NOTE: Unofficial translation - for information only

Reg. No. 1557 of 30 November 2004: Regulations relating to the quality of supply in the Norwegian power system

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Regulations relating to the quality of supply in the power system

Chapter 1. Introductory provisions

Section 1-1. *Purpose*

These regulations shall contribute to ensuring a satisfactory quality of supply in the Norwegian power system and socially efficient operation, expansion and development of the power system. This shall include giving consideration to such public and private interests as are affected.

Section 1-2. *Scope*

These regulations apply to those who wholly or partially own, operate or use electrical installations or electrical equipment that are connected to the Norwegian power system, and those who pursuant to the Energy Act are designated system operators.

These regulations do not apply to Norwegian territorial waters, direct-current voltage systems or railway installations in Norway with a frequency of 16 2/3 Hz.

Section 1-3. *Derogation*

Private agreements concerning a quality of supply other than that stipulated by these regulations may be entered into. When entering into such agreements, the grid company shall provide an explicit account of the consequences this will have for the grid customer. Other grid customers shall receive a quality of supply that complies with the provisions in these regulations.

Section 1-4. *Definitions*

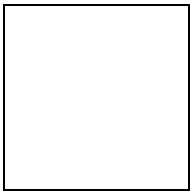
For the purposes of these regulations, the following definitions apply:

a) *Interruption*: A condition characterised by the absence of electrical power for one or more end users, where the supply voltage is below 1% of the declared voltage level. Interruptions are classified as long interruptions (> 3 minutes) and short interruptions (≤ 3 minutes).

b) *Flicker*: Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

c) *Flicker severity:* Intensity of flicker annoyance is defined by the UIE-IEC flicker measuring method is and evaluated by the following quantities:

   1. Short-term severity (P_{st}) measured over a period of ten minutes.
   2. Long-term severity (P_{lt}) calculated from a sequence of 12 P_{st} values over a two-hour interval, according to the following expression:



d) *Interharmonic voltages*: Sinusoidal voltages of a frequency between the harmonics, i.e. the frequency is not an integer multiple of the fundamental frequency of the supply voltage.

e) *Temporary overvoltages:* Sudden increase in the rms value of the voltage to more than 110% of the declared voltage level for a duration lasting from 10 milliseconds to 60 seconds.

f) *Voltage dips:* Sudden reduction in the rms value of the voltage to less than 90%, but greater than 1%, of the declared voltage level for a duration lasting from 10 milliseconds to 60 seconds.

g) *Steady state voltage variations*: Changes in the steady state rms value of the voltage measured over a given time interval.

h) *Quality of supply*: Quality of the electricity supply according to stated criteria.

i) *Reliability of supply:* The ability of the power system to deliver electrical energy to end users. Reliability of supply is associated with the frequency and duration of interruptions to the supply voltage.

j) *Calibration traceability*: Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

k) *Grid customer*: An entity that operates or owns installations or equipment for the use or generation of electricity that is connected to a grid company's installation. A grid company connected to another grid company shall also be regarded as a grid customer.

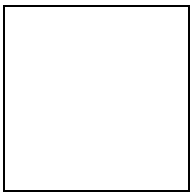
l) *Grid company*: Trading licensee that owns transmission grids or is responsible for grid services.

m) *Grid services:* One or more of the following:

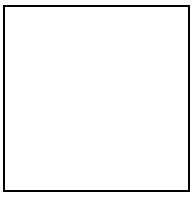
1. Transmission of power, including operation and maintenance of grid installations and investment in them.
2. Pricing.
3. Metering, billing and customer services.
4. Supervision and safety.
5. Coordination of operations.
6. Mandatory contingency measures
7. Mandatory power system studies or local energy studies

n) *Nominal voltage*: The voltage by which a system is designated or identified by and to which certain operating characteristics are referred.

o) *Harmonic voltages:* Sinusoidal voltages with a frequency equal to an integer multiple of the fundamental frequency of the supply voltage. Total harmonic distortion of the supply voltage is expressed by:



Individual harmonic distortion for each integer multiple of the fundamental frequency is expressed by:



where U_1 is the fundamental component voltage, U_h is a given harmonic voltage component and h is the component's harmonic order.

p) *Mains signalling voltage:* Signals that are superimposed on the supply voltage for the purpose of transmitting information via the public power line network. Signals used in the public power line network may be classified into three categories:

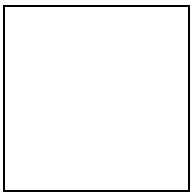
1. Ripple control signals: superimposed sinusoidal signals between 110 and 3000 Hz.
2. Power line carrier signals: superimposed sinusoidal signals between 3 and 148.5 kHz.
3. Mains-marking signals: superimposed short-term alterations (transients) at

selected points of the voltage waveform

q) *End user:* Purchaser of electrical energy who does not resell it.

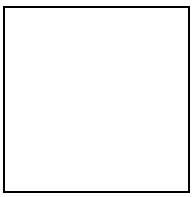
r) *Voltage quality:* The quality of the voltage according to stated criteria.

s) *Rapid voltage change*: A single rapid variation of the rms value of the voltage between two consecutive levels that are sustained for a definite but unspecified duration. A rapid voltage change is expressed by:



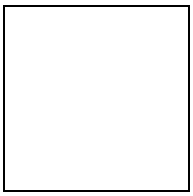
where ΔU_{max} is the maximum voltage difference over the course of a change in the voltage characteristic, and U_N is the nominal voltage value.

t) *Voltage unbalance:* Condition in a multiphase system in which the rms values of the line voltage (fundamental component) or the phase angles between consecutive line voltages are not all equal. The degree of unbalance is calculated as the ratio between the negative and positive sequence components of the voltage, and can be expressed as:



U_- is the negative sequence component of the voltage

U_+ is the positive sequence component of the voltage



U_{ij} represents the fundamental component of the line voltage between the numbered phases.

u) *Connection point:* Point in the transmission grid where the input or tapping of power, or exchanges between grid companies take place.

v) *Transient overvoltages*: High frequency or over frequency overvoltages that normally last for less than one half cycle (10 ms). The rise time can vary from less than a microsecond up to a few milliseconds.

Chapter 2. General provisions

Section 2-1. *Rectification*

Those covered by these regulations shall, in the event of incidents in their own installations that entail interruptions or reduced capacity to supply end users, restore full supply to the end users in question without undue delay. Connection points of significance to life and health shall be given priority.

Those covered by these regulations shall, if their installations are to blame for non-compliance with the provisions of these regulations, rectify the situation without undue delay. The duty to rectify does not apply to grid customers if the limit values are exceeded only in their own connection point, and the grid company to which they are connected does not experience any problems in consequence of this.

Special remuneration may not be demanded for obligations according to the first and second paragraphs.

Section 2-2. *Notification by grid customers*

Grid customers shall, without undue delay, inform the grid company to which they are connected about incidents in their own installations or equipment when it is likely that the grid company may experience problems with complying with the provisions in these regulations.

Section 2-3. *Disconnection of grid customers and notification by grid companies*

Grid companies may disconnect grid customers to carry out maintenance, renewal, expansions, fault detection, and fault rectification.

In the event of planned work involving interruptions or reduced capacity to supply end users, grid companies shall inform the affected grid customers about their timing and duration a reasonable amount of time prior to the work commencing. The information shall be provided in an appropriate manner.

Section 2-4. *Connections in own grid installations*

Grid companies may, as far as possible, carry out operational connections in their grid installations to limit the scope of the situations covered by sections 2-1, 2-2 and 2-3.

Section 2-5. *Grid companies' procedure in the event of dissatisfaction with quality of supply*

Enquiries by grid customers about the quality of supply shall be made to the grid company to which the customer is connected. Obvious causes leading to breaches of the provisions in these regulations shall be rectified without undue delay, cf. section 2-1.

In the event of an enquiry without an obvious cause, the grid company shall carry out the necessary measurements and investigations. In such cases the grid company may require written grounds stating significant factors.

The grid company shall, as soon as possible, and within one month, send the grid customer a preliminary assessment and work schedule. The measurements carried out shall at least have a duration of one week and shall as far as possible reflect the equivalent operating conditions referred to in the enquiry.

The grid company shall, as soon as possible, and within four months, determine who is responsible for implementing any measures pursuant to section 2-1. If the situation is regarded as originating from a connected grid customer, including other grid companies, the grid company shall bring up the matter in writing with the parties concerned and inform them about their obligation to rectify the situation pursuant to these regulations.

Time limits specified in the third and fourth paragraphs may be waived if there are weighty grounds for doing so. The grid customer shall be informed in writing of the reason and given a new work schedule with specified dates.

The grid company may not demand special remuneration for dealing with cases in accordance with the first to fifth paragraphs.

Section 2-6. *Disagreements concerning compliance with these regulations*

Disagreements concerning compliance with these regulations may be brought before the Norwegian Water Resources and Energy Directorate for a decision. Decisions taken by the Norwegian Water Resources and Energy Directorate pursuant to this paragraph are individual decisions, cf. the Public Administration Act.

In the event of a disagreement, grid companies shall inform grid customers about the first paragraph.

Section 2-7. *Recording of reliability of supply and voltage quality*

Grid companies shall record short interruptions due to incidents in their own high-voltage installations. Such records shall include the number, duration, and interrupted power of these short interruptions.

Grid companies shall record long interruptions pursuant to the regulations concerning financial and technical reporting, income caps for network operations and transmission tariffs.

Grid companies shall at any given time record temporary overvoltages and voltage dips at one or more measuring points in their own high-voltage installations. Such recordings shall be carried out in different characteristic grid installations, and shall cover the number, duration and voltage deviations of these temporary overvoltages and voltage dips.

Grid companies shall at any given time record rapid voltage changes greater than 4% at one or more measuring points in their own high-voltage installations. Such recordings shall be carried out in different characteristic grid installations, and shall include the number of rapid voltage changes and the maximum change in voltage.

Data recorded pursuant to the first, third and fourth paragraphs shall be saved for ten years.

Section 2-7, third and fourth paragraphs, enters into force on 1 January 2006.

Chapter 3. Requirements regarding reliability of supply and voltage quality

Section 3-1. *Reliability of supply*

The Norwegian Water Resources and Energy Directorate may order those covered by these regulations to implement measures to reduce the scope or consequences of short and long interruptions.

Section 3-2. *Voltage frequency*

The system operator shall ensure that the voltage frequency and time deviations are normally kept within the provisions of the Nordic system operation agreement.

In systems temporarily without physical connections to adjacent transmission grids, the system operator shall ensure that the voltage frequency is normally kept within 50 Hz ± 2%.

Section 3-3. *Steady state voltage variations*

Grid companies shall ensure that steady state voltage variations are within a range of ± 10 % of the nominal voltage measured as a one-minute mean value, in connection points in the low-voltage system.

Section 3-4. *Temporary overvoltages and voltage dips*

The Norwegian Water Resources and Energy Directorate may order those covered by these regulations to implement measures to reduce the scope or consequences of temporary overvoltages and voltage dips.

Section 3-5. *Rapid voltage changes*

Grid companies shall ensure that rapid voltage changes do not exceed the following values in connection points with the respective nominal voltage value, UN [kV], for the respective frequency:

Frequency of rapid voltage changes	***Rapid voltage change***	
	$0.23 \leq U_N \leq 1$	$1 < U_N$
1 change per 24-hour period	10	6
Up to 24 changes per 24-hour period	5	4
More than 24 changes per 24-hour period	3	3

Section 3-6. *Flicker severity*

Grid companies shall ensure that flicker severity does not exceed the following values in connection points with the respective nominal voltage value, UN [kV], for the respective time intervals:

	$0.23 \leq U_N \leq 35$	$35 < U_N$	***Time interval***
Short-term flicker severity, P_{st}	1.2	1.0	95% of the week
Long-term flicker severity, Plt	1.0	0.8	100% of the time

Section 3-7. *Voltage unbalance*

Grid companies shall ensure that the degree of voltage unbalance does not exceed 2% in connection points, measured as a ten-minute mean value.

Section 3-8. *Harmonic voltages*

Grid companies shall ensure that the total harmonic distortion of the voltage waveform does not exceed 8 %, measured as a ten-minute mean value, and that it does not exceed 5 %, measured as a one-week mean value, in connection points with nominal voltages from 230 V to 35 kV.

Grid companies shall, in connection points with nominal voltages from 230 V to 35 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

Odd harmonics				***Even harmonics***	
Not multiples of 3		***Multiples of 3***			
Order h	**U_h**	**Order h**	**U_h**	**Order h**	**U_h**
5	6.0%	3	5.0%	2	2.0%
7	5.0%	9	1.5%	2	1.0%
11	3.5%	> 15	0.5%	> 6	0.5%
13	3.0%				
17	2.0%				
19, 23, 25	1.5%				
> 25	1.0%				

Grid companies shall ensure that the total harmonic distortion of the voltage waveform does not exceed 3 %, measured as a ten-minute mean value, in connection points with nominal voltages from 35 kV to 245 kV.

Grid companies shall, in connection points with nominal voltages from 35 kV to 245 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

Odd harmonics				***Even harmonics***	
Not multiples of 3		***Multiples of 3***			
Order h	**U_h**	**Order h**	**U_h**	**Order h**	**U_h**
5	3.0%	3	3.0%	2	1.5%
7, 11	2.5%	9	1.5%	4	1.0%
13, 17	2.0%	15,21	0.5%	6	0.5%
19, 23	1.5%	> 21	0.3%	> 6	0.3%
25	1.0%				
> 25	0.5%				

Grid companies shall ensure that the total harmonic distortion of the voltage waveform does not exceed 2 %, measured as a ten-minute mean value, in connection points with nominal voltages above 245 kV.

Grid companies shall, in connection points with nominal voltages above 245 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

Odd harmonics				***Even harmonics***	
Not multiples of 3		***Multiples of 3***			
Order h	**U_h**	**Order h**	**U_h**	**Order h**	**U_h**
5, 7	2.0%	3	2.0%	2	1.0%
11, 13, 17, 19	1.5%	9	1.0%	4,6	0.5%
23, 25	1.0%	15,21	0.5%	> 6	0.3%
> 25	0.5%	> 21	0.3%		

Section 3-9. *Interharmonic voltages*

The Norwegian Water Resources and Energy Directorate may stipulate limit values for interharmonic voltages in connection points.

Section 3-10. *Mains signalling voltage*

The Norwegian Water Resources and Energy Directorate may stipulate limit values for signal voltages superimposed on the supply voltage in connection points.

Section 3-11. *Transient overvoltages*

The Norwegian Water Resources and Energy Directorate may order those covered by these regulations to implement measures to reduce the scope or consequences of transient overvoltages.

Chapter 4. Information about reliability of supply and voltage quality

Section 4-1. *Terms and conditions in agreements about the connection and use of* grid installations

Grid companies shall ensure that grid agreements signed pursuant to the regulations concerning financial and technical reporting, income caps for network operations and transmission tariffs, stipulate terms and conditions regarding the quality of supply. These terms and conditions can not offer grid customers a poorer quality of supply than the minimum requirements stipulated in these regulations, unless a private agreement has been signed regarding derogation pursuant to section 1-3.

Section 4-2. *Information about technical matters regarding reliability of supply and voltage quality*

Upon receiving an enquiry from a grid customer, grid companies shall provide information about the applicable regulations that relate to the quality of supply.

At the request of a current or future grid customer, grid companies shall provide information within one month about reliability of supply and voltage quality in their own installations. Information about the following elements shall be provided:

a) Nominal supply voltage in connection points and limit values for voltage quality.

b) Results of fault analyses carried out pursuant to the regulations relating to the system responsibility.

c) Results of data recorded pursuant to section 2-7.

d) Estimated number of current and future short interruptions in the grid customer's connection point, based on historical data recorded pursuant to section 2-7, first paragraph.

e) Estimated number and duration of current and future long interruptions in the grid customer's connection point, based on historical data recorded pursuant to section 2-7, second paragraph.

f) Estimated number of current and future temporary overvoltages and voltage dips in their own supply areas, based on historical data recorded pursuant to section 2-7, third paragraph.

g) Calculated minimum and maximum short-circuit power for connection points in the high-voltage system. Affected grid customers connected to the high-voltage system shall be informed of significant changes in minimal and maximum short-circuit power.

h) Special conditions in the grid that may have an effect on the quality of supply, in order to prepare grid customers for conditions that might arise. Examples of these include: particular risk of phase interruptions in coil earthed networks or switching transients, use of automatic reconnection in their own grid installations, natural conditions, etc.

Grid companies may not demand special remuneration for information provided pursuant to the first and second paragraphs.

Based on actual measurements at a given point in the grid, grid companies shall provide information about the level of steady state voltage variations, flicker severity, degree of voltage unbalance, and harmonic voltages, when so requested in writing by current or future grid customers.

Grid companies may demand the reimbursement of necessary costs for carrying out the obligations pursuant to the fourth paragraph.

Section 4-2, second paragraph, litra d), enters into force on 1 January 2006.

Section 4-2, second paragraph, litra f), enters into force on 1 January 2007.

Section 4-3. *Measurement methodology and calibration as well as documentation of equipment precision*

Measurements of quality of supply shall be carried out in accordance with the relevant standards prepared by the International Electrotechnical Commission – IEC or the European Committee for Electrotechnical Standardization – CENELEC.

The instruments used shall be calibrated in accordance with the instrument suppliers' specifications with respect to frequency and methodology. The calibration traceability for the individual measurement parameters shall be documented.

The precision and limitations of the measuring equipment shall be stated in the documentation of the measurement results. The measurement results plus uncertainties shall be within the limit values specified in these regulations.

Chapter 5. Other provisions

Section 5-1. *Monitoring and inspection activities*

The Norwegian Water Resources and Energy Directorate shall carry out monitoring and inspection activities to ensure that the provisions of these regulations are complied with. Those covered by these regulations shall assist in conducting monitoring and inspection activities. Among other things, this includes providing the documentation necessary for carrying out monitoring and inspection activities.

Section 5-2. *Orders and coercive fines*

The Norwegian Water Resources and Energy Directorate may issue those orders necessary to implement these regulations.

The Norwegian Water Resources and Energy Directorate may stipulate coercive fines for contravening orders issued pursuant to the first paragraph.

Section 5-3. *Appeals*

Individual decisions made by the Norwegian Water Resources and Energy Directorate may be appealed to the Ministry. The appeal shall be addressed to the Ministry and submitted to the Norwegian Water Resources and Energy Directorate for preliminary processing.

Section 5-4. *Exemptions*

The Norwegian Water Resources and Energy Directorate may in special circumstances grant exemptions from these regulations.

Section 5-5. *Entry into force*

These regulations shall enter into force on 1 January 2005.

Section 2-7, third and fourth paragraphs, and section 4-2, second paragraph, litra d), enter into force on 1 January 2006.

Section 4-2, second paragraph, litra f), shall enter into force on 1 January 2007.