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TECHNICAL REPORT

Guidelines for the design of interconnected power systems

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDELINES FOR THE DESIGN OF INTERCONNECTED POWER SYSTEMS

FOREWORD

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IEC/TR 62511, which is a technical report, has been prepared by IEC technical committee 8: Systems aspects for electrical energy supply.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
8/1346/DTR	8/1364/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

GUIDELINES FOR THE DESIGN OF INTERCONNECTED POWER SYSTEMS

1 Scope

The primary objective of this Technical Report is to provide guidelines in planning and design of the interconnected power system (IPS) and consequently achieve the delivery of reliable supply service. The guidelines for the design of interconnected power systems within this document will enhance system reliability, mitigate many of the adverse impacts associated with the loss of a major portion of the system or unintentional separation of a major portion of the system, and will not be consequential because of normal design contingencies.

In the context of this Technical Report, interconnected power system means an entity's (control area or a system operator) high-voltage transmission system that can adversely impact other connected systems due to faults and disturbances within its area. In the case of large areas, the system operator may define a subset of its area to keep the adverse impact contained within a smaller portion of its system.

This Technical Report specifies the recommended techniques for securing an IPS to ensure a high level of reliability. Generally, interconnected power systems are synchronously connected or asynchronously connected through DC interconnections. This document aims to ensure that the interconnections are designed and operated consistently on both ends. The recommendations include design and operation requirements to withstand the primary contingencies specified in this document.

It is recommended that each entity ensures that its portion of the high voltage IPS is designed and operated in unison with these guidelines. This precaution is recommended, otherwise additional system interconnections can cause significant adverse impacts on reliability of the connected entities. Each entity is also encouraged to make use of committees, task forces, working groups, interregional studies and other methods in order to ensure their IPS is constantly updated/enhanced and maintained, in such a way that it is in agreement with these guidelines.

NOTE The application of this guide is for high voltage transmission systems (generally over 50 kV). However, mitigation measures for certain system conditions, such as under frequency load shedding (UFLSh), are frequently required for low voltage distribution systems; hence, for the purpose of this transmission guide, interconnected control areas and/or system operators can establish the voltage level, as required. In addition, the design guidelines in this document are intended only for those elements of the IPS (not the entire high voltage transmission system) that can adversely impact other connected system(s) due to faults and disturbances within an area or a predefined subset of a large area. This document also provides guidance to determine such elements of the IPS.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

3 Terms and definitions

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

3.1
adequacy
ability of an electric power system to supply the aggregate electric power and energy required by the customers, under steady-state conditions, with system component ratings not exceeded, bus voltages and system frequency maintained within tolerances, taking into account planned and unplanned system component outages

Note 1 to entry: The ability may be measured by one or several appropriate indices.

[SOURCE: IEC 60050-191:1990, 191-21-01]

3.2
continuous capacity
rated continuous load-carrying ability, expressed in megawatts (MW) or megavolt-amperes (MVA) of generation, transmission, or other electrical equipment

3.3
maximum capacity of a unit
the maximum power that could be generated by a unit, under continuous operation with all of its components in working order

Note 1 to entry: This power may be gross or net.

[SOURCE: IEC 60050-602:1983, 602-03-08]

3.4
contingency
event, usually involving the loss of one or more elements, which affects the IPS at least momentarily

3.5
control area
electric system or systems, bounded by interconnection metering and telemetry, capable of controlling generation to maintain its net interchange schedule with other control areas and contributing to frequency regulation of interconnections

3.6
demand
the magnitude of an electricity supply, expressed in kilowatts or kilovoltamperes

[SOURCE: IEC 60050-691:1973, 691-02-02]

3.7
element of power system
any electric device with terminals that may be connected to other electric devices

EXAMPLE A generator, transformer, circuit breaker, or bus section.

3.8
emergency
any abnormal system condition that requires automatic or manual action to prevent or limit the loss of transmission facilities, or generation supply that could adversely affect the reliability of the electric system

Note 1 to entry: An emergency is considered to exist in a region of an entity where a firm load has to be shed.

3.8.1
emergency limits
limits which can be utilized for the time required to take corrective action

Note 1 to entry: The limiting condition for voltages should recognize that voltages should not drop below that required for suitable system stability performance, and should not adversely affect the operation of the IPS.

Note 2 to entry: The limiting condition for equipment loadings should be such that cascading outages will not occur as a result of the operation of protective devices upon the failure of facilities. (Various definitions of equipment ratings are found in this guide.)

3.8.2
applicable emergency limits
limits which depend on the duration of the occurrence and on the policy of the given entity regarding loss of life to equipment, voltage limitations, etc.

3.9
fault
an unplanned occurrence or defect in an item which may result in one or more failures of the item itself or of other associated equipment

Note 1 to entry: A fault is often the result of a failure of the item itself, but may exist without prior failure.

[SOURCE: IEC 60050-604:1987, 604-02-01, modified – addition of Note 1 to entry]

3.9.1
delayed fault clearing
fault clearing which is consistent with the correct operation of a breaker failure protection group and its associated breakers, or of a backup protection group with an intentional time delay

3.9.2
normal fault clearing
fault clearing which is consistent with the correct operation of the protection system and with the correct operation of all circuit breakers or other automatic switching devices intended to operate in conjunction with that protection system

3.10
generation (of electricity)
a process of producing electrical energy from other forms of energy

Note 1 to entry: The amount of electric energy produced, usually expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

[SOURCE: IEC 60050-601:1985, 601-01-06 modified – modified definition and addition of Note 1 to entry]

3.11
high-voltage d.c. link
HVDC link
an installation for transmitting large quantities of electricity at high-voltage d.c., including the converter substations

[SOURCE: IEC 60050-601:1985, 601-04-01]

3.12
interconnected power system
IPS
interconnected electrical power system within a wide area, comprised of system elements assigned to different local areas within the same operating authority or a different operating authority (e.g. ISOs) on which faults or disturbances can have a significant adverse impact outside of the local area

3.13
interconnection
interconnexion
single or multiple transmission links between transmission systems enabling electric power and energy to be exchanged between these networks by means of electric circuits and/or transformers

Note 1 to entry: In the context of this document interconnection refers to facilities that connect two or more IPSs or control areas. Additionally, interconnection also refers to the facilities that connect a non-utility generator to a control area or IPS.

[SOURCE: IEC 60050-601:1985, 601-01-11, modified – "electricity" replaced by "electric power and energy", "systems" replaced by "networks", "electric" added to "circuits" and addition of Note 1 to entry]

3.14
load
device intended to absorb power supplied by another device or an electric power system

[SOURCE: IEC 6005-151:2001, 151-15-15]

3.14.1
firm load
load that is not an interruptible load – load that is served on a guaranteed basis, 100 % of the time

3.14.2
interruptible load
load of particular consumers which, according to contract, can be disconnected by the supply undertaking for a limited period of time

[SOURCE: IEC 60050-603:1986, 603-04-41]

3.15
load relief
reduction in amount of customer load caused by deliberate voltage reduction in response to an abnormal operating condition of the electric power system and/or load shedding

3.16
load shedding
the process of deliberately disconnecting preselected loads from a power system in response to an abnormal condition in order to maintain the integrity of the remainder of the system

[SOURCE: IEC 60050-603:1986, 603-04-32]

3.17
load current
I_{load}
highest continuous ampere on line or other series elements rating, that most closely approximates a 4-hour rating of the line

3.18
native
belonging to the person, place or thing in question

3.19
operating limit
the maximum value of the most critical system operation parameter(s) which meets: (a) pre-contingency criteria as determined by equipment loading capability and acceptable voltage conditions, (b) stability criteria, and (c) post-contingency loading and voltage criteria

3.20
outage
unavailability
the state of an item of being unable to perform its required function

[SOURCE: IEC 60050-603:1986, 603-05-05]

3.20.1
forced outage
unplanned outage whose onset, automatic or manual, cannot be deferred

[SOURCE: IEC 60050-191:1990, 191-24-03]

3.20.2
maintenance outage
the removal of equipment from service to perform work on specific elements that can be deferred

3.20.3
planned outage
outage scheduled in advance, for maintenance or other purposes

[SOURCE: IEC 60050-191:1990, 191-24-01]

3.21
pole (of an equipment)
in certain types of equipment such as switchgear, the part corresponding to one of the phases in a.c. or to one of the polarities in d.c.

Note 1 to entry: According to the number of poles within the equipment, it is called: single-pole equipment, two-pole equipment, etc.

[SOURCE: IEC 60050-601:1985, 601-03-11]

3.22
HVDC terminal
rectifier and an inverter, with associated filter banks and control equipment, tied together by a transmission line or bus

3.23
protection
provisions for detecting faults or other abnormal conditions in a power system, for enabling fault clearance, for terminating abnormal conditions, and for initiating signals or indications

Note 1 to entry: The term “protection” is a generic term for protection equipment or protection systems.

Note 2 to entry: The term “protection” may be used to describe the protection of a complete power system or the protection of individual plant items in a power system e.g. transformer protection, line protection, generator protection.