmonized approach for calculating and reporting production loss and production efficiency in the operating phase, including forecasting during this life cycle phase. This will enable precise and consistent feedback of production performance for use in production and operational planning to achieve optimal PE for the operators and associated industry stakeholders. Focus is given to actual produced volume and reference production volume, e.g. production potential that will depend on reservoir and well constraints, plant/process constraints, export/transportation constraints and market constraints. Standardization of PE reporting across the industry will drive consistency and provide better quality PE information and communication for operators and partners.

Petroleum, petrochemical and natural gas industries — Calculation and reporting production efficiency in the operating phase

1 Scope

This document provides requirements and guidance for reporting of production performance data and production loss data in the operating phase by use of production loss categorization. It supplements the principles of ISO 20815:2018, Clause E.3 and Annex G by providing additional details.

This document focusses on installations and asset elements within the upstream business category. Business categories and associated installations and plants/units, systems and equipment classes are used in line with ISO 14224:2016, Annex A.

The production loss categories given in Annex A are given at a high taxonomic level and supplements the reporting of failure and maintenance parameters as defined in ISO 14224:2016, Annex B.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

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 http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
achieved production potential
production potential (3.1.43) that in retrospect can be verified as the maximum achievable production in a given time period

Note 1 to entry: Achieved production potential is the sum of the achieved production and the estimated *production loss* (3.1.40) occurring in the four production potential elements: *well production potential* (3.1.58), *plant production capacity* (3.1.34), *export capacity* (3.1.12) and *market potential* (3.1.26).

Note 2 to entry: Achieved production potential can vary over time.

3.1.2
asset
item (3.1.21), thing or entity that has potential or actual value to an organization

Note 1 to entry: Physical assets usually refer to equipment, inventory and properties owned by the organization. Physical assets are the opposite of intangible assets, which are non-physical assets such as leases, brands, digital assets, licenses, intellectual property rights, reputation or agreements.

Note 2 to entry: A grouping of assets referred to as an asset system (see ISO 55000:2014, 3.2.5) could 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* (3.1.50), *equipment classes* (3.1.11), subunits, components, etc. as described in ISO 14224:2016, Table 2. In this document, *asset element* (3.1.3) is used to group these as shown in Table A.2.

[SOURCE: ISO 55000:2014, 3.2.1, modified — Notes 2 and 3 to entry have become Notes 1 and 2 to entry, respectively, new Note 3 to entry has been added.]

3.1.3
asset element
underlying *item* (3.1.21) for the *asset* (3.1.2) that is needed for the asset to deliver its product

Note 1 to entry: In this document, which is applicable for upstream business category, the asset elements are wells (including reservoir), subsea installations, production facilities (including process and utilities), and export and import facilities as shown in Table A.2. For other business categories, the asset elements will be different.

Note 2 to entry: The underlying items of the individual asset element will be *systems* (3.1.50) and relevant *equipment classes* (3.1.11) as defined in ISO 14224:2016, and as shown in Table D.1.

3.1.4
availability
ability to be in a state to perform as required

Note 1 to entry: Various availability terms are defined in ISO 14224:2016, ISO 20815:2018 and ISO/TR 12489:2013.

[SOURCE: IEC 60050-192:2015, 192-01-23, modified — Note 1 to entry has been modified, Note 2 to entry has been deleted.]

3.1.5
conventional resources
oil and gas resources where the reservoir rock characteristics and fluid trapping mechanisms permit reservoir fluids to readily flow into the wellbore

Note 1 to entry: This usually includes conventional, reasonably permeable and connected, sandstone and carbonate reservoirs.

3.1.6
corrective maintenance
maintenance (3.1.24) carried out after fault detection to effect restoration

[SOURCE: IEC 60050-192:2015, 192-06-06, modified — Note 1 to entry has been deleted.]

3.1.7
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

Note 1 to entry: See Figure B.1 for further information.

[SOURCE: ISO 20815:2018, 3.1.8]

3.1.8
down time
time interval during which an *item* (3.1.21) 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 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) or production down time (see Figures I.1 and I.2 in ISO 20815:2018). Down time for other operations such as drilling is not addressed in this document but can affect production or prolong the production down time. It is important to distinguish between the equipment down time itself and the down time of the plant to which the equipment belongs; this document focusses on down time of the latter.

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

3.1.9
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.

Note 2 to entry: The term 'downstream' is sometimes used in this document to reflect installations to which products from installations within upstream business category are transported whereas these installations do not necessarily belong to the downstream business category.

[SOURCE: ISO 14224:2016, 3.17, modified — Note 2 to entry has been added.]

3.1.10
enhanced oil recovery
EOR
reservoir process involving the injection of materials not normally present in the reservoir to enhance the overall oil recovery from such reservoir

Note 1 to entry: Also denoted tertiary oil recovery processes; includes chemical, thermal and gas miscible processes, among others.

3.1.11
equipment class
class of similar type of equipment units (e.g. all pumps)

Note 1 to entry: See ISO 14224:2016, Annex A for equipment specific data.

[SOURCE: ISO 14224:2016, 3.18]

3.1.12
export capacity
maximum volume rate that can be exported

Note 1 to entry: The export capacity can be limited by oil or gas or any other product (e.g. produced water and CO_2). Both the capacity of the export systems (e.g. pipeline) and the downstream receiving facilities needs to be considered.

Note 2 to entry: The export capacity is a volume rate applicable for the product exported. Restrictions in the flowrate to storage caused by limitations in the capacity of export pumps, pipeline capacity, etc., will affect export capacity. Limited storage volume resulting in reduced or no production due to insufficient offtake capacity (e.g. shuttle tanker delay) is an event and will not affect the export capacity but it is a *production loss* (3.1.40).

Note 3 to entry: The plant export capacity can vary over time.

3.1.13
failure
loss of ability to perform as required

Note 1 to entry: A failure of an *item* (3.1.21) is an event that results in a fault (i.e. a state) of that item. This is illustrated in the figure in ISO 20815:2018, 3.1.50 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 modified, Notes 2 and 3 to entry have been deleted.]

3.1.14
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]

3.1.15
failure impact
effect of a *failure* (3.1.13) 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' (ISO 14224:2016, 3.9), 'degraded failure' (ISO 14224:2016, 3.11) and 'incipient failure' (ISO 14224:2016, 3.40). Classification of failure impact on taxonomy levels 3 to 5 (see ISO 14224:2016, Figure 3) is shown in ISO 14224:2016, Table 3.

Note 2 to entry: Classification of failure impact on taxonomy levels 4 and 5 (see ISO 14224:2016, Figure 3) is shown in ISO 14224:2016, Table 3. See also ISO 14224:2016, C.1.10.

[SOURCE: ISO 14224:2016, 3.28]

3.1.16
human error
discrepancy between the human action taken or omitted and that intended

[SOURCE: IEC 60050-192:2015, 192-03-14, modified — "or required" has been deleted from the definition, example has been deleted.]

3.1.17
improved oil recovery
IOR

process used to improve the overall oil recovery from a reservoir, including but not limited to *enhanced oil recovery* (3.1.10)

Note 1 to entry: IOR includes not only reservoir recovery processes (secondary and tertiary), but also other techniques such as infill drilling and artificial lift.

Note 2 to entry: Secondary recovery processes refer to processes involving the injection of gas and/or water, mostly for reservoir pressure *maintenance* (3.1.24).

3.1.18
injection efficiency
IE
I_E
ratio of injected volume to the *injection potential* (3.1.19) over a specified period of time

Note 1 to entry: This is a volume-based performance measure similar to *production efficiency* (3.1.39).

Note 2 to entry: Injection availability is a time-based measure.

3.1.19
injection potential
V_{IP}
maximum volume that can be injected in a reservoir within a given time period, considering the capacity of injection systems and injection wells

Note 1 to entry: Injection potential can be related to injection of gas, water, CO_2 or other products.

Note 2 to entry: The maximum volume that can be injected may be taken to mean the 'optimum' volume that is injected to achieve optimal reservoir management. The optimum volume is often the one that maximizes economic recovery from the field. This optimum volume can be less than the maximum volume defined by the physical system capacity of the injection system, wells or reservoir.

3.1.20
integrity
ability of a barrier to function as required when needed

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

Note 2 to entry: There are different definitions of integrity: plant, *asset* (3.1.2), *system* (3.1.50), pipeline (see DNVGL-ST-F101:2017), well (see ISO 16530-1:2017, 3.73), mechanical, safety (see ISO/TR 12489:2013, 3.1.2), structural (see ISO 19900:2019, 3.50) and technical.

[SOURCE: ISO 20815:2018, 3.1.22]

3.1.21
item
subject being considered

Note 1 to entry: The item can be an individual part, component, device, functional unit, equipment, subsystem, or *system* (3.1.50).

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 also ISO 14224:2016, Figure 3.

[SOURCE: IEC 60050-192:2015, 192-01-01, modified — Note 4 and 5 to entry have been deleted.]

3.1.22
life cycle phase
discrete stage in the life cycle with a specified purpose

Note 1 to entry: The different life cycle phases 'Explore', 'Appraise', 'Select', 'Define', 'Execute', 'Operate' and 'Abandon' are further described in ISO 15663:2021, 4.5.

Note 2 to entry: This document focusses on the life cycle phase 'Operate' and uses the term 'operating phase' in this respect.

[SOURCE: ISO 15663:2021, 3.1.28, modified — Note 2 to entry has been added.]

3.1.23
lost revenue
total cost of lost or deferred production due to *down time* (3.1.8)

Note 1 to entry: See further information regarding estimation of lost revenue in ISO 15663:2021, Clause C.4, and a more general definition of lost revenue is given in ISO 15663:2021, 3.1.29.

[SOURCE: ISO 20815:2018, 3.1.25, modified — Note 1 to entry has been added.]

3.1.24
maintenance
combination of all technical and management actions intended to retain an *item* (3.1.21) in, or restore it to, a state in which it can perform as required

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

3.1.25
maintenance impact
effect of the *maintenance* (3.1.24) 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.

Note 2 to entry: For the calculation of PE data, it can be beneficial to separate the *production loss* (3.1.40) arising from the failure event and from the maintenance impact on production, into two different production loss categories. See further guidance in A.3.2.

[SOURCE: ISO 14224:2016, 3.52, modified — Note 2 to entry has been added.]

3.1.26
market potential
maximum volume rate that can be received by the market

Note 1 to entry: A sales contract can limit the market potential.

Note 2 to entry: The market potential can vary over time.

Note 3 to entry: The market potential reflects market constraints when determining the *structural maximum production potential* (3.1.49). When determining the *structural maximum injection potential* (3.1.48) market potential means the maximum volume that can be delivered by the market.

3.1.27
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, modified — Example has been deleted.]

3.1.28
modification
combination of all technical and administrative actions intended to change an *item* (3.1.21)

Note 1 to entry: Modification is not normally part of *maintenance* (3.1.24) but is frequently performed by maintenance personnel. This is typically the maintenance activity 'Modify' as defined in ISO 14224:2016, Table B.5.

Note 2 to entry: In this document, the use of the term modification is primarily meant to cover major modification activities. See further details in 8.2.2 with respect to how such major modifications are reflected in PE reporting.

[SOURCE: ISO 14224:2016, 3.67, modified — Notes 2 and 3 to entry have been deleted, new Note 2 to entry has been added.]

3.1.29
operative well
well that it is economically warrantable to operate

Note 1 to entry: The individual well potential is part of the *well production potential* (3.1.58) even if the well is temporarily shut down due to equipment failure, well intervention, valve testing, reservoir monitoring, etc. See also Table 4.

Note 2 to entry: Economic warrantability will be defined by the operator. Various economic subject matters will determine this economic margin, e.g. CAPEX, OPEX and revenue factors.

3.1.30
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 ISO 20815:2018, Annex F.

[SOURCE: ISO 20815:2018, 3.1.41]

3.1.31
performance requirement
required minimum level for the performance of the *system* (3.1.50)

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

[SOURCE: ISO 20815:2018, 3.1.42]

3.1.32
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, modified — Example has been deleted.]

3.1.33
planned event
event that is intentional, the start and end time is determined, and the effect of the event in terms of consequences is predictable

Note 1 to entry: See further information in 8.2.

Note 2 to entry: See production loss categories associated with planned events in Table A.1.

3.1.34
plant production capacity
maximum processed volume through the plant that can be achieved in the absence of any failure, interruption or any other event

Note 1 to entry: The plant production capacity is related to the product used for production efficiency calculation (see 7.3). The plant production capacity can be limited by the capacity of systems handling other product streams, e.g. condensate, gas or produced water, or by the capacity of utility systems.

Note 2 to entry: The plant production capacity can vary over time.

Note 3 to entry: The plant represents the *systems* (3.1.50) between the elements well and export as illustrated in Figure 5.

3.1.35
preventive maintenance
maintenance (3.1.24) carried out to mitigate degradation and reduce the probability of *failure* (3.1.13)

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

Note 2 to entry: Preventive maintenance can be categorized as shown in ISO 14224:2016, Figure 6.

[SOURCE: IEC 60050-192:2015, 192-06-05 — Note 2 to entry has been added]

3.1.36
primary product
hydrocarbon product that is the main contributor to the production target from an *asset* (3.1.2)

Note 1 to entry: The primary product can be crude oil, condensate or gas. The primary product from an asset (e.g. an individual upstream field or field infrastructure consisting of various installations) will be a result of reservoir characteristics, field development planning and facility design as determined by the production strategy of the field or installation in question.

Note 2 to entry: The primary product can change throughout the operating phase of the asset.

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

Note 1 to entry: Production assurance activities relate closely to the integrity management of the installations. See definition of *integrity* (3.1.20).

Note 2 to entry: See further information in ISO 20815:2018 with respect to *production assurance* (3.1.37) for a variety of oil and gas activities.

[SOURCE: ISO 20815:2018, 3.1.45, modified — Note 2 to entry has become Note 1 to entry, new Note 2 to entry has been added.]

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

Note 1 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 2 to entry: See ISO 20815:2018, Clause G.1 and Figure G.1 for further information.

[SOURCE: ISO 20815:2018, 3.1.46, modified — Notes 1, 2, 4 and 5 to entry have been deleted, Note 3 to entry has become Note 1 to entry, new Note 2 to entry has been added.]

3.1.39
production efficiency
PE
P_E
ratio of production to *production potential* (3.1.43) over a specified period of time

Note 1 to entry: PE calculation methodology is described in 5.4.1. There are two methods for PE calculations as described in in 7.2 to 7.4.

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, see also 6.3.

Note 4 to entry: *Production efficiency* (3.1.39) is a term often used by operators for historic *production availability* (3.1.38) in the operating phase and is a reported measure, but in principle the same measure as predicted production availability that is a modelled measure. See also 3.1.38.

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 Annex A.

3.1.40
production loss
difference between *production potential* (3.1.43) and actual production

Note 1 to entry: Production loss is caused by planned or unplanned activities or events. Annex A defines production the 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.

3.1.41
production performance
capacity of a *system* (3.1.50) to meet demand for deliveries or performance

Note 1 to entry: *Production availability* (3.1.38), *deliverability* (3.1.7) 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.

Note 3 to entry: In this document, p*roduction efficiency* (3.1.39) is used as the measure for production performance.

[SOURCE: ISO 20815:2018, 3.1.47, modified — Note 3 to entry has been added.]

3.1.42
production performance analysis
systematic evaluations and calculations carried out to assess the *production performance* (3.1.41)

Note 1 to entry: Various measures used in production performance analysis to address various parts of the hydrocarbon production chain are shown in Annex B. Production availability analysis is an analysis that normally covers the entire *asset* (3.1.2); see ISO 20815:2018, Clause I.5.

[SOURCE: ISO 20815:2018, 3.1.48, modified — 'of a system' has been removed from the definition, Notes 1 and 2 to entry have been deleted, new Note 1 to entry has been added.]

3.1.43
production potential
V_{PP}
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: Production potential can be expressed as *structural maximum production potential* (3.1.49) or *achieved production potential* (3.1.1).

Note 3 to entry: Production potential is the maximum production potential that is technically feasible and economically acceptable and is the minimum of the four production potential elements: *well production potential* (3.1.58), *plant production capacity* (3.1.34), *export capacity* (3.1.12) and *market potential* (3.1.26). See also Figure 5.

Note 4 to entry: For business categories *midstream* (3.1.27), *downstream* (3.1.9) and *petrochemical* (3.1.32) where there is not a continuous flow from the reservoir to the plant, reservoir and wells might not be relevant for the production potential. However, limitations on import capacity are still to be considered when determining the production potential.

Note 5 to entry: In this document, *production efficiency* (3.1.39) is calculated using 'production potential' instead of the more general 'reference production volume'. See Clause B.2.

3.1.44
reliability
ability of an *item* (3.1.21) to perform a required function under given conditions for a given time interval

[SOURCE: ISO 14224:2016, 3.81 modified — Notes to entry have been deleted.]

3.1.45
reliability management
activities undertaken to achieve reliability related *performance objectives* (3.1.30) and requirements

[SOURCE: ISO 20815:2018, 3.1.52 modified — Notes to entry have been deleted.]

3.1.46
safety critical equipment
equipment and *items* (3.1.21) of permanent, temporary and portable equipment playing an important role in safety systems/functions

[SOURCE: ISO 14224:2016, 3.84]