Translation from Romanian

Technical norm

Requirements for grid connection of wind power plants

ANRE code: 51.1.017.0.00.03/04/09

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CHAPTER I

Purpose

Article 1 This technical norms sets the minimal technical requirements that wind generating module / parks connected to electricity networks of public interest should comply with, so as both safe operation of the electric power system and conditions to installed as great capacity as possible in such parks can be provided. This technical norm is an addition to chapter 5 from the Technical Code of transmission grid- Connection conditions to the transmission grid, as well as to chapter 5 from the Technical Code of distribution networks- Connection conditions to distribution networks.

CHAPTER II

Domain

Article 2 This technical norm is applied in the relationships between network operators and users asking for connection of wind power generating modules / parks to the electricity networks of public interest.

CHAPTER III

GLOSSARY

Article 3 (1) The terms and phrases defined in the Technical Code of transmission grid (Grid Code) are used in this technical norm. In addition the terms and acronyms provided below are defined in the sense of this regulation.

(2) Acronyms:

ANRE	National Regulatory Authority in the Energy Domain
WPP	Wind power park/plant – WPP
DWPP	Dispatchable wind power park
NDWPP	Non-dispatchable wind power park
EMS	Energy management system
WT (WT)	Wind generating module (Wind Turbine)
DSO	Distribution system operator
TSO	Transmission and system operator
CP	Common connection point or connection point

PIF	Commissioning
SCADA	IT monitoring, control and data acquisition system for some technological process or installation
NPS	National power system

(3) Definitions:

Bus-bars of the WPP	Electric bus-bars which generating modules of a wind power park are connected as an internal park grid
Wind power park (WPP)	One or several wind electricity modules connected in the same point to the electricity network of public interest
Dispatchable wind power park (DWPP)	Wind power park of installed capacity higher than 10 MW in the connection point
Non-dispatchable wind power park (NDWPP)	Wind power park of installed capacity lower or equal to 10 MW in the connection point
Generating module	Assembly of equipment (usually rotating) meant to generate electricity by converting another form of energy
Wind generating module (WT)	Generating module capable to transform the kinetic energy of wind into electricity – (Wind Turbine)
Network operator	According to each case, the transmission and system operator, a distribution operator or another holder of electricity network of public interest
Nominal capacity of a wind generating module	Maximum electric power for continuous operation that a wind generating unit can generate under normal operational condition, value which generally the manufacturer indicates
Available capacity (of a WT or a WPP)	Maximum electric power that can be generated uninterruptedly by the WT / WPP in the momentan conditions
Installed capacity (of a WPP)	Sum of the nominal capacities of the WT constituting the WPP

Connection point (CP)	Physical point of the electricity network where an user is connected into

CHAPTER IV

Reference documents

Article 4 This methodology is applied by corroboration with the provisions of the norms below:

a) Electricity law 13/207, with later amendments and additions;

b) Law 220/2008 determining the promotion system of electricity generation from renewable energy sources;

c) Governmental Decision 90/2008 approving the Regulation for users' connection to electricity networks of public interest;

d) Order 20/2004 of the president of the National Regulatory Authority in the Energy Domain approving the Technical Code of the electricity transmission network, with later amendments;

e) Order 128/2008 of the president of the National Regulatory Authority in the Energy Domain approving the Technical Code of electricity distribution networks, revision I;

f) Order 129/2008 of the president of the National Regulatory Authority in the Energy Domain approving the Regulation establishing the connection solutions for users to the electricity networks of public interest;

g) Order 48/2008 of the president of the National Regulatory Authority in the Energy Domain approving the Methodology with respect to issuing the location endorsements;

h) Order 4/2007 of the president of the National Regulatory Authority in the Energy Domain approving the Technical norm with respect to delimiting the protection and safety areas associated to power capacities, revision I, with later amendments and additions;

i) Order 38/2007 of the president of the National Regulatory Authority in the Energy Domain approving the Procedure with respect to settling the misunderstandings related to concluding contracts between economic operators in the electricity sector, the electricity supply contracts and the network connection contracts;

j) Order 17/2007 of the president of the National Regulatory Authority in the Energy Domain approving the Performance standard for electricity transmission and system services;

k) Order 28/2007 of the president of the National Regulatory Authority in the Energy Domain approving the Performance standard for electricity distribution services;

CHAPTER V

Requirements for dispatchable wind power parks (DWPP)

Article 5 DWPP should fully comply with the requirements of the Technical Code of transmission grid / of the Technical Code of distribution networks and this regulation.

Article 6 DWPP should be capable to generate for limitless period in the CP, simultaneously the maximum active and reactive power corresponding to meteorological conditions, in accordance with the equivalent P-Q diagram it has received endorsement for, within the frequency range 49.5÷50.5 Hz and the admissible voltage range.

Article 7 (1) WPP should provide the capability:

a) To operate uninterruptedly at frequency values in the range of 47.5÷52 Hz;
b) To stay connected to the electricity network in the frequency range of 47.0 ÷ 47.5 Hz for minimum 20 seconds;
c) To stay connected to the electricity network when frequency fluctuations occur up to 0.5 Hz/sec rates;
d) To operate uninterruptedly upon voltage ranging 0.90 ÷ 1.10 Un in the connection point;

Article 8 (1) WT should remain operational:

a) Upon frequency variations ranging 49.5 ÷ 47.5 Hz; straight reduction of the available active power, proportional to the frequency deviation, is admitted when frequency drops below 49.5 Hz;
b) Upon frequency variations up to 0.5 Hz/s rates and/or voltage fluctuations ranging 0.90 ÷ 1.10 Un;

(2) Operating at abnormal voltage or frequency values should not lead to reducing the available active power of the WT by more than 20%;

Article 9 WT should remain operational when voltage drops and variations occur on one or all phases in the connection point, like those shown in figure 1:

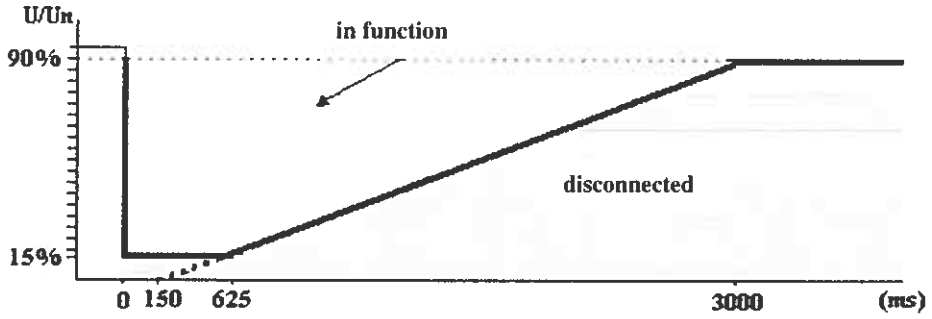

Figure 1- Shape of voltage drops when the WT should remain operational

(2) During voltage drops DWPP should generate active power corresponding to the level of residual voltage and maximize the injected reactive current without exceeding the operational limits of the DWPP. DWPP should be capable to generate the maximum reactive power for minimum 3 seconds.

(3) When voltage is restored to normal operational limits in the electricity network DWPP should generate the entire available active power in the shortest time possible, with load variation gradient of at least 20% from the installed capacity per second (MW / sec).

Article 10 (1) DWPP will be equipped with automatic active power control loop with, frequency dependence (frequency / power automatic control). This will run according to frequency / active power profile shown in figure 2, where Pd represents the available active power. The coordinates of points A, B, C, D and E depend on frequency, on the active power that can be generated by the power park and the setpoint value limiting active power within the following ranges: A (50-47 Hz), B (50-47 Hz), C (50-52 Hz), and DE (50-52 Hz). The position of such points should be set according to the network operator's requirements with maximum ±10 mHz error. The frequency metering error should not exceed ±10 mHz.

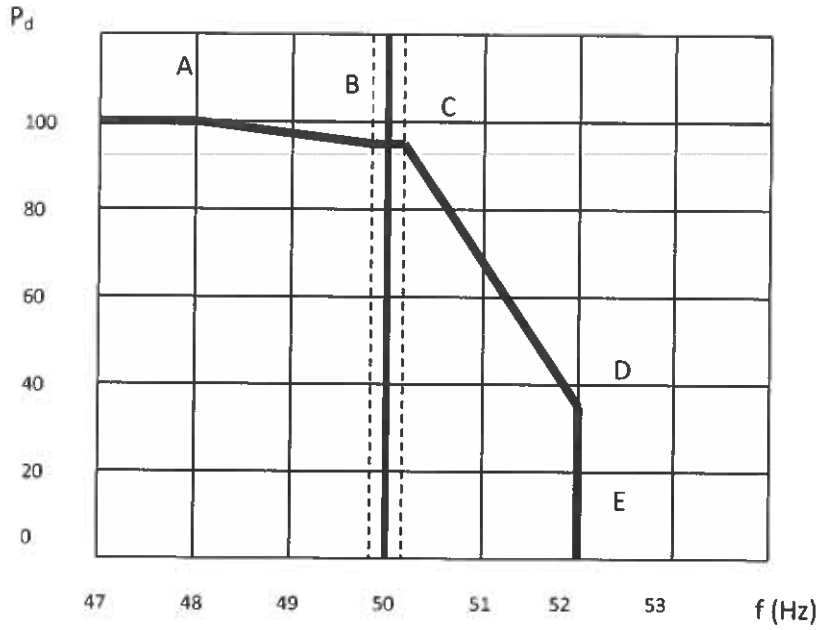

Figure 2- Active power –frequency profile for DWPP

(2) The active power generated due to frequency excursions can be provided as much as possible proportionally with the active power generated by each unit of the DWPP, not by on-off generating modules turning. The ramp rate of each WT in operation should be at least 60% from the nominal capacity per minute (MW/min).

(3) DWPP disconnecting is admitted if frequency reaches to some value higher than what corresponds to D-E segment from the characteristic curve provided in figure 2. The re-connection conditions are established by the TSO.

(4) At frequency variations DWPP should provide the capability:

a) To reduce active power by at least 40% of the installed capacity / Hz when frequency grows above 50.2 Hz;

b) To increase active power up to the maximum limit of available active power when frequency drops below 49.8 Hz;

Article 11 (1) The active power generated by a DWPP must be able to be limited to a setpoint value.

(2) The setpoint value level should be set locally or automatically received via remote control, within the range between technically minimum power and the installed capacity of the power park.

(3) DWPP should provide control of active power in the connection point with accuracy of ±5% from the installed capacity (as 10 minutes' average power).

Article 12 (1) Under normal operation DWPP should provide the capability:

a) To set the linear increase / decrease rate of the generated active power to the value required by the network operator (MW / minute);

b) Upon request of the network operator, to reduce the generated active power to the requested level (including stopping) by complying with the ramp rate (loading / unloading) established. The ramp rate should be observed both in case of natural power variation (enhanced wind speed) and upon setpoint power variations. The above provisions do not refer to unexpected stops;

(2) The power ramp rate should have a value settable within a 10% range from the installed capacity per minute and the maximum admissible rate provided by the manufacturer.

Article 13 (1) DWPP should install protection systems which should provide tripping.
(2) In the technical connection endorsement the network operator can request additional installation of automation systems in the DWPP, capable to quickly shutdown, event up to disconnection.

Article 14 (1) The manufacturer shall be responsible for protecting the GGE-s and of their auxiliary installations against damages, which might be caused by faults within their own installations or by impact from the electricity network over them when DWPP disconnection protections trip or upon network incidents (short-circuits with and without grounding, tripping of network protections, transient over-voltage etc.), as well as in case of exceptional / abnormal operating conditions.

(2) At the DWPP - NPS interface protections are regulated by the network operator.

Article 15 In case a WT trips due to the wind speed being outside the design limits, it must have the ability to automatically reconnect when the wind speed returns to normal operating values.

Article 16 (1) In case of voltage values within the admissible range in the connection point the reactive power generated / absorbed by a DWPP should provide continuously adjusted corresponding to a power factor set at least in the 0.95 capacitive and 0.95 inductive range.

(2) DWPP should be capable to provide automatic voltage / reactive power control in the CP in any of the following modes:

a) Voltage control
b) Control of reactive power exchanged with the NPS
c) Power factor control

(3) The network operator establishes the detailed terms of voltage and reactive power control in the technical connection endorsement (ATR).

(4) The response rate of the voltage co ntrol system should be at least 95% of the available reactive power per second.

Article 17 Under the network normal operational regime DWPP should not generate in the connection point fast voltage fluctuations higher than ±5% of the nominal voltage.

Article 18 The DWPP connection solution should take into account avoiding the WPP operation in islanding regime, including by protections which should disconnect the DWPP under such regime.

Article 19 (1) The design conditions provided in standards SR EN 61400-1:2006 Wind turbines, Part 1: Design conditions; SR EN 61400-2:2006 Wind turbines, Design conditions for small turbines, constitute the minimum specific requirements for the WT. The parameters characteristic for electricity quality generated by the WT are assessed and measured in accordance with the requirements provided at least in standard SR EN 61400-21:2003 Wind turbines, Part 21: Measuring and evaluating the power quality characteristics from wind turbines connected to an electricity network;

(2) Regardless of the number of WT and of auxiliary installations in operation and no matter what the power output is, DWPP should provide power quality performance in the CP according to applicable standards.

Article 20 The network operator verifies and makes sure the connection and operation of the DWPP planned to be installed does not lead to violating the applicable power quality norms.

Article 21 In order to carry out studies determining the connection or planning solution the applicant places at the network operator's disposal a simulation model for the wind park / generating module. Such model should be provided in a format requested by the network operator. The model should point out the WPP /WT parameters necessary for calculations of both steady-state regimes and of dynamic / transient regimes.

Article 22 Before commissioning the DWPP a test plan is agreed by joint agreement with the network operator, which establishes the testing procedure whereby DWPP proves its capability to comply with the connection conditions required by the network operator in the connection endorsement. Such tests also include verification of the operation simulation model.

Article 23 DWPPCEED should be equipped with metering and monitoring systems for operation and for power quality in the CP.

Article 24 In special circumstances found out by one's own studies the network operator Is entitle to require additional or more restrictive conditions than what has been provided above.

CHAPTER VI

Requirements for non-dispatchable wind power parks (NDWPP)

Article 25 (1) The minimum requirements for **NDWPP** with installed capacity ≥ 1 MW but not higher than 10 MW are those included in articles 5 ÷ 9, 13 ÷ 15, 17 ÷ 20.
(2) The following minimum requirements are set for **NDWPP** with installed capacity ≤ 1 MW:
a) They should be connected and disconnected by remote control;
b) They should operate in parallel to the network without generating voltage fluctuations higher than ±5% from the nominal voltage;
c) They should comply with the qualitative terms of the electricity generated set by the network operator according to applicable norms;

(3) The network operator can require for the **NDWPP** additional or more restrictive terms than the above with a view to provide safe operation of the electricity network and to protect the other users, including avoidance of operation under islanding regime.

CHAPTER VII

Requirements for telecommunication equipment

Article 26 The license holder for electricity generation by WT/WPP with installed capacity higher than 1 MW should provide continuity of information transmission to the network operator and the TSO.

Article 27 (1) All DWPP must be able to be monitored and controlled remotely.
(2) The control functions and metered values should provide the possibility to be placed at the network operator's disposal upon request, in an agreed interface point with the EMS-SCADA system.
(3) The information necessary to be transmitted on-line by the DWPP to the EMS-SCADA system includes at least- the active and reactive power generated, voltage and frequency values, position of switch elements in the connection point, the active energy generated, the frequency / power control (yes / no), wind speed and direction, atmospheric pressure, temperature etc.
(4) The information necessary to be transmitted on-line by the NDWPP includes at least the values of active and reactive power generated.
(5) The network operator shall also specify other information that must be sent by the WPP and shall sign a confidentiality agreement with the manufacturer, regarding this information.

Article 28 The license holder for electricity generation in the DWPP is compelled to provide the TSO with the output (active power) forecasts based on meteorological data, for the mid (1 ÷ 3 days) or short term (4 ÷ 24 hours).

CHAPTER VIII

Information that needs to be transmitted by the WPP

Article 29 The license holder for electricity generation in DWPP will send the technical data indicated in table 1.1 or 1.2 for each wind power park to which they are request connection or commissioning tests for. The power stations will only be set into operation after carrying out the operating tests, ensuring integration within the *network operator*'s *SCADA* system and sending the results of the tests carried out to the *network operator* in accordance with the following tables and the procedures drawn up by the *network operator*.

S- standard planning data;

D- detailed planning data;

R- data notified in order to elaborate the solution study and the connection application;

P – data sent at least 3 months before the PIF

T- data determined (recorded) after the tests included in the testing, monitoring and control activities. This data shall be determined during the PIF tests, and shall be sent to the network operator within 10 days after the PIF.

Table 1.1

Data for dispatchable wind power parks

Data description (symbol)	Measuring generating modules	Data category
Manufacturing company of the wind electricity unit	Name	S, R
Number of wind generating modules constituting the DWPP	Number	S, R
Type of wind generating generating modules constituting the DWPP	Description	S, R
Type approval for the wind electricity generating module	Certificate number	S, R
Network connection, bus-bar location and connection point	Text, diagram	S, R
Nominal voltage in the connection point	kV	S, R
Electrical diagram of the entire wind power park	Diagram	D, P
In the wind power park		
Nominal (rated) active power of the DWPP	MW	S, R
Maximum nominal apparent power at the bus-bar of the DWPP	MVA	S, R
Maximum net active power at the bus-bar of the DWPP	MW	S, R
Operational frequency at nominal parameters	Hz	D, P
Maximum / minimum variation rate of the active power that can be achieved in the DWPP	MW/min	P, T
Consumption of auxiliary services at maximum power generated at the bus-bar	MW	T
Special connection / disconnection conditions for the wind power park, others than those for component wind generating modules	Text	S, R, P
Mathematical model of the wind power park and the simulations made	Text	D, P
Active power control in the CP (control loop)	Control diagram, loading-unloading rate	D, P
Voltage control in the CP (control loop)	Control diagram	D, P
Power factor control in the CP (control loop)	Control diagram	D, P
P-Q diagram in the connection point	Graphical data	P, T
Parameters of the line connecting to the NPS		S
Data about the wind generating generating modules constituting the wind power park		
Type of wind generating module (horizontal / vertical shaft)	Description	S, R
Number of blades	Number	S, R
Rotor diameter	m	S, R
Height of rotor axis	m	S, R
Control system of blades (pitch/stall)	Text	S, R
Control system for speed (fixed / double speed / variable)	Text	S, R
Type of generator	Description	S, R
Type of frequency converter and nominal parameters (kW)		S, R
Nominal active power	MW	S, R
Maximum active power metered at the bus-bar of the DWPP - Medium value in 60 seconds - Medium value in 0.2 seconds	MW	T
Maximum active power admitted	MW	S, R
Nominal apparent power	kVA	S, R
Variation rate of active power	MW/min	P, T
Reactive power specified as medium 10 minutes' value depending on the 10 minutes' medium value of active power generated*)	kVAr	S, T
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Nominal wind speed (corresponding to nominal capacity)	m/s	S, R
Disconnecting wind speed	m/s	S, R
Variation of generated power with wind	Variation curve	S, R
P-Q diagram in the CP	Graphical data	S, R, P, T

MV / 110 kV transformer generating modules whereby the DWPP **is connected to the 110 kV bus-bar**		
Number of windings	Text	S, R
Nominal capacity of each winding	MVA	S, P
Nominal transformer ratio	kV/kV	S, R
Short-circuit voltage values by winding pairs	% of Unom	S, R
Idle run losses	kW	S, P
On load losses	kW	S, P
Magnetizing current	%	S, P
Connection group	Text	S, P
Control range	kV-kV	S, P
Control diagram (longitudinal or long-transversal)	Text, diagram	D, P
Size of control step	%	D, P
Saturation curve	Diagram	D, P
Electricity quality parameters for each generating module (designed / achieved)		
Flicker coefficient for continuous operation*)		S, T
Flicker step factor for switching operations*)		S, T
Voltage fluctuation factor*)		S, T
Maximum number of switches every 10 minutes *)		S, T
Maximum number of switches every 2 hours *)		S, T
At bus-bar level		
Total current distortion factor THDi *)		S, T
Harmonics (up to 50) *)		S, T
Non-symmetry factor of negative sequence		S, T

*) According to the attached tables

Table 1.2

Data for non-dispatchable wind power park with capacities ranging 1 ÷ 10 MW

Data description (symbol)	Measuring generating modules	Data category
Manufacturing company of the wind electricity generating module	Name	S, R
Number of wind generating modules constituting the NDWPP	Number	S, R
Type of wind generating generating modules constituting the NDWPP	Description	S, R
Type approval for the wind electricity generating module	Certificate number	S, R
Network connection, bus-bar location and connection point	Text, diagram	S, R
Nominal voltage in the connection point	kV	S, R
Electrical diagram of the entire wind power park	Diagram	D, P
In the wind power park		
Nominal active power of the NDWPP	MW	S, R
Maximum apparent power at the bus-bar of the NDWPP	MVA	S, R
Maximum net active power at the bus-bar of the NDWPP	MW	D, P
Operational frequency at nominal parameters	Hz	D, P
Consumption of auxiliary services at maximum power generated at the bus-bar	MW	T
Special connection / disconnection conditions for the wind power park, others than those for component wind generating modules	Text	S, R, P
Parameters of the line connecting to the NPS		S
Data about the wind generating generating modules constituting the wind power park		
Type of wind generating module (with horizontal / vertical shaft)	Description	S, R
Number of blades	Number	S, R
Rotor diameter	m	S, R
Height of rotor axis	m	S, R
Control system of blades (pitch/stall)	Text	S, R

Control system for speed (fixed / double speed / variable)	Text	S, R
Type of generator	Description	S, R
Type of frequency converter and nominal parameters	kW	S, R
Nominal active power	MW	S, R
Maximum active power metered at the bus-bar of the NDWPP - Medium value in 60 seconds - Medium value in 0.2 seconds	MW	T
Maximum active power admitted	MW	S, R
Nominal apparent power	kVA	S, R
Variation rate of active power	MW/min	P, T
Reactive power specified as medium 10 minutes' value depending on the 10 minutes' medium value of active power generated*)	kVAr	S, T
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Nominal wind speed (corresponding to nominal capacity)	m/s	S, R
Disconnecting wind speed	m/s	S, R
Variation of generated power with wind	Table	S, R
P-Q diagram in the CP	Graphical data	S, R, P, T
LV / MV, respectively MV / 110 kV transformer generating modules whereby the NDWPP **is connected to the MV or to the 110 kV bus-bar**		
Number of windings	Text	S, R
Nominal capacity of each winding	MVA	S, P
Nominal transformer ratio	kV / kV	S, R
Short-circuit voltage values by winding pairs	% of Unom	S, R
Idle run losses	kW	S, P
On load losses	kW	S, P
Magnetizing current	%	S, P
Connection group	Text	S, R
Control diagram (longitudinal or long-transversal)	Text, diagram	D, P
Size of control step	%	D, P
On load control	YES / NO	D, P
Saturation curve	Diagram	D, P
Electricity quality parameters for each generating module (designed / achieved)		
Flicker coefficient at continuous operation *)		S, T
Flicker step factor for switching operations *)		S, T
Voltage fluctuation factor *)		S, T
Maximum number of switches every 10 minutes *)		S, T
Maximum number of switches every 2 hours *)		S, T
At bus-bar level		
Total current distortion factor THDi *)		S, T
Harmonics (up to 50) *)		S, T
Non-symmetry factor of negative sequence		S, T

*) According to the attached tables

Annex to Table 1.1, Table 1.2

The information in the tables must be in accordance with the definitions and metering procedures from CEI 61400-21. Deviations from the transmitted values should be notified. If the network operator asks for it, he should receive a testing report. Any subsequent changes must be approved by network operator.

Reactive power / wind generator

Active power at outlet (% of Pn)	Active power at outlet (kW)	Reactive power (kVAr)
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		

Reactive power evaluated at P_{mc} (kVAr)	
Reactive power evaluated at P_{60} (kVAr)	
Reactive power evaluated at $P_{0.2}$ (kVAr)	

Voltage fluctuations

Under continuous operation

Phase angle of the network impedance, ψ_k	30°	50°	70°	85°
Annual average wind speed, v_a	Flicker coefficient, c (ψ_k, v_a)			
6.0 m/s				
7.5 m/s				
8.5 m/s				
10.0 m/s				

In case of switching operations

Case of switching operation	Switching at start-up speed (Vcut-in)			
Maximum number of switches, N_{10}				
Maximum number of switches, N_{120}				
Phase angle of network impedance, ψk	30°	50°	70°	85°
Flicker step factor, kf (ψk)				
Voltage fluctuation factor, ku (ψk)				

Case of switching operation	Switching at nominal speed (Vn)			
Maximum number of switches, N_{10}				
Maximum number of switches, N_{120}				
Phase angle of network impedance, ψk	30°	50°	70°	85°
Flicker step factor, kf (ψk)				
Voltage fluctuation factor, ku (ψk)				

Case of switching operation	Worst switch between wind generating modules			
Maximum number of switches, N_{10}				
Maximum number of switches, N_{120}				
Phase angle of network impedance, ψk	30°	50°	70°	85°
Flicker step factor, kf (ψk)				
Voltage fluctuation factor, ku (ψk)				

Current harmonics

Rank	Active power at outlet (kW)	Harmonic current (% of In)	Rank	Active power at outlet (kW)	Harmonic current (% of In)
2			3		
4			5		
6			7		
8			9		
10			11		
12			13		
14			15		
16			17		
18			19		
20			21		
22			23		
24			25		
26			27		
28			29		
30			31		
32			33		
34			35		
36			37		
38			39		
40			41		
42			43		
44			45		
46			47		
48			49		
50					

Maximum total current distortion factor (% of In)	
Output power for the maximum total current distortion factor (kW	

CHAPTER IX

Final provisions

Article 30 (1) In accordance with article 30 par (2) of the Electricity law 13/2007 network operators can issue technical approvals for the connection of WPP within their networks only to the extent in which the total installed capacity in the WPP does not impact the safe operation of the NPS. They will send copies of such endorsements to the TSO within three days from issuance.

(2) The maximum power that can be installed in the WPP as well as the additional power reserve necessary for NPS safety, depending on the installed capacity in the WPP, will be established by the TSO according to the specific procedure elaborated by them and approved by ANRE.

(3) TSO publishes quarterly on its website the amount of total installed capacity in the WPP which valid technical connection endorsements have been issued for, and the maximum amount of installed capacity in the WPP which technical connection endorsements can be issued for.

Notice: This document has been notified to the EC in accordance with Directive 98/34/EC of the European Parliament and Council of 22 June 1998, amended by Directive 98/48/EC, which has been transposed in the national legislation by Governmental Decision 1016/2004.