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Edition 1.0 2023-09

TECHNICAL SPECIFICATION

colour inside

Wind energy generation systems –
Part 30: Safety of wind turbine generators – General principles for design



IEC TS 61400-30:2023-09(en)



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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WIND ENERGY GENERATION SYSTEMS –

Part 30: Safety of wind turbine generators – General principles for design

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IEC TS 61400-30 has been prepared by IEC technical committee 88: Wind energy generation systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
88/910/DTS	88/935A/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61400 series, published under the general title *Wind energy generation systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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WIND ENERGY GENERATION SYSTEMS –

Part 30: Safety of wind turbine generators – General principles for design

1 Scope

This part of IEC 61400, which is a Technical Specification, specifies the essential health and safety requirements related to the design of wind turbines with horizontal axes with the exception of those included in the scope of IEC 61400-2.

For other wind turbine concepts such as vertical axes, floating, or smaller turbines (see IEC 61400-2), the principles of this document are valid, however they are adjusted to the actual concept.

This document focuses on requirements for safe operation, inspection, maintenance, installation and decommissioning.

2 Normative references

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

IEC 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

IEC 60204-1:2016, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

IEC 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV*

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60950-1, *Information technology equipment − Safety − Part 1: General requirements*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61310-1, *Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61400-1:2019, *Wind energy generation systems – Part 1: Design requirements*

IEC 61400-3-1, *Wind energy generation systems – Part 3-1: Design requirements for fixed offshore wind turbines*

IEC TS 61400-3-2, *Wind energy generation systems – Part 3-2: Design requirements for floating offshore wind turbines*

IEC 61400-24, *Wind energy generation systems – Part 24: Lightning protection*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61936-1:2021, *Power installations exceeding 1 kV AC and 1,5 kV DC − Part 1: AC*

IEC 62040 (all parts), *Uninterruptible power systems (UPS) – Part 1: Safety requirements*

IEC 62061:2021, *Safety of machinery – Functional safety of safety-related control systems*

IEC 62271-200, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 62485 (all parts), *Safety requirements for secondary batteries and battery installations*

ISO 3864 (all parts), *Graphical symbols – Safety colours and safety signs*

ISO 4413, *Hydraulic fluid power – General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power – General rules and safety requirements for systems and their components*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 7250 (all parts), *Basic human body measurements for technological design*

ISO 9355 (all parts), *Ergonomic requirements for the design of displays and control actuators*

ISO 11228 (all parts), *Ergonomics – Manual handling*

ISO/TR 11688-1, *Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 1: Planning*

ISO/TR 11688-2, *Acoustics − Recommended practice for the design of low-noise machinery and equipment − Part 2: Introduction to the physics of low-noise design*

ISO 12100:2010, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

ISO 13732-1, *Ergonomics of the thermal environment – Methods for the assessment of human responses to contact with surfaces – Part 1: Hot surfaces*

ISO 13732-3, *Ergonomics of the thermal environment − Methods for the assessment of human responses to contact with surfaces − Part 3: Cold surfaces*

ISO 13849-1:2015[1], *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 13849 (all parts), *Safety of machinery − Safety-related parts of control systems*

ISO 13850:2015, *Safety of machinery – Emergency stop function – Principles for design*

ISO 13854, *Safety of machinery – Minimum gaps to avoid crushing of parts of the human body*

ISO 13857, *Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14118, *Safety of machinery – Prevention of unexpected start-up*

ISO 14119, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*

ISO 14120, *Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards*

ISO 14122-1, *Safety of machinery – Permanent means of access to machinery – Part 1: Choice of fixed means and general requirements of access*

ISO 14122-2, *Safety of machinery – Permanent means of access to machinery – Part 2: Working platforms and walkways*

ISO 14122-3, *Safety of machinery – Permanent means of access to machinery – Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4:2016, *Safety of machinery – Permanent means of access to machinery – Part 4: Fixed ladders*

ISO 14567, *Personal protective equipment for protection against falls from a height – Single-point anchor devices*

ISO 15534 (all parts), *Ergonomic design for the safety of machinery*

ISO 19353:2019, *Safety of machinery – Fire prevention and fire protection*

ISO 20607, *Safety of machinery – Instruction handbook – General drafting principles*

EN 353-1, *Personal fall protection equipment – Guided type fall arresters including an anchor line – Part 1: Guided type fall arresters including a rigid anchor line*

EN 353-2, *Personal protective equipment against falls from a height – Part 2: Guided type fall arresters including a flexible anchor line*

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[1] Withdrawn.

EN 1005 (all parts), *Safety of machinery – Human physical performance*

EN 12198 (all parts), *Safety of machinery – Assessment and reduction of risks arising from radiation emitted by machinery*

EN 12464-1, *Light and lighting – Lighting of workplaces – Part 1: Indoor workplaces*

EN 16165:2021, *Determination of slip resistance of pedestrian surfaces – Methods of evaluation*

CIE 97:2005, *Guide on the maintenance of indoor electric lighting systems*

ICAO Annex 14. 9th Edition, July 2022

3 Terms and definitions

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

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

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

3.1
hazard
potential source of harm

[SOURCE: ISO/IEC Guide 51:2014, 3.2]

3.2
significant hazard
hazard which has been identified as relevant and which requires specific action by the designer to eliminate or to reduce the risk according to the risk assessment

Note 1 to entry: A relevant hazard is identified as the result of one step of the process described in Clause 5.

[SOURCE: ISO 12100:2010, 3.8, modified – Note 1 to entry has been changed.]

3.3
risk
combination of the probability of occurrence of harm (physical injury or damage to health) and the severity of that harm

[SOURCE: ISO 12100:2010, 3.12, modified – "(physical injury or damage to health)" has been added.]

3.4
intended use
use of a machine in accordance with the information for use provided in the instructions

[SOURCE: ISO 12100:2010, 3.23]

3.5
protective measure
measure intended to achieve adequate risk reduction, implemented:

- by the designer (inherently safe design, safeguarding and complementary protective measures, information for use) and/or
- by the user (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training)

[SOURCE: ISO 12100:2010, 3.19]

3.6
environment
surroundings in which a product or system exists, including air, water, land, natural resources, flora, fauna, humans, and their interrelation

[SOURCE: IEC Guide 109:2012, 3.3]

3.7
environmental conditions
characteristics of the environment (wind, altitude, temperature, humidity, etc.) which may affect the wind turbine behaviour

[SOURCE: IEC 61400-1:2019, 3.17]

3.8
external conditions
factors affecting operation of a wind turbine, including the environmental conditions (temperature, snow, ice, etc.) and the electrical network conditions

[SOURCE: IEC 61400-1:2019, 3.18]

3.9
anchorage
for a personal protective equipment, structure or part of structure which can support load from fall protection or rescue systems

3.10
anchor point
component or sub-system that functions as an interface between the anchorage and a fall protection, work positioning, rope access or rescue system for the purpose of coupling the system to the anchorage

Note 1 to entry: It can be intended or not intended to be removable.

3.11
limited free fall
limited distance that can be compared with "fall on the actual level" i.e., a trip or slip where person is falling onto the surface/ground on which he or she was standing/walking ~ a fall at same level

Note 1 to entry: "Limited free fall" distance is set to maximum 0,5 m.

3.12
fall protection
system (including all components) a worker/technician uses to provide protection from falling and/or to safely arrest and mitigate the impact of a worker/technician’s fall if one occurs

Note 1 to entry: Examples of personal fall protection systems include personal fall arrest systems, positioning systems and travel restraint systems.

3.13
fall arrest
system used to arrest a worker/technician in a fall from a walking-working surface, consisting of a body harness, anchorage and connector

Note 1 to entry: The means of connection can include a lanyard, deceleration device, lifeline, or a suitable combination of these.

3.14
work positioning
system of equipment and connectors that, when used with a body harness or body belt, allows a worker/technician to be supported on an elevated vertical surface, such as a wall or windowsill, and work with both hands free

Note 1 to entry: Positioning systems also are called "positioning system devices" and "work-positioning equipment."

3.15
fall/travel restraint
combination of an anchorage, anchor point, lanyard (or other means of connection) and body support that a worker/technician uses to eliminate the possibility of a worker/technician going over the edge of a walking-working surface

3.16
evacuation
in a wind turbine, process of leaving the wind turbine in an emergency situation, when persons are able to use the predefined access route

Note 1 to entry: Successful evacuation will result in personnel being transferred to a place of safety.

3.17
escape
in a wind turbine, process of leaving the wind turbine in an emergency situation when the persons are unable to use the predefined access route.

Note 1 to entry: It is a last resort method of getting out of the wind turbine.

3.18
rescue
in a wind turbine, operation to retrieve an injured person out of the turbine or a person unable to self-rescue to a place of safety

3.19
rescue equipment
in a wind turbine, system of equipment, anchorage and connectors that, when used with a body harness, rescue harness or body belt, allows a worker/technician to be rescued by getting descended from an elevated vertical surface, such as a machine, structure, etc.

3.20
place of safety
means an onshore or safe offshore location or vessel where medical treatment and other facilities for the care of survivors are available

3.21
place of temporary safety
place where a person is not exposed to the fire or the fire effects (e.g., such as smoke or falling objects)

Note 1 to entry: It can be a refuge inside the wind turbine or the sea.

3.22
available safe egress time
ASET
amount of time from fire ignition to the development of untenable conditions

3.23
required safe egress time
RSET
amount of time, measured from fire ignition that required for the last person to evacuate to a place of safety or place of temporary safety

3.24
control functions
functions of the control system that based on information about the condition of the wind turbine and/or its environment, adjust the wind turbine in order to maintain it within the operating limits defined by the wind turbine designer

3.25
control system
system implementing the wind turbine control, protection and safety functions, including sensors, logic elements, actuators, communication networks and power supplies

Note 1 to entry: The intent of the control system is to control operation of the wind turbine by active and passive means and keep the operating parameters within the design limits.

3.26
control station
location inside or outside the wind turbine where a control panel, a control device or arrangement of control panels and control devices or other means to manually control the wind turbine is located

3.27
design limits
maximum or minimum values used in a design

3.28
substructure
part of an offshore wind turbine support structure which transfers the loads acting on the structure into the seabed

3.29
boat landing
area where access from the vessel takes place, i.e., the part of the access ladder where the fender tubes are placed

3.30
performance level
PL
discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

3.31
required performance level
PL_{R}
performance level (PL) applied in order to achieve the required risk reduction for each safety function

[SOURCE: ISO 13849-1:2015, 3.1.24]

3.32
restricted space
enclosed or partially enclosed space, not intended for continuous human occupancy that has a restricted, limited, or impeded means of entry or exit because of its construction

Note 1 to entry: It can be thought of as a work area in which the only hazard is the difficulty of getting into or out of the space. All other hazards are either non-existent or have been eliminated or controlled.

3.33
confined space
enclosed or partially enclosed space that is not designed or intended for continuous human occupancy, with a restricted, limited, or impeded means of entry and exit because of its construction, and which can become hazardous to a person entering it, due to either an atmosphere that is or can be injurious (by oxygen deficiency or flammability, explosivity or toxicity), or due to an activity which can produce adverse or harmful consequences

3.34
equipment
single apparatus or set of devices or apparatuses, or the set of main devices of an installation, or all devices necessary to perform a specific task

3.35
safe state
condition of the wind turbine with an acceptable level of residual risks according to the risk assessment

3.36
safety-related part of a control system
SRP/CS
part of a control system that responds to safety-related input signals and generates safety-related output signals

[SOURCE: ISO 13849-1:2015, 3.1.1, modified – Notes to entry have been deleted]

3.37
safety functions
in wind turbine, functions of the control system whose failure can result in an immediate increase of the risk(s)

3.38
safety integrity level
SIL
discrete level (one out of a possible three) for describing the capability to perform a safety function where safety integrity level three has the highest level of safety integrity and safety integrity level one has the lowest

[SOURCE: IEC 62061:2021, 3.2.24]

3.39
standstill
condition of a wind turbine that is stopped

[SOURCE: IEC 61400-1:2019, 3.54]

3.40
wind turbine
<wind turbine> generator system which converts the kinetic wind energy into electric energy

[SOURCE: IEC 61400-1:2019, 3.71, modified – "generator system" has been deleted from the term, generator has been added to "system" in the definition.]

3.41
rest platform
in wind turbines, horizontal platform, which allows more than one person to rest (standing and sitting)

3.42
moveable rest landing
in wind turbines, small horizontal platform where a single person can rest (standing) with both feet fully supported

3.43
service lift
machine with a fully enclosed load carrying unit including floor, walls, doors and roof which is guided and intended for transport of persons and materials between different levels

4 Principal elements

4.1 General

The wind turbine shall be designed according to the principles in ISO 12100 for the significant hazards as a minimum as identified in Annex A of the present document.

A wind turbine shall be designed and constructed so that it can be installed, operated, adjusted, maintained and decommissioned in a safe way.

Identification of the essential health and safety requirements, their risk assessment and risk reduction shall be done in accordance with ISO 12100.

The measures adopted to fulfil the essential health and safety requirements shall be applied with the following principles in the order given:

- eliminate the risks;
- take the necessary protective measures in relation to risks that cannot be eliminated;
- inform users of the residual risks by means of signs or instructions.

This document shall be used together with the mentioned IEC and ISO standards in Clause 2.

The design of the wind turbine shall consider intended use and reasonably foreseeable misuse during its lifecycle as defined in ISO 12100.

4.2 Significant hazards

The limitation of use for machinery as wind turbine shall be done as specified in ISO 12100:2010, 5.3. An informative list of relevant factors for consideration when preparing risk assessment specific for wind turbine can be found in Annex A.

4.3 Frequency of exposure

When deciding the frequency of exposure to a specific hazard in the wind turbine and determining the required performance level or safety integrity level of a safety function, ISO 12100:2010, Clause 5 shall be followed.

If the frequency is classified as high or low, ISO 13849-1:2015, A.2.2 can be used as a guide.