



IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity

STANDARDS

IEEE Power and Energy Society

Developed by the
Analytic Methods in Power Systems Committee

IEEE Std 762™-2023
(Revision of IEEE Std 762-2006)



IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity

Developed by the

Analytic Methods in Power Systems Committee
of the
IEEE Power and Energy Society

Approved 30 March 2023

IEEE SA Standards Board

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Abstract: Outlined in this document are standardized terminology and indexes for reporting electric generating unit reliability, availability, and productivity performance measures that recognize the power industry's needs, including marketplace competition. This standard also includes equations for equivalent demand forced outage rate (EFORd), newly identified outage states, energy weighted equations for group performance indexes, definitions of outside management control (OMC), pooling methodologies, and time-based calculations for group performance indexes. It includes consideration of variable energy resource units and resource unavailability and new indexes appropriate for that purpose.

Keywords: available state, EFORd, equivalent demand forced outage rate, forced outage, IEEE 762, maintenance outage, OMC, outside management control, planned outage, pooling methodology, power generation reliability, renewable energy, solar power generation, transition between active states, unavailable state, weighted factor, wind energy generation•

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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PDF: ISBN 978-1-5044-9618-6 STD26094
Print: ISBN 978-1-5044-9619-3 STDPD26094

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Introduction

This introduction is not part of IEEE Std 762-2023, IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity.

Measures of generating unit performance have been defined, recorded, and utilized by the electric power industry for more than 60 years. The continuing focus on generating unit performance in a competitive marketplace has caused regulatory agencies, system operators, and generator owners to place strong emphasis on performance measures.

This standard was first approved for trial use in 1980 and for full use in 1987, based on efforts started in 1968, to provide terminology and indexes for use in existing data systems or in future systems. A revision in 2006 provided new indexes for units providing non-base load service. It defined sufficient data categories (states, times, capacity levels) such that suitable indexes for conventional units in all types of service can be calculated. It also provided indexes for groups of units, indexes that include the time a unit performs non-generating functions, and indexes that exclude events outside management control (OMC).

The focus of this 2023 revision is on adding performance measures for variable energy resource (VER) or renewable generation, reflecting the rapidly increasing share of such generators in the supply portfolio of many regions around the world and interest in their impact on resource adequacy. Concepts introduced in this revision include:

- Energy resource (3.11), the energy in a renewable energy source or a fuel, and resource unavailability (3.21), including both full and partial unavailability of the energy resource
- System vs. unit indexes (5.1), where a system index represents the effect of a generator on system reliability analysis and reflects resource unavailability, while a unit index represents the performance of a generator excluding the influence of a variable energy resource
- Expected capacity (5.2.6), the calculated capacity available at a particular time for given ambient or meteorological conditions and energy resource limitations
- Sub-units (3.22), multiple identical generators at a single location reported as an aggregate
- Generation-based performance indexes (9.3, 9.5, and 9.7), for which the base is maximum or expected generation rather than active hours
- Critical period (3.7), a specified set of hours of elevated risk for the system, and critical period indexes (9.8.4–9.8.7), which are calculated from data restricted to the critical period

Generation-based factors and rates are regarded as essential for the incorporation of variable energy resource units into the standard, because expected generation is not a simple multiple of the active hours in the period. In a sense, these are a class of indexes measuring the productivity of a generating unit. The IEEE 762-2006 Working Group performed an in-depth review of the concept and practices for commercial availability, but concluded that commercial availability should be studied further, and should not be incorporated into the standard at that time. Although the current Working Group did not address commercial availability in depth, the new generation-based indexes may be considered a first step in toward indexes of commercial availability. A future step would be to account for the financial impacts of variations in unit performance, which may be considered for a revised or new standard concerning commercial availability. Nor is the storage component of hybrid VER/storage plants addressed. It is anticipated that storage will be addressed in a subsequent revision.

The IEEE 762-2023 Working Group has sought in developing the terms and indexes defined for VER units both to accommodate the fundamental differences between VER and Conventional units, and to maintain as

much conceptual and logical consistency as possible between the two types. The Working Group has also sought in communicating these terms and indexes to facilitate ready understanding both of the similarities and differences between the types, and of the background and application of the terms and indexes to each of the types with minimal confusion from the other type.

To these ends, this 2023 revision includes as informative annexes application guides focusing exclusively on each of categories, while the main body presents the formal definitions with the variations among the types together in the same place. Therefore, the reader seeking an introduction to or an overview of use of the standard for one type of generator—conventional or VER—is directed first to Annex A for Conventional units or Annex B for VER units.

Acknowledgments

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IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity

1. Overview

1.1 Scope

~~Although~~ A generating Unit generally includes all equipment from the resource ~~fuel~~ supply system up to the high-voltage terminals of the generator step-up transformer and the station service transformers. ⁷ Any event preventing the ~~ability of the~~ generating Unit from producing ~~to produce~~ electricity at its maximum capacity is covered in the scope of this standard. ~~Sometimes, the generating unit cannot provide the power required to the customer because of problems not related to the power plant equipment. Some examples of these “external events” are transmission system failures, labor strikes, and catastrophic storms.~~

~~NOTE—See Annex D for a discussion on these external events.[†]~~

Reliability in this standard encompasses measures of the ability of generating Units to perform their intended function in a specified period. *Availability* measures are concerned with the fraction of time in which a Unit is capable of providing service and accounts for outage frequency and duration. *Productivity* measures compare ~~are concerned with~~ the total power produced by a Unit ~~plant with respect~~ to its potential power production. ~~A plant could comprise a unit or a number of units. Therefore,~~ Productivity measures consider the magnitude of events ~~event~~ as well as the frequency and duration of events ~~event~~.

Sometimes, unforeseen events render the generating Unit unable to provide the power required to the customer because of problems unrelated to the power plant equipment. Some examples of these “external events,” called “Outside management control,” are transmission system failures, labor disputes, catastrophic storms and lack of fuel or another needed energy resource. Other events deprive the Unit of a resource needed for it to generate electricity, in a way that was anticipated in the planning and design of the plant. Units of this type are referred to as Variable energy resource (VER) units.

~~This standard was developed for application at the unit level; it does not address applications at the plant component or system level. Because of these exceptions, care should be taken when using this standard below the unit level.~~

Many of the performance indexes defined in Clause 9 8 are expressed as either outage rates or factors, and it is important to note the difference. A factor represents the percentage of time in the active state within a period of study that a Unit or Units occupied a given state, as in Availability factor (AF), Forced outage factor (FOF), or Service factor. A factor may also represent the percentage of a total outcome achieved. For example, Net ~~as~~ capacity factor ~~is represents~~ the ratio of Net actual generation to Net maximum ~~theoretically possible~~ generation. Factors may be added to provide a total accounting for unit states during a given period.

By comparison, outage rates provide a measure of the probability, calculated from historical data, of the existence of an outage state any time in the future or under certain conditions. While the denominator of the Forced outage factor, for example, is Active hours, the denominator of the Forced outage rate excludes Planned outage hours, Maintenance outage hours, and Reserve shutdown hours.

Attaching the term “equivalent” to any rate or factor, as Equivalent availability factor (EAF) or Equivalent forced outage rate (EFOR), indicates that both full outages and deratings have been considered in the calculation.

The term “demand” applied to a rate, as in $EFOR_d$, indicates that the ~~rate probability~~ of an occurrence has been calculated ~~estimated~~ for periods when the Unit is in demand to generate. The term “Critical period” denotes an index calculated using only data from historical hours included in a specified Critical period, hours in which there was an elevated risk of shortage.

This standard includes indexes both for application at the unit level and for pooling the performance of a Group of Units. Group indexes can be either Weighted, indicating ~~When statistics are combined for more than one unit, the term weighted indicates~~ that data from each Unit influence the total in proportion to its capacity size or other indicated weighting factor, or unweighted. See Clause ~~9 and~~ Clause 10.

1.1 Scope

This document standardizes terminology and indexes for reporting electric generating unit reliability, availability, and productivity performance measures that recognize ~~while recognizing~~ the power industry’s needs, including marketplace competition. This standard also includes consideration of VER units and Resource unavailability, and new indexes appropriate for that purpose. This document does not address common mode or dependent outages. ~~equations for equivalent demand forced outage rate ($EFOR_d$), newly identified outage states, discussion of commercial availability, energy weighted equations for group performance indexes, definitions of outside management control (OMC), pooling methodologies, and time-based calculations for group performance indexes.~~

1.2 Purpose

This standard is intended to aid the electric power industry in reporting and evaluating electric generating unit reliability, availability, and productivity. It was originally developed to overcome difficulties in the interpretation of electric generating unit performance data from various systems and to facilitate comparisons among different systems. The standard also makes possible the exchange of meaningful data among systems in North America and throughout the world. [It includes both indexes for unit performance analysis, which exclude outages or deratings owing to resource unavailability, and indexes for system reliability analysis, which include outages and deratings owing to Resource unavailability as well as equipment unavailability. The distinction recognizes that Resource unavailability affects the contribution of a Unit to system reliability, but is not something for which plant management should be held responsible.](#)

[The primary purpose of this standard is to define summary statistics of historical data, for reporting and analyzing outage occurrences, and to facilitate exchange of data between utilities. If indexes from Clause 9 or Clause 10 of this standard are used as inputs to predictive models, it is necessary to ensure that \(a\) the generators and the environment in which their performance was observed are similar to the system whose performance is to be predicted; \(b\) the period of observation over which the input data were collected is a sufficient multiple of the mean service time to outage to achieve a reasonable confidence interval for the indexes to be used in the predictive models, and \(c\) although this standard does not address common mode and dependent events, adequate consideration of such events has been given to avoid the fallacy of assuming that all outages are independent.](#)

1.3 Word usage

[The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted \(*shall* equals *is required to*\).^{6,7}](#)

⁶ [The word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.](#)

⁷ [The word *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.](#)

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*)."

1.4 Using this standard

Review the application guide for the type of generation of interest—Annex A or Annex B—for an overview of the key concepts in the context of the selected generation type.

Equations are presented starting in Clause 6. Performance indexes are presented in Clause 9. Because equations and the definitions of variables make up the bulk of the standard, variables are only occasionally defined immediately following an equation. Rather, the reader is advised to refer to Annex C, in which acronyms are listed in alphabetical order with the full name of the variable and a cross-reference to the place the variable is defined. Also, at the beginning of Annex C, there is a list of letters used to denote some of the most common words in variable names and subscripts used to denote variants of variables or indexes.

Note also the general progression of clauses within the main body of the standard, starting with Clause 3:

- 3) Definitions of general terms
- 4) Unit states
- 5) Capacity terms
- 6) Time designations
- 7) Generation (energy) terms

- 8) [Equivalent hours](#)
- 9) [Performance indexes of an individual unit](#)
- 10) [Group performance indexes](#)

[The application guides have diagrams showing the hierarchical relationships between key terms in Clause 4 through Clause 7.](#)

2. Normative references

The following referenced documents are indispensable for the application of this document ([i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained](#)). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

[There are no normative references in this standard.](#)

~~None~~

3. Definitions of general terms

3.1 Introduction

[For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁸](#)

[For abbreviations and acronyms see Annex C.](#)

3.2 Auxiliary group

[A Group \(3.14\) of Units \(3.23\) designated as Auxiliary units \(3.4\).](#)

⁸[IEEE Standards Dictionary Online](#) is available at: <http://dictionary.ieee.org>.

3.3 Auxiliary load

Energy consumed within the plant boundary to support energy production, also called plant use.

3.4 Auxiliary unit

A Unit whose output can be temporarily added to replace that of another Unit (or Units) within the same Plant (3.18) that become(s) unavailable. Auxiliary units are available and connected to the system but are generally held in reserve.

3.5 Capacity

(See 5.2.)

3.6 Conventional unit

(See 3.23.2.)

3.7 Critical period

A specified set of hours for which particular time, generation, or index values are to be accumulated or calculated. A value restricted to a Critical period is denoted by the subscript K, for example AH_K is the Available hours in the Critical period.

The set of hours in a Critical period is denoted $\{TH_K\}$.

NOTE—A Critical period should be specified to represent hours with elevated risk of capacity shortfall. Examples of a Critical period:

- Selected hours of peak demand, or peak net demand after subtracting an hourly VER generation profile or other load modifier, or shortage periods defined by low reserve margins

— A multi-year set of seasons or selected hours from multiple years⁹

3.8 Customer

An entity that purchases the power produced by a Plant, whether for its own use or for resale.

NOTE—The power produced may be delivered through facilities owned by a separate Interconnection provider (see 3.15).

3. Definitions

~~This clause provides the conceptual definitions of the basic performance indexes while the equations to calculate the indexes are included in Clause 8 or Clause 10. The specific subclause in Clause 8 or Clause 10 is referenced for each defined term.~~

~~**3.1 availability factor (AF):** The fraction of a given operating period in which a generating unit is available without any outages.~~

~~NOTE—See 8.6.~~

~~**3.2 demand forced outage rate (FOR_d):** A measure of the probability that a generating unit will not be available due to forced outages when there is demand on the unit to generate.~~

~~NOTE—See 8.16.2.~~

~~**3.3 derating adjusted utilization forced outage probability (DAUFOP):** A measure of the probability that a generating unit will not be available when needed (derating included).~~

~~NOTE—See 8.17.3.~~

~~**3.4 equivalent availability factor (EAF):** The fraction of a given operating period in which a generating unit is available without any outages and equipment or seasonal deratings.~~

² ~~†~~ Notes to text, tables, and figures are ~~given~~ for information only and do not contain requirements needed to implement ~~the~~ this standard.

NOTE—See 8.11.

~~3.5 equivalent availability factor excluding seasonal deratings (EAF_{xs}): The fraction of a given operating period in which a generating unit is available without any outages and equipment deratings.~~

NOTE—See 8.11.1.

~~3.6 equivalent forced outage factor (EFOF): The fraction of a given operating period in which a generating unit is not available due to forced outages and deratings.~~

NOTE—See 8.20.

~~3.7 equivalent forced outage rate (EFOR): A measure of the probability that a generating unit will not be available due to forced outages or forced deratings.~~

NOTE—See 8.17.

~~3.8 equivalent demand forced outage rate (EFOR_d): A measure of the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate.~~

NOTE—See 8.17.2.

~~3.9 equivalent forced outage rate total—generating or other functions (EFOR_t): A measure of the probability that a generating unit will not be available due to forced outages or forced deratings including the exposure to nongenerating functions.~~

NOTE—See 8.17.1.

~~3.10 equivalent maintenance outage factor (EMOF): The fraction of a given operating period in which a generating unit is not available due to maintenance outages and maintenance deratings.~~

NOTE—See 8.21.

~~**3.11 equivalent planned outage factor (EPOF):** The fraction of a given operating period in which a generating unit is not available due to planned outages and planned deratings.~~

~~NOTE—See 8.18.~~

~~**3.12 equivalent unavailability factor (EUF):** The fraction of a given operating period in which a generating unit is not available due to outages and deratings.~~

~~NOTE—See 8.10.~~

~~**3.13 equivalent unplanned outage factor (EUOF):** The fraction of a given operating period in which a generating unit is not available due to forced and maintenance outages and forced and maintenance deratings.~~

~~NOTE—See 8.19.~~

~~**3.14 forced outage factor (FOF):** The fraction of a given operating period in which a generating unit is not available due to forced outages.~~

~~NOTE—See 8.3.~~

~~**3.15 forced outage rate (FOR):** A measure of the probability that a generating unit will not be available due to forced outages.~~

~~NOTE—See 8.16.~~

~~**3.16 forced outage rate total (FOR_T):** A measure of the probability that a generating unit will not be available due to forced outages including the exposure to nongenerating functions.~~

~~NOTE—See 8.16.1.~~

~~**3.17 gross capacity factor (GCF):** The gross energy that was produced by a generating unit in a given period as a fraction of the gross maximum generation (GMC). GMC is the period hours (PH) times the gross maximum capacity (GMC).~~

~~NOTE—See 8.12.~~

~~**3.18 gross output factor (GOF):** Gross capacity factor (GCF) when the period is applicable only to the inservice state.~~

~~NOTE—See 8.14.~~

~~**3.19 maintenance outage factor (MOF):** The fraction of a given operating period in which a generating unit is not available due to maintenance outages.~~

~~NOTE—See 8.4.~~

~~**3.20 net capacity factor (NCF):** The net energy that was produced by a generating unit in a given period as a fraction of the net maximum generation (NMG). NMG is the period hours (PH) times the net maximum capacity (NMC).~~

~~NOTE—See 8.13.~~

~~**3.21 net output factor (NOF):** Net capacity factor (NCF) when the period is applicable only to the inservice state.~~

~~NOTE—See 8.15.~~

~~**3.22 planned outage factor (POF):** The fraction of a given operating period in which a generating unit is not available due to planned outages.~~

~~NOTE—See 8.1.~~

~~**3.23 starting reliability (SR):** A measure of the probability that a generating unit will start successfully when required.~~

~~NOTE—See 8.24.~~

~~**3.24 unavailability factor (UF):** The fraction of a given operating period in which a generating unit is not available due to outages.~~

~~NOTE—See 8.5.~~

~~3.25 utilization forced outage probability (UFOP): A measure of the probability that a generating unit will not be available due to forced outages when there is demand on the unit to generate.~~

~~NOTE—See 8.16.3. UFOP is the same as demand forced outage rate (FOR_d) (see 3.2); however, UFOP is used in Canada.~~

~~3.26 unplanned outage factor (UOF): The fraction of period a generating unit is not available due to unplanned outages.~~

~~NOTE—See 8.2.~~

~~3.27 weighted availability factor (WAF): The capacity weighted availability factor for a fleet of units. See: availability factor (AF).~~

~~NOTE—See 10.6.~~

~~3.28 weighted demand forced outage rate (WFOR_d): The capacity weighted demand forced outage rate for a fleet of units. See: demand forced outage rate (FOR_d).~~

~~NOTE—See 10.16.2.~~

~~3.29 weighted derating adjusted utilization forced outage probability (WDAUFOP): The capacity weighted derating adjusted utilization forced outage probability for a fleet of units. See: derating adjusted utilization forced outage probability (DAUFOP).~~

~~NOTE—See 10.17.3.~~

~~3.30 weighted equivalent availability factor (WEAF): The capacity weighted equivalent availability factor for a fleet of units. See: equivalent availability factor (EAF).~~

~~NOTE—See 10.11.~~

~~3.31 weighted equivalent availability factor excluding seasonal deratings (WEAF_{xs}): The capacity weighted equivalent availability factor excluding seasonal deratings for a fleet of units. See: equivalent availability factor excluding seasonal deratings (EAF_{xs}).~~

NOTE—See 10.11.1.

~~3.32 weighted equivalent forced outage factor (WEFOF):~~ The capacity-weighted equivalent forced outage factor for a fleet of units. ~~See: equivalent forced outage factor (EFOF).~~

NOTE—See 10.20.

~~3.33 weighted equivalent forced outage rate (WEFOR):~~ The capacity-weighted equivalent forced outage rate for a fleet of units. ~~See: equivalent forced outage rate (EFOR).~~

NOTE—See 10.17.

~~3.34 weighted equivalent demand forced outage rate (WEFOR_d):~~ The capacity-weighted equivalent demand forced outage rate for a fleet of units. ~~See: equivalent demand forced outage rate (EFOR_d).~~

NOTE—See 10.17.2.

~~3.35 weighted equivalent forced outage rate total—generating or other functions (WEFOR_T):~~ The capacity-weighted equivalent forced outage rate total—generating or other functions for a fleet of units. ~~See: equivalent forced outage rate total—generating or other functions (EFOR_T).~~

NOTE—See 10.17.1.

~~3.36 weighted equivalent maintenance outage factor (WEMOF):~~ The capacity-weighted equivalent maintenance outage factor for a fleet of units. ~~See: equivalent maintenance outage factor (EMOF).~~

NOTE—See 10.21.

~~3.37 weighted equivalent planned outage factor (WEPOF):~~ The capacity-weighted equivalent planned outage factor for a fleet of units. ~~See: equivalent planned outage factor (EPOF).~~

NOTE—See 10.18.

~~3.38 weighted equivalent unavailability factor (WEUF):~~ The capacity-weighted equivalent unavailability factor for a fleet of units. ~~See: equivalent unavailability factor (EUF).~~

NOTE—See 10.10.

~~3.39 weighted equivalent unplanned outage factor (WEUOF): The capacity-weighted equivalent unplanned outage factor for a fleet of units. See: equivalent unplanned outage factor (EUOF).~~

NOTE—See 10.19.

~~3.40 weighted forced outage factor (WFOF): The capacity-weighted forced outage factor for a fleet of units. See: forced outage factor (FOF).~~

NOTE—See 10.3.

~~3.41 weighted forced outage rate (WFOR): The capacity-weighted forced outage rate for a fleet of units. See: forced outage rate (FOR).~~

NOTE—See 10.16.

~~3.42 weighted forced outage rate total—generating or other functions (WFOR_T): The capacity-weighted forced outage rate total—generating or other functions for a fleet of units. See: forced outage rate total—generating or other functions (FOR_T).~~

NOTE—See 10.16.1.

~~3.43 weighted maintenance outage factor (WMOF): The capacity-weighted maintenance outage factor for a fleet of units. See: maintenance outage factor (MOF).~~

NOTE—See 10.4.

~~3.44 weighted planned outage factor (WPOF): The capacity-weighted planned outage factor for a fleet of units. See: planned outage factor (POF).~~

NOTE—See 10.1.

~~3.45 weighted unavailability factor (WUF): The capacity-weighted unavailability factor for a fleet of units. See: unavailability factor (UF).~~

NOTE—See 10.5.

~~3.46 weighted utilization forced outage probability (WUFOP): The capacity weighted utilization forced outage probability for a fleet of units. See: utilization forced outage probability (UFOP).~~

NOTE—See 10.16.3.

~~3.47 weighted unplanned outage factor (WUOF): The capacity weighted unplanned outage factor for a fleet of units. See: unplanned outage factor (UOF).~~

NOTE—See 10.2.

3.9 Dates

3.9.1 Service date ~~(SD)~~

The ~~service~~ date ~~is~~ when a Unit ~~is~~ ~~was~~ initially made available to supply power commercially to the system placed in the active state.

NOTE—A Unit may have generated power on a test basis before its Service date.

3.9.2 Deactivation date

The ~~deactivation~~ date ~~is~~ when a Unit was placed into an Inactive state (see 4.3). ~~the deactivated~~

NOTE—Inactive state was formerly named Deactivated shutdown state.

3.9.3 Reactivation date

The ~~reactivation~~ date ~~is~~ when a Unit was returned to the Active state from an Inactive ~~the deactivated shutdown~~ state.

3.10 Demand (for a unit)

A condition where a Unit will be dispatched for economic or reliable operation of the system (security reasons) if it is available. Economic reasons occur when the Unit's incremental cost of operation is lower than the marginal cost of production for the dispatched system as a whole. Security reasons occur if the Unit is a preferred source of VAr support, operational reserves, local support in the event of tie line outages, or other measures of system support, even if its MW output is not competitive under economic dispatch. This term is not applicable to Units whose output must be taken by the Customer for contractual or other reasons.

A time period where there is demand for the Unit may be referred to as a "period of demand," whether or not the Unit is available to satisfy that Demand. Such a period is not a "unit state," but it is a condition which can exist for any Unit in the Active state (4.2). Typically, periods of demand during planned or maintenance outages, i.e., those taken intentionally, are not reported, and periods when the Unit is in Reserve shutdown are never periods of demand.

3.11 Energy resource

The energy contained in burnable or nuclear fuel, flowing water, wind, sunlight or geothermally heated water that can be converted into electrical energy.

NOTE—Cooling water at a particular temperature needed to support Unit operation at a specified capacity is not an "Energy resource" within the meaning of this definition. Hence a reduction in capacity due to lack of cooling water is a derating, not a state of Resource unavailability.

3.12 Equivalent

A performance index adjusted to consider the effect of Unit deratings.

3.13 Gross

Referring to the total capacity for energy production or the total energy produced, without reduction for Auxiliary load (3.3). Also see Net (3.16).

3.14 Group

A subset of the Units within a Plant, designated by the Plant owner, distinguished by some common attribute such as ownership, manufacturer, model, commissioning year, collector feeder or step-up transformer. Groups may be further divided into sub-groups if desired.

3.15 Interconnection provider

An entity that takes responsibility for delivering the power generated by the Plant beyond a specified point, usually the revenue meter.

NOTE— A related industry term is “off-taker”.

3.16 Net

Referring to the capacity for energy production or the energy produced that is deliverable at the revenue meter, after reduction for Auxiliary load (3.3).

3.17 Outside management control

A particular reporting system may choose to exclude some outages as “Outside management control”. Typically, these are either external to a defined interface between the Plant and the system, due to an extreme weather event, or due to regulatory or environmental constraints. See Annex D for further discussion.

3.18 Plant

An energy generating facility consisting of one or more Units.

NOTE— An aggregation of distributed generators within the area served by a distribution substation may be considered a Plant for reporting or modeling purposes; however, such distributed generators should not be combined in a single Plant with Conventional units.

3.19 Plant operator

An organization that operates all Units in a specified Plant.

NOTE— The Plant operator is responsible for reporting the performance of the Units they operate.

3.20 Plant owner

An organization that owns all Units in a specified Plant.

3.21 Resource unavailability

The full or partial unavailability of the Energy resource (3.11) for a generator.

3.22 Sub-unit

One of multiple identical generators at a single location that is reported as an aggregate.

3.23 Unit

3.23.1 Introduction

One or more generators, collectors or other devices converting another form of energy to electrical energy, including, but not limited to, any thermodynamic devices such as boilers, reactors, reciprocating engines, or turbines performing an intermediate conversion to mechanical energy. If multiple devices are used to convert another form of energy to electrical energy, they are so interrelated that the combination is normally and most efficiently operated as a single entity.

A Unit is the lowest reportable entity for reliability indexes.

Examples include:

- a) A generator, a steam turbine on a common shaft with the generator, and one or more boilers dedicated to that turbine.

- b) Multiple generators and turbines, one turbine being supplied from dedicated boilers, the other being supplied by reheated steam from the first turbine. This is referred to as a cross-compound Unit.
- c) A generator and a steam turbine supplied from one or more boilers supplying other similar turbines. The boiler, or any combination of boilers, can supply any turbine. Each turbine and its connected generator are referred to as a common header Unit and the Group of such Units supplied from a common steam header is referred to as a common header Group.
- d) A generator and a waterwheel.
- e) A generator and a combustion turbine.
- f) Two or more generators, each powered by a combustion turbine, together with an additional generator powered by a steam turbine receiving its energy from a heat recovery boiler utilizing the exhaust gases of the combustion turbine(s). This is referred to as a combined cycle Unit. However, the performance of the turbines may be reported individually under particular reporting schemes.
- g) A wind turbine.
- h) One or more photovoltaic (PV) panels whose dc output is inverted to system frequency by a common inverter.
- i) A Group or sub-group (3.14) of multiple identical wind turbines or PV panel-supplied inverters at a single location, for which the individual wind turbines or inverters are denoted Sub-units (3.22).

NOTE 1— Multiple generators within a single Unit may operate at different voltages and/or speeds, except in the case of example i).

NOTE 2— Multiple identical Units within a Plant, particularly smaller Units, may be reported at the Group or sub-group level rather than the individual unit level.

NOTE 3— A hydroelectric Unit may be classified as either Conventional or VER, depending on how it is operated.

3.23.2 Conventional unit

Conventional units include:

- Nuclear and fossil (steam) Units, including multi-boiler/multi-turbine Units;
- Hydro and pumped storage Units (see note below);
- Gas turbines, jet engines, and reciprocating engines (including diesel engines);
- Combined-cycle Units (or blocks) consisting of one or more gas turbines/jet engines and one or more heat recovery boilers;
- Co-generation Units;
- Fluidized bed combustion Units;
- Geothermal Units;
- Other miscellaneous Conventional units (such as variable fuel, biomass, landfill gases, etc.) used to generate electric power for the grid and similar in design and operation as the Units listed.

NOTE 1— A run-of-river hydro Unit may be categorized as a Variable energy resource unit.

NOTE 2— Units burning biomass and landfill gas, using conventional steam or combustion turbine technology but operating primarily to dispose of something undesirable, whenever available, may exhibit the characteristics of a Variable energy resource unit in that Resource unavailability is a normal part of operation and the electricity generated is a byproduct.

3.23.3 Variable energy resource unit (VER unit)

A Unit for which Resource unavailability (see 3.21) is a normal occurrence. Run of river hydro Units, wind turbines and PV arrays are examples of VER units.

3.24 Unit owner

An organization that owns one or more Units and is responsible for reporting their performance.

7. Energy terms

~~Similar to capacity terms, energy terms can be expressed as gross or net quantities.~~

~~NOTE—Maximum generation = available generation + unavailable generation + seasonal unavailable generation = actual generation + reserve generation + unavailable generation + seasonal unavailable generation.~~

7.1 Actual generation (AAG)

~~Actual generation is the energy that was generated by a unit in a given period. Actual generation can be expressed as gross actual generation (GAAG) or net actual generation (NAAG).~~

3.25 Unit starts

3.25.1 Attempted unit start

An Attempted unit start is the action to bring a Unit from a shutdown to the In-service state. Repeated initiations of the starting sequence without performing ~~accomplishing~~ corrective repairs are counted as a single attempt.

NOTE—Unit starts may include those for pumping or synchronous condensing mode, if applicable.

3.25.2 Starting failure

Starting failure is the inability to bring a Unit from [an](#) ~~some~~ Unavailable state or Reserve shutdown state to the Inservice state within a specified period. The specified period may be different for individual Units. Repeated failures within the specified starting period are counted as a single starting failure.

3.25.3 Actual unit start

The Actual unit start is the occurrence of bringing a Unit from [an](#) ~~some~~ Unavailable state or the Reserve shutdown state to the In-service state within a specified period. The specified period may be different for individual Units.

3.26 Weighted

[A group performance index where the performance of the Units is weighted.](#)

[NOTE—Net installed capacity is often used but other weighting methods may be appropriate.](#)

~~4.2 Deactivated shutdown~~

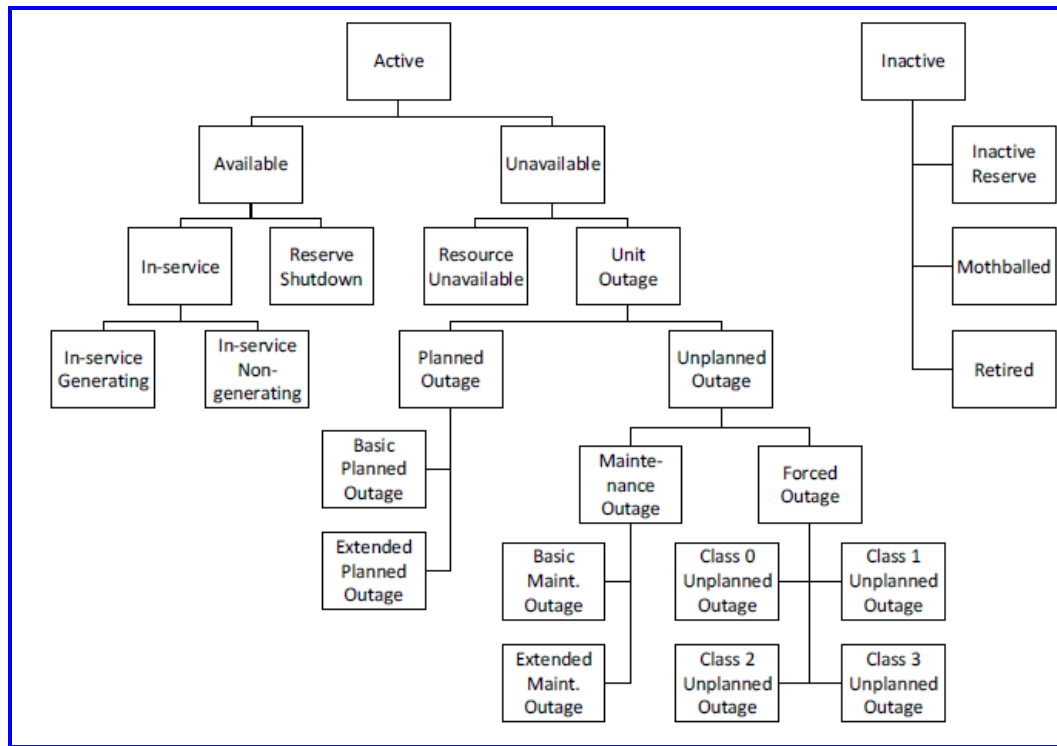
~~The deactivated shutdown state is where a unit is unavailable for service for an extended period of time for reasons not related to the equipment.~~

4. Unit states

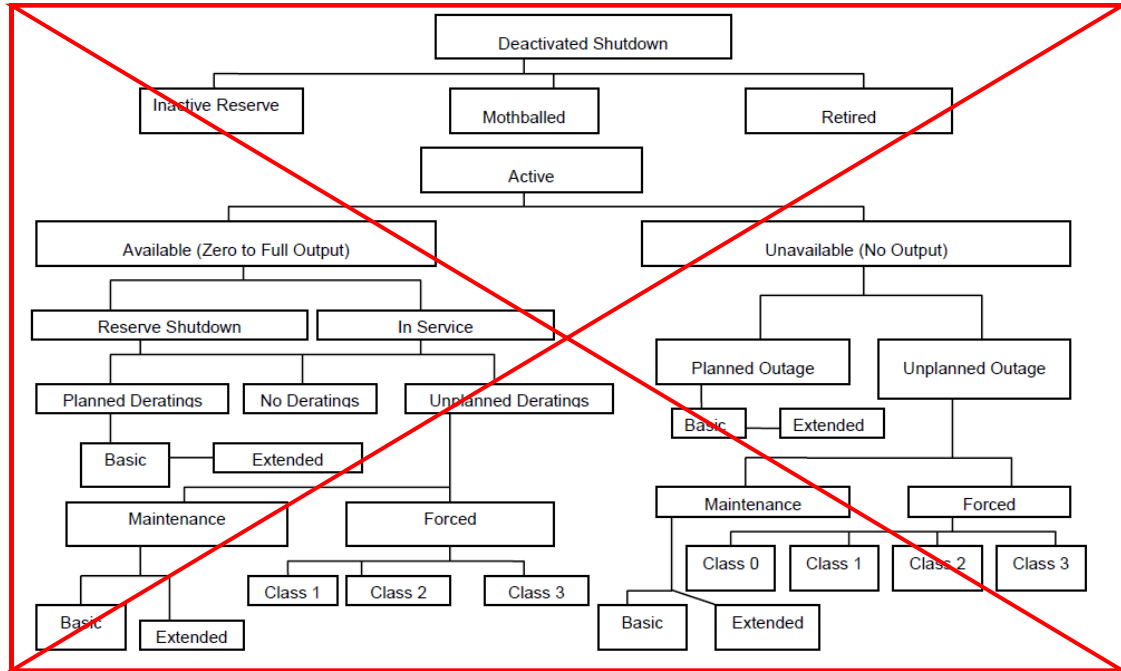
4.1 Introduction

A unit state is a particular unit condition that is important for collecting data on performance. [Unit state does not depend on the generation level it can achieve \(its capacity\) but on whether it can generate at all, and if not, the reasons why it cannot. See Clause 5 for a discussion of partial unit capacity and the measurement of hours within this condition.](#)

NOTE—The state definitions are related as shown in Figure 1. The [basic and extended maintenance outage and class 0, 1, 2, and 3 unplanned outage stages](#) are not applicable to VER units. Annex E lists [the states that were defined in each version of this standard and, for the small number of states whose names have changed, each version of the name](#). Transitions between [active](#) states are described in Annex [F B](#).



[\(New\)](#)



(Deleted)

Figure 1—Relationships ~~Relation~~ between unit states

4.2 Active

4.2.1 General

~~The active state is where a unit is in the population of units being reported.~~

~~NOTE—~~A Unit initially enters the Active state on its Service date [\(3.9.1\)](#) and leaves the Active state on a Deactivation date [\(3.9.2\)](#).

NOTE—A Unit can be returned to the Active state from the Inactive state.

4.2.2 Available

4.2.2.1 General

The Available state is where a Unit is capable of providing service, regardless of whether it is actually in service and regardless of the capacity level that can be provided.

4.2.2.2 In-service

The In-service state is where a Unit is electrically connected to the system ~~and performing generation function.~~

4.2.2.2.1 In-service generating ~~nongenerating mode~~

The In-service generating ~~nongenerating mode~~ state is where a Unit is electrically connected to the system and performing its generating function.

4.2.2.2.2 In-service non-generating

The In-service non-generating state is where a Unit is electrically connected to the system and performing a non-generating function. This state may occur when the Energy resource is either available or not available. However, for accounting purposes, the In-service non-generating and Resource unavailable states are mutually exclusive, with In-service non-generating having priority. That is, if the Unit is providing non-generating service when the resource is unavailable, the state is accounted as In-service non-generating.

NOTE 1—Certain types of Units may be performing functions other than generating while ~~being~~ in service and exposed to failure: A pumped storage Unit can be in pumping mode, ~~an electrochemical energy storage unit (battery) can be in charging mode,~~ and a steam or combustion turbine or a hydro Unit can be in synchronous condensing mode.

~~NOTE 2—Certain types of generating units may be kept on line at minimum output when there is no demand on the unit to reduce the number of starts.~~

4.2.2.3 Reserve shutdown

The Reserve shutdown state is where a Unit is available, but not in service. [This is usually due to lack of Demand, to low or negative energy pricing, or where the cost of operation exceeds the market price of electricity.](#)

NOTE—This state is sometimes referred to as *economy shutdown*.

4.2.3 Unavailable

[4.2.3.1 General](#)

[The Unavailable state is where a Unit is not capable of operation because of a Unit outage or Resource unavailability. The Unavailable state persists until the Unit is made available for operation as described in 4.2.3.3.1 in the case of a Unit outage or, in the case of Resource unavailability, until that state ends.](#)

[4.2.3.2 Resource unavailable](#)

[A state in which the Energy resource \(see 3.11\) used by the Unit is not available but the Unit is otherwise available. Examples include:](#)

- [1. Unavailability that is normal to the technology employed and occurs regularly \(hour to hour, diurnal, seasonal\) for such resources as sunlight, wind, and water, as for VER units.](#)
- [2. Unavailability due to interruption of an Energy resource caused by inadequacy or diversion of the Energy resource to other users by the supplier, or transportation infrastructure disruption, including interruptions that may be declared to be Outside management control \(see 3.17\) or *force majeure*.](#)
- [3. A state in which the amount of the Energy resource available to the Unit is insufficient to allow operation at the installed net capacity, but is sufficient to allow operation above a threshold amount.](#)

All Unit outages take precedence over Resource unavailability. A state in which both the Unit and the Energy resource are unavailable contributes to unit unavailability indexes but does not contribute to resource unavailability indexes. The application of this rule ensures that the Unit outage state and the Resource unavailable state are mutually exclusive in calculating the unavailability indexes.

4.2.3.3 Unit outage

4.2.3.3.1 General

The Unit outage **unavailable** state is where a Unit is not capable of operation because of operational or equipment failures, external restrictions (as defined in Annex D), testing, work being performed, or an adverse condition. The Unit outage state persists until the Unit is made available for operation, either by being synchronized to the system (In-service state) or by being placed in the Reserve shutdown state.

4.2.3.3.2 Planned outage

4.2.3.3.2.1 General

The Planned outage state is where a Unit is unavailable due to inspection, testing, nuclear refueling, or overhaul. A Planned outage is scheduled well in advance.

NOTE—The distinction between Basic and Extended planned outages is not applicable to VER units.

4.2.3.3.2.2 Basic planned outage

The Basic planned outage state is the Planned outage as originally scheduled and with a predetermined duration.

4.2.3.3.2.3 Extended planned outage

The Extended planned outage state is the extension of the Basic planned outage beyond its predetermined duration.

NOTE—Extended planned outage applies only when planned work exceeds predetermined duration. ~~An~~ ~~The~~ extension, due to a condition discovered during the Planned outage that forces the extension of the Planned outage, is classified as a Class 1 unplanned outage (see 4.1.2. ~~3.3.3.3.3~~ ~~2.1.2~~). A ~~Starting~~ ~~startup~~ failure would result in a Class 0 unplanned outage (see ~~4.2.3.3.3.2~~ ~~4.1.2.2.1.1~~)

4.2.3.3.3 Unplanned outage

4.2.3.3.3.1 General

The Unplanned outage state is where a Unit is Unavailable, but is not in the Planned outage state.

NOTE 1— When an Unplanned outage is initiated, the Unit outage is classified according to one of five classes, as defined in 4.2.3.3.3.2.2, 4.2.3.3.3.2.3, and 4.2.3.3.3.2 ~~1.2.2.1.1~~ through 4. ~~2.3.3.3.5.1.2.2.1.4~~ ~~and 4.1.2.2.2.1~~ ~~and 4.1.2.2.2.2~~. A Class 0 unplanned outage applies to a ~~Starting~~ ~~startup~~ failure, and Class 1 applies to a condition requiring immediate outage. Also, an Unplanned outage starts when a Planned outage ends, but is extended due to unplanned work. Class 2, Class 3, and Maintenance outage apply to Unit outages where some delay is possible in removing the Unit from service. The class (2, 3, or maintenance) of outage is determined by the amount of delay that can be exercised in the removal of the Unit. The class of outage is not made more urgent if the time of removal is advanced due to favorable conditions of system reserves or availability of replacement capacity for the predicted duration of the outage. However, an Unplanned outage starts when the Unit is removed from service or is declared Unavailable when it is not in service.

NOTE 2—During the time the Unit is in the Unplanned outage state, the outage class is determined by the outage class that initiates the state.

NOTE 3— In some cases, the opportunity exists during Unplanned outages to perform some of the repairs or maintenance that would have been performed during the next Planned outage. If the additional work extends the outage beyond that required for the Unplanned outage, the remaining outage should be reported as a Planned outage.

4.2.3.3.3.2 Maintenance ~~Forced~~ outage

4.2.3.3.3.2.1 General

A Maintenance ~~forced~~ outage could ~~cannot~~ be deferred beyond the end of the next weekend but requires that a Unit be removed from the Available state or another Unplanned outage state before the next Planned outage.

NOTE—The distinction between Basic and Extended maintenance outages is not applicable to VER units.

4.2.3.3.3.2.2 Basic maintenance outage

The Basic maintenance outage state is the Maintenance outage as originally anticipated, and it may or may not be of a predetermined duration.

4.2.3.3.3.2.3 Extended maintenance outage

The Extended maintenance outage state is the extension of the Basic maintenance outage beyond its anticipated duration.

NOTE—Extended maintenance outage applies only when the maintenance work exceeds anticipated duration. The extension, due to a condition discovered during the Maintenance outage that forces the extension of the Maintenance outage, is classified as a Class 1 unplanned outage (see ~~4.2.3.3.3.3.3 2-1-2~~). A Starting ~~startup~~ failure would result in a Class 0 unplanned outage (see ~~4.2.3.3.3.3.2-1-1~~).

4.2.3.3.3.3 Forced outage

4.2.3.3.3.3.1 General

A Unit outage that cannot be deferred beyond the end of the next weekend.

NOTE—The distinction between Class 0, 1, 2, and 3 unplanned outages is not applicable to VER units.

4.2.3.3.3.3.2 Class 0 unplanned outage (starting failure)

A Class 0 unplanned outage results from the unsuccessful attempt to place the Unit in service (see [3.25.2](#)) ~~4.1.3.1~~).

4.2.3.3.3.3.3 Class 1 unplanned outage (immediate)

A Class 1 unplanned outage requires immediate removal from the existing state.

NOTE—A Class 1 unplanned outage can be initiated from either the In-service state or Reserve shutdown state. A Class 1 unplanned outage can also be initiated from the Planned outage state. See the note in 4. [2.3.3](#) ~~4.2. 3. 1-2~~.

4.2.3.3.3.3.4 Class 2 unplanned outage (delayed)

A Class 2 unplanned outage does not require immediate removal from the In-service state, but requires removal within [six hours](#) ~~6-h~~.

4.2.3.3.3.3.5 Class 3 unplanned outage (postponed)

A Class 3 unplanned outage can be postponed beyond [six hours](#) ~~6-h~~, but requires that a Unit be removed from the In-service state before the end of the next weekend.

NOTE—Class 2 and Class 3 can be initiated only from the In-service state.

4.3 Inactive (Deactivated shutdown)

4.3.1 General

A Unit is in the Inactive state when it is declared out of service by the Unit owner with a distant or indefinite date for its return to service, and no work is scheduled to permit a return to service. A Unit is in the Inactive state only if it was previously in the Active state. This does not include a Unit under construction or preoperational testing because it is not yet in the Active state.

A Unit may be placed in an Inactive state due to component failure, damage from an external cause, regulatory requirements, or other issues necessitating repairs that are uneconomic. When a Unit is placed in the Inactive state the Unit is typically unstaffed.

~~4.1.2.2.2 Maintenance outage~~

~~A maintenance outage can be deferred beyond the end of the next weekend, but requires that a unit be removed from the available state or another unplanned outage state before the next planned outage.~~

4.3.2 Inactive reserve

A Unit in the Inactive reserve state ~~is where a unit~~ is unavailable for service, but can be brought back into service in a relatively short period of time, typically measured in days.

4.3.3 Mothballed

A Unit in the Mothballed state ~~is where a unit~~ is unavailable for service, but can be brought back into service with appropriate amount of notification, typically weeks or months. The Unit is complete but its condition may be unknown, or extensive work would be required to return it to service.

4.3.4 Retired

[A Unit in](#) the Retired state is ~~where a unit is~~ unavailable for service and not expected to return to service in the future. [Essential parts may be removed for use on other Units or the Unit may be partially or completely disassembled.](#)

5. Capacity terms

5.1 Introduction

[Terms that involve capacity or energy or that are derived from capacity or energy quantities can be expressed as Gross or Net quantities. \(A “G” or an “N” prefix is used to indicate the basis.\) The mandating authority should specify whether capacity \(and energy\) quantities are to be reported on a Gross or Net basis. In any case, users should take care to use a Gross or Net basis consistently as appropriate to the purposes of the analysis. Otherwise comparisons and calculated rates or factors may have limited usefulness.](#)

[Terms in Clause 7 through Clause 10 may apply or be defined in different ways for different types of Units or for different purposes. Thus there are variants for different types of generating Units \(conventional vs. VER\) and for different purposes \(system vs. unit\). System terms represent the contribution of Units to system reliability analysis. Unit terms represent the performance of Units excluding the influence of a variable Energy resource. The acronyms of variants will be denoted by subscripts:](#)

- [— C: Conventional units](#)
- [— V: VER units](#)
- [— S: System reliability analysis](#)
- [— U: Unit performance analysis](#)

If neither C nor V is present, the term is applicable to both Conventional and VER units; if neither S or U, to both system and unit analyses. Legacy databases might not include any of these subscripts, in which case the term should be interpreted as the CS variant, since the terms in previous editions of this standard were defined primarily for Conventional units and system reliability analysis.

When there are variants, a subheading indicates the applicability or definition for each generator type— conventional or VER—and purpose—system or unit. When there is no such subheading, the applicability and definition are the same for all generator types and all purposes. When a generator type is indicated, but not a purpose, the applicability and definition are the same for both purposes for that generator type. Similarly, when a purpose is indicated, but not a generator type, the applicability and definition are the same for both generator types for that purpose.

~~Terms that involve capacity can be expressed as gross or net quantities.~~

NOTE—The capacity definitions are related as shown in Figure 2 for Conventional units and in Figure 3 for VER units. ~~The correlation between the capacity derating definitions in this clause and partial outage definitions in use by industry is shown in Annex A.~~

5.2 Capacity

5.2.1 Introduction

The capability of a Unit to convert another form of energy to electrical energy, measured in watts or a multiple of watts.

Conventional Unless qualified as “short term” or a “variable energy resource,” Capacity is understood to be continuous, or sustainable indefinitely without degradation of life due to equipment heating.

NOTE 1— Capacity is commonly qualified as nameplate, dependable, available, installed or maximum.

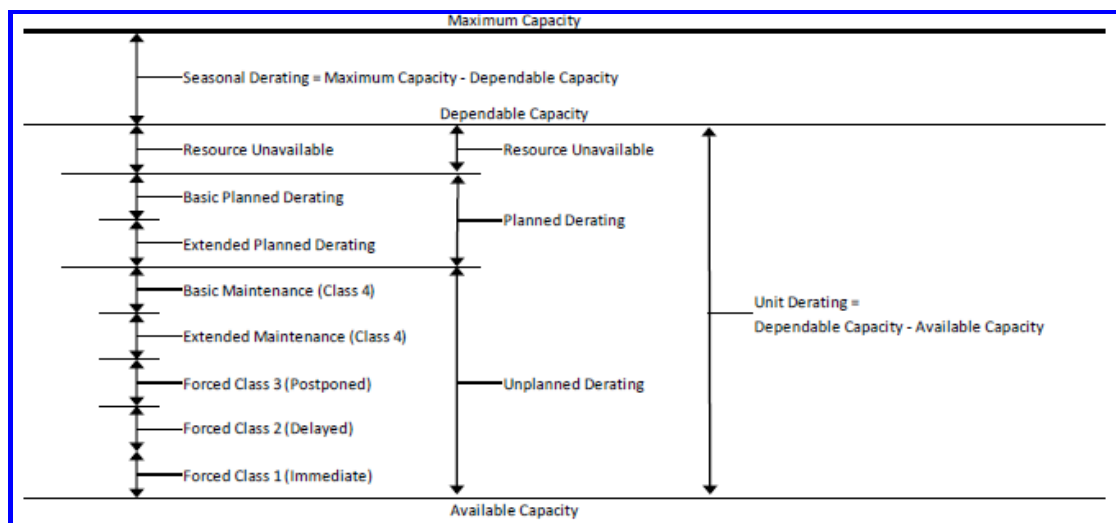
NOTE 2— Capacity may be aggregated for Units in a Group or Plant.

VER VER capacity is energy resource constrained and can vary from zero to maximum in a short time.

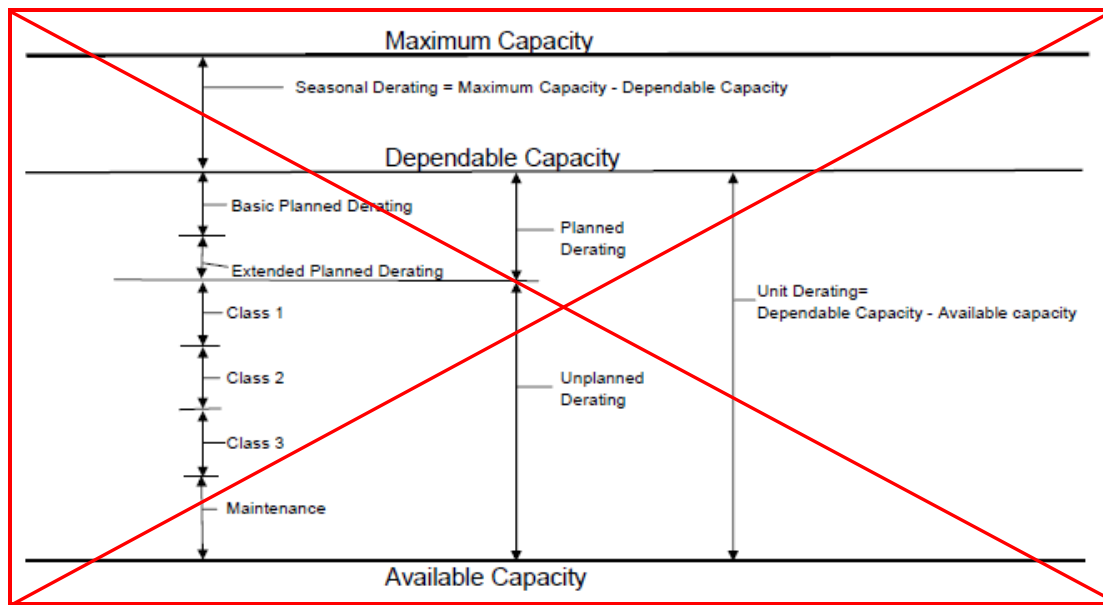
NOTE 1— VER capacity is commonly qualified as available, expected, installed or maximum.

NOTE 2— VER units typically comprise multiple identical Sub-units (see 3.22). Therefore, VER capacity is usually aggregated for Sub-units and may be aggregated for Units in a Group or Plant.

NOTE 3— Individual VER Sub-units may have Unit outages and Unit deratings; but it is more common to look at Plant, Group, or Unit indexes where individual Sub-unit outages and deratings are aggregated to the Plant, Group, or Unit level.



(New)



(Deleted)

~~NOTE—All capacity and deratings are to be expressed on either gross or net basis.~~

Figure 2—Unit capacity levels for Conventional units

5.2.2 Installed capacity (IC)

The Installed capacity, determined in accordance with ISO (International Standards Organization) standards, without any Unit derating or limitation of any needed resource.

Conventional Installed capacity may be modified by the Plant owner for different ambient conditions specified by the system operator.

VER For wind Units, the capacity of the Unit is also known as the system capacity and is defined by the manufacturer usually in equipment purchase agreements.

For solar, the capacity of the Unit is defined by the inverter ac capacity and may be adjusted lower if the dc capacity (panels) is less than the ac inverter Capacity.

For run of river hydro Units, the capacity of the Unit is defined in the same manner as for Conventional units.