MINISTRY OF ECONOMY, LABOR AND ENTREPRENEURSHIP

Pursuant to Article 25, paragraph 3 of the Electricity Market Act (*Official Gazette*, no. 177/04), Minister of Economy, Labor and Entrepreneurship herewith passes

THE GRID CODE

I. GENERAL PROVISIONS

Article 1

These Network and System Rules (hereinafter referred to as the «Grid Code») set out operation and management, development and construction of, and connection to the transmission and the distribution system, as well as metering rules in accounting points.

Article 2

(1) The Grid Code sets out the following:

- technical and other conditions for user connection to the system,
- technical and other conditions for safe electricity system operation,
- procedure in the times of the electricity system crises,
- technical and other conditions for interconnection and interaction of systems,
- technical and other conditions for accounting for the measured electricity.

(2) This Grid Code sets out operation and management of the transmission and the distribution system, including development planning, and rights and obligations as well as interrelations of electricity market participants with the aim of securing reliable and efficient electricity system operation.

(3) Technical and other conditions, procedures, rights and obligations referred to in paragraphs 1 and 2 of this Article, are defined in the APPENDIX which is a component part of this Grid Code.

(4) This Grid Code shall apply to energy undertakings and system users.

Article 3

Croatian Energy Regulatory Agency (CERA) may organize a conciliation procedure for all potential disputes arising from the application of this Grid Code pursuant to the Conciliation Act (*Official Gazette*, no. 163/03).

II. TRANSITIONAL AND FINAL PROVISIONS

Article 4

(1) Energy undertakings and system users shall harmonize their acts on their rights and obligations, technical and operating conditions and procedures (rules of regulations, instructions, conditions, rules, recommendations and other) as well as plans for their electric power facilities and equipment, with the provisions of this Grid Code in the period of 12 months from the date this Grid Code becomes effective. Energy undertakings shall make their acts public by having them published.

(2) In the course of the period referred to in paragraph 1 above, currently effective acts - technical and operating conditions and procedures as well as plans shall apply where they are in accordance with this Grid Code.

Article 5

This Grid Code shall come into effect on the eight day from its publication in the *Official Gazette*, and its implementation shall start from April 1, 2006.

Minister:

Branko Vukelić (signed)

1 GLOSSARY

The terms, defined by the Energy Act (*Official Gazette*, no. 68/01 and 177/04), Electricity Market Act (*Official Gazette*, no. 177/04) and General conditions of electricity supply are used consistently in this Grid Code. The Glossary of the Grid Code encompasses only terms that are in the Grid Code used frequently and that have not been defined in the above stated regulations.

Introductory note: The terms defined elsewhere in this Glossary or in the above stated regulations are written in Italics.

Term	**Definition**
(n-1) criterion	Technical safety criterion used in operation management and *system* development and construction planning. It refers to the unavailability of a *system* unit (line, transformer, generator). Meeting the safety criterion is assessed in relation to the permitted voltage levels in *system* nodes, and system units' thermal *load*.
access to the grid	Right to non-discriminatory *access to the grid* by market participants who are not *grid* owners. Based on access to the *grid suppliers* contract *electricity supply* with *generators* and *customers* pursuant to the *use of system agreement*, and the *Transmission System Operator* or the *Distribution System Operator* grant them permission to use the *system*.
accounting figure	Figure reflecting electricity parameters retrieved from *metering devices* in an *accounting point*; serves for electricity settlement. It can be measured or estimated. Estimation is conducted pursuant to the *General conditions of electricity supply*.
accounting interval	Time period in which average active power to be injected or withdrawn in an *accounting point* is contracted, typically 15 minutes or its multiple (for example 1 hour).
accounting point database	Data base containing the following: *metering data*, data on equipment for an *accounting point* and data on communicational parameters.
accounts coordination center	A center established for the purpose of: -consideration and assessment of *exchange* programs during the planning phase -consideration of values read on the meters on *interconnecting lines* and calculation of provisional values of energy *exchange* -real-time supervision -calculation of *inadvertent interchange* -calculation for compensatory programs. According to international regulations (*UCTE*) the centers are: the Main control center of the RWE Energie in Brauweiler and the Swiss System Operator in Laufenburg.
accuracy class	Scope of possible error that a *metering device* shall not exceed if being used within the declared scope of measurement, the declared working conditions, and within the valid period of authentication.
active energy	Electric energy transformed into a different type of power, for example mechanical, thermal, chemical, light or sound.

active power	Electric *power* available for transformation into a different type of power, for example mechanical, thermal, chemical, light or sound. It is the mean value of the product of multiplication of current voltage and current values in a certain time period.
ancillary services	Those are available individual services provided by the *system user* (e.g. *generator*) or the *Distribution System Operator* upon the request of the *Transmission System Operator* for the provision of which (technical solution, operating costs) *Transmission System Operator* shall be adequately remunerated. Those services are used by the *Transmission System Operator* to provide *system services*. Wind farms with asynchronous operations are a specific type of generating units to which these provisions of the *Grid Code* regarding the provision of *system services* typically do not apply.
ancillary services in the distribution system	Those are available individual services provided by the *system user* (e.g. *generator*) upon request of the *Distribution System Operator* for the provision of which (technical solution, operating costs) *Distribution System Operator* shall be remunerated. Those services are used by the *Distribution System Operator* to provide services in the *distribution system*. Those services are contracted in a special agreement.
apparent power	The product of multiplication of voltage and current values. In symmetric three-phase system it is $\sqrt{3}$ times voltage times current. It is a square root of the sum of squares of *active* and *reactive power*. Note: The effective value of a variable is a square root of the mean value of the square of current values of a variable in a certain time interval.
attestation	Allows the use of *metering devices* for a certain number of years during which the device is from a legal point of view within the tolerance limits of *accuracy class*. Attestation is conducted by an authorized measurement laboratory supervised by the relevant state institution.
auto-reclosure	*A short interruption* lasting 1.5 seconds, single-pole or three-pole, occurring due to disconnection of one *circuit-breaker* (in case of single-feed to the *fault location*) or more circuit-breakers (in case of multiple-end feed to the *fault location*). Successful auto-reclosure: if the fault is cleared during this short deenergized period. Unsuccessful auto-reclosure: if the fault is not cleared, and equipment is disconnected by protective equipment.
available power (net, gross)	Permanent power of a generating unit attainable in *normal operating conditions*. It is limited by the capacity of the *power station's* bottleneck, and is disclosed for each new long term state (e.g. generating set replacement, aging). Temporary changes (e.g. to replace *power station components* that *broke down*) are not disclosed. *Net available power* is *gross available power* decreased by *auxiliary service power*.
available transmission capacity	Available transmission capacity is a variable which expresses *transfer capability* between two adjacent connected *control areas*. It is determined as a difference between *net transfer capacity* and the *notified transmission flow*. It is the assessed remaining *transfer capability* for further commercial activities between two connected *control areas* for the observed period.
bay	Part of the *switchyard* containing circuit-breakers, *current transformers* and other equipment of one outlet serving as a connection of, for example, a line, energy transformer or a generator, to the busbars.

black start	It is a start-up of a *generating unit* from shut-down without the presence of voltage from the system, into a state ready for synchronization, which is taking *over the load*.
circuit-breaker	Serves for making and breaking electrical circuits under operating and *fault* conditions in the *electric power system*. Note: *Fault* may or may not have electric manifestation. Here, naturally we deal with a *fault* that has electric manifestation (for ex. short-circuit current) that a *circuit-breaker* must withstand.
circuit-breaker breaking current	Maximum current a circuit-breaker can break at the highest declared voltage for the circuit-breaker and in other declared circumstances.
component	Component part of each *system unit* or *generating unit*; a unit consists of components.
congestion	Congestion occurs when market participants in a certain time period demand *transmission* through a certain transmission line in the *system* which exceeds its *transmission capacity* or due to *system disturbances*.
consumption management	All systematic measures undertaken to secure peak *load* decrease, or to improve harmonization of demand with the possibilities of electricity supply.
continuous output	Highest *output* a *generating unit* can withstand if used as prescribed and without time limit, without endangering its life span or safety. It can change in the course of a year (e.g. due to different conditions of cooling water supply).
control area	The area for which the *system operator* holds responsibility for *primary control, secondary and tertiary control*, as well as exchange with other control areas and blocks within the space of obligations resulting from membership in the *UCTE*. Each *control area* is encircled by *exchange* measuring points.
control block	A control block comprises one or more *control areas* which, in reference to the *power-frequency control* actions, stand separately from other *interconnected* control blocks. Control block ensures that the summated *schedules* of *control areas* towards other control blocks are implemented, and restores the frequency and *exchange power* to its set point value following a deviation. Control block is not responsible for *primary control*, this task falls under the responsibility of an individual *control area*.
covering electricity losses	Procedure where contracting with electricity generators or purchase on the electricity market is used to set off the difference between electricity withdrawn and injected.
current transformer	Transformer or a similar device used for decreasing high voltage or high currents to levels appropriate for feeding *metering devices*, measuring instruments, protective and control devices, with galvanized separation from the electric power *system*.
customer facilities	Customer's technical facilities.
damage, breakdown	State in which a *system unit* or a *generating unit* may not be put into operation without repair or replacement of at least one *component.*

damping ratio ζ	Index of relative rate of amplitude (decay or growth) of a simple oscillation of linear system, where 0 corresponds to undamped oscillations with constant amplitude,1 refers to non-oscillatory aperiodic transient phenomnon; negative damping ratio corresponds to an inciting phenomenon (oscillatory phenomenon amplitude growth) with time. Index of relative rate of amplitude (decay or growth) of a simple oscillation (or a single oscillatory component of a complex transient) of linear system where: – $\zeta<0$ means unstable oscillations with increasing amplitude – $\zeta=0$ corresponds to a borderline event of undamped oscillations with constant amplitude – $\zeta<0<1$ corresponds to stable (damped) oscillations – $\zeta=1$ means non-oscillatory (aperiodic) *transient phenomenon.*
dead band	It is set intentionally on a controller; as opposed to the undesired *neutral zone*. It is the range through which an input variable may be varied, without causing an effect in the output signal.
deficiency	A state of the observed *system unit* or *generating unit* presenting a difference in relation to a fully operational state, yet such wherein permanent operation of the unit is enabled, either with full of decreased capacity.
deviation from schedule	Difference between units approved and measured based on the *delivery and takeover schedule*, in an *accounting period* and the average values of *active energy and power* in *normal operating conditions*.
distributed generating unit	*Generating unit* connected to the *distribution system* and under the authority of the *Distribution System Operator*.
distribution facilities operator	Serving, authorized and competent person or persons for managing *distribution system* or its part.
distribution system management	Procedure covering operation planning, management and supervision over the *distribution system*.
distribution system operation management	A *distribution system* activity for overcoming and limiting influence of disturbances and *breakdowns* within the framework of available operating possibilities, acting pursuant to directions for operation planning. Operation management covers the following: – supervision of the *system* operation, – performing switching operations, – coordinating the operation of management and maintenance services in the field, – responding to the calls of the *distribution system users*.

distribution system services	The services of the distribution system are the following: *-distribution system management,* *-frequency control* *-voltage control in the distribution system* *-restoration of supply after disturbances* -standard tariff, consumption and lighting management, *-securing reactive power outside the limits of permissible power factor,* *-securing quality of supply above the standard,* *-securing other non-standard services,* and the *Distribution System Operator* secures those services for the distribution *system users*.
disturbance	A series of unexpected events and states in the *electric power system* that may impair *normal operation*, or lead to *operation under fault conditions*.
disturbance defense plan	*Disturbance defense plan* includes the following: -the role of each *generating unit* in the disturbance defense program and the procedure to be followed in the event of a disturbance -*capability of tripping onto auxiliary supplies, capability of isolated operation,* and *black start capability* of each generating unit -the criteria for automatic disconnection from the system of each *generating unit* - the role of the *Transmission System Operator* in the disturbance defense program and the procedure to be followed in the event of a disturbance - the role of each *customer connected to the transmission system* and *the Distribution System Operator* in the disturbance defense program and the procedure to be followed in the event of a disturbance -underfrequency load shedding plan.
earth fault factor	Earth fault factor in a certain point of the *electric power system* is the ratio between the effective value of a sound phase-to-earth during a *fault* and effective value of a phase-to-earth voltage when there is no fault. The 110, 220 and 400 kV nominal voltage *network* is considered to be efficiently earthed if the earth fault factor is below 1.4.
electric power system	A group of interconnected *power stations*, *networks*, and *plants and apparatuses*. In it functional wholes, divided according to technical, economic or other criteria can be observed. Abbreviated version in an intelligible context is *system* only.
Electric power system (network)	*Network for electricity supply*, a group of connected *units of power transmission* network or *distribution* network. It may be divided according to: - areas over which it extends - *control areas* - tasks - method of operation - voltage - ownership - type of current Abbreviated version in an intelligible context is *system* only.
electric power system collapse	It is a *disturbance* in which the system is divided into at least two parts within a *control area*, due to the *outage* of a transmission line – or lines, where in each of these parts a large-scale *interruption of electricity supply* may occur.

electric power system management	All actions undertaken by the *Transmission System Operator*, who exerting influence upon *system units* or *generating units* – directly or through operators in transmission system centers, operators in generating units and operators in the distribution system – realizes safe and reliable operation of the *electric power system,* namely, the supply of *customers* with quality electricity.
electricity delivery	Process wherein the *customers* are supplied with electricity via one or more *accounting points* in the *electric power system*.
emergency reserve	Reserve, realized through an agreement between two Transmission System Operators on electricity delivery in the event of operation under fault conditions in the system of one of the two Operators.
estimated metering data	Data obtained by estimating the flow of not measured or incorrectly measured electricity at a certain *accounting point* for the purpose of electricity settlement exclusively.
exchange	Agreed *power/energy flow* between two adjacent connected *control areas* which is the result of *power/energy* withdrawal in one or more *withdrawal points* of a *control area* and simultaneous injection of *power/energy* from one or more *injection points* of another *control area*.
failure	Transition of a *system unit* or a *generating unit* from operating into a fault state. Note: see *fault* and note 2 under *outage*.
fault	It is a state in which the observed *system unit* or a *generating unit* cannot any longer perform all its functions. It may be transient, temporary and permanent. Successful auto-reclosure defines a fault as transient. Temporary fault is if a successful auto-reclosure was achieved without repair or replacement, regardless of how much time has elapsed until the reclosure, while the fault is permanent if a successful auto-reclosure was possible only after a repair or replacement of a *component* of the observed unit. Permanent fault is called a *breakdown*. See also *failure*.
feeding (with electricity)	When a *customer* is connected to the system and the connection is live, currently being used or is ready for use. See: (*electricity) supply*
flicker	It is the occurrence of a disturbance in human sight when the illumination of a lighting fixture changes. The phenomenon occurs as a consequence of change of a certain level and frequency of power supply voltage capsule of a lighting fixture. The occurrence is most commonly characterized by two severity indices: - flicker severity, short term (the period of 10 minutes), P_{st} - flicker severity, long term (12 measurings P_{st} in the period of 120 minutes), P_{lt}: $P_{lt} = \sqrt[3]{\frac{1}{12}\sum_{k=1}^{12} P_{stk}^3}$
frequency control	It is a *system service* by which system frequency is maintained within the declared limits. To maintain system frequency *primary control* of generating set's speed is used, as well as the *secondary control* system in which a certain number of generating sets in *generating units* is included, and *minutes reserve* system in which a certain number of generating sets is also included.
fuel types	Energy sources whose combustion releases energy (fossil fuels: coal, oil derivatives, gas) and/or nuclear fuel.

generating unit	A part of a *power station* that, according to certain criteria, may be separated. For example a thermal power station unit with steam busbars, cogeneration plants, hydro generating set, combustible cells, sun module. Note: A *power station* consists of a generating unit/generating units, *unit transformer* and a switchyard.
generating units' auxiliary consumption	The consumption of auxiliary facilities of a *generating unit* (for ex. for water treatment, water, air or fuel supply, flue gas dust collection), including losses from the *unit transformer*. A distinction is drawn between the generating set's auxiliary power in operation and at rest.
generating unit's auxiliary power	Electric *power* expressing, for a *generating unit*, the consumption of auxiliary equipment (for ex. for water treatment, water feed to the steam generator, fresh air and fuel supply, flue gas dust collection), including loss from the *unit transformer*. It is different during a generating set's auxiliary power in operation and at rest.
inadvertent interchange	It is the difference between the *exchange* in real time and exchange as foreseen by the *Transmission System Operator* or the *Distribution System Operator (*exchange schedule).
incentivization of energy efficiency	Collective measures whereby energy undertakings and customers are given incentives to use electricity or any other form of energy more efficiently.
initial symmetrical short-circuit power	Product of multiplication: $\sqrt{3}$ times nominal voltage times initial symmetrical short-circuit current of the three-pole short-circuit.
interconnection	A collection of all *control areas* in synchronous operation.
interconnecting line	Line or a transformer which connects *transmission systems* under the authority of individual *Transmission System Operators*.
interface	Point of division between the system of the *Transmission System Operator* or the *Distribution System Operator* and *system user*. Details are specified in the *connection conditions* where i*nterface* elements on the secondary level are also defined. *Interface* between *two Transmission System Operator*s or between a *Transmission* S*ystem Operator* and a *Distribution System Operator* is defined in a bilateral agreement.
interval meter	*A meter* that memorizes electricity usage in each *accounting interval*, thus storing the *load* curve.
impermissible power deviation	A *deviation from the schedule* for ±10% in relation to the active power value of the approved *injection and withdrawal schedule*.
island operation	Operating conditions of *generating unit* wherein it can safely endure *partial load* in an isolated part of the *electric power system*.
large-scale disturbance	A large-scale disturbance is a *disturbance* in the *electric power system* of such intensity and duration that it results in the *outage* of one or more large *generating units* or in the *failure* of one or more *transmission system* lines.
load	In *electric power system* same as *power*. It can refer to each individual *system unit*, *generating unit*, a part of the system or the entire electric power system, as well as the *injection and withdrawal points* in the *system*.

loop flow	The result of load flows in the *interconnection* (natural loop flow) which is defined as a difference between the physical power exchange and the agreed *delivery schedules* with exchanged power balances of certain *control areas*. Physical power flows are conditioned by a distribution of the impedances between nodes, and *injection* and *withdrawal* capacity in the *system* nodes.
market representative, agent	Legal person representing a person and performing all transactions in its behalf and pursuant to its authorization.
metering data	Data on the collected electricity parameters retrieved from the *metering devices*. The data can be measured or *estimated metering data*.
metering data base	Data base containing confirmed *metering data*.
metering device	Legal metering devices: *electricity meters*, *current transformers* and timers which shall have a type approval and valid *attestation*.
metering equipment	Comprises the following: *metering devices* and other measuring equipment situated at the metering point. Other measuring equipment comprises the following: lines and connections, fuses, tariff management devices, communication devices, overload protective devices, devices for registering mean power and total accounting values etc. Other measuring equipment is not subject to obligatory approval and attestation.
metering point	A point of *meter* (directly connected) or *current transformer* (semi-directly of indirectly connected) connection.
minimum safe output	The value below which *power* shall not drop in continuous operation for specific reasons related to the facility or fuel supply. If minimum safe output refers to a shorter time interval rather than to continuous operation, this should be indicated accordingly.
minutes reserve	*Power* available following a *power outage*, and shall, in 15 minutes at the latest, replace secondary reserve (intended for *primary control*). It is realized in rotating generating sets during *secondary control* operation and by engaging other available generating sets including gas *power stations* and disconnecting *customer load*.
net transfer capacity	Net transfer capacity is a parameter disclosing the *transfer capability* between two adjacent connected *control areas*. It is defined by a difference between the *total transfer capacity* and *safety transmission margin*. It is the assessed largest possible safe physical *power* flow between two *control areas*.
network nominal capacity	Voltage designating and labeling the network. Operating voltage is current voltage value, differing from the nominal voltage for the amount of the permissible deviation. Standard nominal voltages of public electric power networks in Croatia are: 0.4, 10, 20, 35(30), 110, 220 and 400 kV.
network unit	Network units are as follows: lines, transformers, *bays* and busbars, and units for *reactive power* compensation.
neutral zone	Scope defined by the frequency limit within which the controller does not respond, determined by a common imperfect operation of the controller and the machine.
no-load condition	No-load condition of a *generating unit* is a state in which a *generating unit* is disconnected from the *electric power system* and is under no load, at nominal rotation speed, with excited generator.

nominal capacity of a generating unit	*Permanent capacity of a generating unit* determined by the connection conditions, and according to which the unit is dimensioned. If doubtful, it shall be determined upon the construction of a facility, in *normal operating conditions*. *Nominal capacity* of a unit in cogeneration is referred to as electric *nominal capacity*.
normal operation	Normal operation has the following characteristics: secure *normal operation* -all *customers* are supplied -all *limit values* are observed -*(n-1) criterion* is met at all points -adequate *power station* and *transmission system* reserves are available normal operation at risk -*(n-1)- criterion* is not met at all points.
operating state of the electric power system	Operating state of an electric power system may be the following: -safe *normal operation* - *normal operation* at risk -*operation under disturbance conditions* -*electric power system collapse*.
operation under extraordinary conditions	Status of the *electric power system* wherein the *limit* operating *values* are exceeded and there is a risk of *disturbance* spreading.
operation under fault conditions	*Operation under fault conditions* is characterized by the following: -all customers are still supplied, -voltage and frequency *limit values* have not been maintained, -*generating units* and *network elements overloads* are possible, -*(n-1)-criterion* is no longer met.
outage	Inadvertent transition of a *system unit* or a *generating unit* from operating state to a shut-down. Types of *outage* are: -outage due to proper functioning or malfunctioning of protection operation -manual undeferrable forced outage -manual unnecessary/unexpected outage. Note 1: In the Operating events statistics in the Hrvatska elektroprivreda's transmission system the term «otkaz » is used with the same meaning as "ispad" (outage). Such shut-down is called « forced *outage* ». Note 2 : It should be mentioned that the outage (transition from operating state into shut-down) does not mean the same as the transition from proper functioning into fault state (that is a *failure*): properly functioning unit may also be affected by outage, while malfunctioning one need not be out of operation. Note 3: Planned transition from operating into shut-down is not outage, but rather, planned «planned tripping». After that follows the state called « planned *outage*».

outage	It is the shut-down of a *system unit* or a *generating unit* caused in the event of a forced outage by : -*a fault* on the observed unit -fault on other units which has caused shut-down of the observed unit, that is in the event of a planned outage -required work or modifications on the observed unit -required work or modifications outside the observed unit, yet those that can be performed only during the shut-down of the observed unit. The following is not considered to be an *outage* event: -putting an operating unit on stand-by -shutting down a properly functioning unit because of voltage conditions in the network, short-circuit current limitations and similar reasons -waiting longer than 30 minutes for connection upon receipt of the notification of a generating unit's availability. Outage can lead to *interruption of supply*. See also: *outage, failure, fault and interruption of supply*.
overload	When permissible thermal *load* of the overhead transmission or distribution line, cable or a transformer is violated. Permissible thermal *load* of an overhead transmission or distribution line is defined by a physical construction and can change depending on the external weather conditions. Permissible thermal l*oad* of an overhead transmission or distribution line depends solely on its physical execution. Permissible thermal *load* of a transformer depends on its physical construction, cooling and the duration and level of previous load.
partial load	*Load between the minimum safe output* and *permanent load of a generating unit.*
permanent droop	*Permanent droop* is an inclination of the outer linear characteristic of a controlled generating set (primary speed control and primary voltage control). It is expressed for two basic output control values: voltage frequency (generating set rotation speed) and generator voltage. *Permanent droop* (*s,%*) of the primary generating set speed controller (voltage frequency) is defined as a ratio, multiplied by 100, of the relative frequency deviation (Δf/fn) and permanent relative generating set's *reactive power* deviation ($\Delta P/Pn$), without change in structure and controller adjustment. *Permanent droops* (*s,%*) of the generator voltage primary controller are defined as ratios, multiplied by 100, of the permanent relative deviation of the generator voltage ($\Delta U/Un$) and permanent relative deviations of one of the following variables: reactive power ($\Delta Q/Sn$) or generator's reactive current ($\Delta Ij/In$), and active power ($\Delta P/Sn$) or generator's active current ($\Delta Ir/In$), without change in structure and controller adjustment.
permissible power deviation	*A deviation from the schedule* within the range of ±10% for the duration of 1 hour, in relation to the value *of the active power* value of the approved *schedule.*
Planned exchange (exchange schedule)	Planned exchange (exchange schedule) is agreed hourly *power exchange* (or exchange agreed for a multiple of the hour) between *control areas*.

Planned operation of a power station (power station schedule)	Planned operation (schedule) of a *power station/generating unit* is hourly (or its multiple) power of the *power station* or a *generating unit* confirmed by the *Transmission System Operator*.
plant and apparatus	Equipment and facilities consuming electric power.
power factor	Ratio between *active* and *apparent power*. Indirectly the measure for it is the ratio between *reactive* and *active power*.
power frequency characteristic	It is a constant of the *electric power system* or a *control area*, expressed in MW/Hz or MW/0.1Hz. It says that, with *secondary control* of power-frequency of the *electric power system* or a *control area* in isolated operation turned off, a quasisteady frequency deviation of 1 Hz or 0.1 Hz and decreasing (or increasing) would occur if, in the system or a control area after a *disturbance*, there should be a permanent deficit (or surplus) of *active power* generation, the amount of which in MW would equal the numerical amount of the constant.
power frequency control (load frequency control)	It is a *secondary (frequency) control* on the level of the *electric power system* with a minute response in order to maintain the desired *exchange power* and frequency in an *interconnection*, that is only frequency in isolated operation of a *control area* or a part of an *electric power system*. It is realized through a controller of a *control area* or the *electric power system* operating via the speed control system of *generating units* and group controllers of *power station's active power* if they are installed in *power stations* containing more than one *generating unit*.
power station	A facility in which other forms of energy are transformed into electricity, that is *electricity generation*.
power station operator	Serving, authorized and competent person or persons for managing a *power station* or a chain of *power stations*.
power, electric	Current value is a product of multiplication of voltage and current. If the current value is expressed, time is associated (date, hour, minute). In electric power industry mean power of a defined duration is used (for ex. 15 minutes, or 1 hour); this is a ratio of energy for the duration W (kWh), and the duration T (h), therefore P=W/T.
Pre-assigned transmission capacity	Value defined by the *transfer capacity* between two neighboring *control areas*; it presents a sum of the agreed transfer power confirmed by the *accounting center* for an observed period.
primary (frequency) control	Primary (frequency) control is automatic control operation on the level of the *electric power system* with a momentary response of *active power* realized by a *generating unit* or *plant and apparatus* speed control systems during frequency deviation. It is used for *frequency control* as one of the *system services*.
primary control band	Set range of *primary control* expressed through the value of *active power* within which the *generating unit's* speed control system intervenes automatically in both directions during frequency deviation. It is expressed for each individual *generating unit*, *power station*, *control area* and *interconnection*.

primary control reserve	It is the *power* the observed *control area* shall secure in accordance with the contribution coefficient and momentary *outage of a generating unit* of 3000 MW or less, in the UCTE *interconnection* according to the following equation: $\mathbf{P_i = c_i P_U = \frac{E_i}{E_U} P_U}$ [MW] where: E_i = total power at the gate of all *generating units* of the i-th *control area* [MW] E_U = total power at the gate of all *generating units* in the UCTE *interconnection* [MW] P_U = 3000 MW.
reactive energy	Electric energy not consumed but existing between the *system units* with established electric fields (or *generating units* in preexcited state) and system units with the established magnetic fields, however its flow increases current and system *losses*.
reactive power	Electric *power* required for establishment of electric and magnetic fields. In a chiefly electric field, *reactive power* is capacitive, while in chiefly magnetic field – *reactive power* is inductive. It is a square root of the difference between *apparent* and *active power*.
reserve power	*Power* used to correct deviations in *power* balance between the expected and actual conditions.
restoration of supply	It is a *system service* or a *distribution system service* that comprises technical and organizational measures for limiting *disturbance* and for restoring the quality of supply following its occurrence. The measures for restoration of supply also include equipping *generating units* and network facilities with regard to the possibility of large-scale *disturbances.*
safety of supply	The probability that all *customers* shall be supplied even in case of an unpredictable event.
secondary (frequency) control	Same as *frequency control* or *exchange power*.
secondary control band	Set range of the *secondary control* system expressed in the value of *active power* within which the secondary controller may automatically act in both directions, from the operating point defined by the current value of the secondary control *power*.
secondary control reserve	It is the positive region of the *secondary control band* which is calculated according to the following empirical equation: $\mathbf{R = \sqrt{aL_{max} + b^2}}$ - b [MW] where: a = 10 and b = 150; R = secondary control reserve [MW] L_{max}= maximum consumption capacity of a *control area* for the observed period [MW].
short-circuit close to the power station	If the share of the component of the initial symmetrical short-circuit current of a three-pole short circuit exceeds twice the value of a generator's rated current.

short-circuit current	*Total initial short-circuit current.*
short-circuit power	*Initial power of a three-pole short-circuit.*
short-circuit remote from the power station	If the share of the component of the initial symmetrical short-circuit current of a three-pole short circuit is less than twice the value of a generator's rated current.
stability	The capability of the system to maintain a stabile state following a *disturbance*.
steady-state stability	The system capability to maintain the previous or a steady state close to it, following a minor *disturbance*.
supervision	Insight into the status of processes; it is realized through signalization and measuring.
sustained short-circuit current	Effective current vale at sustained short-circuit in (quasi)stationary state.
switchyard facilities	Switchyard consists of bays and busbars for a particular nominal power. Abbreviated version in an intelligible context is facilities.
synchro-check relay	A device for checking the deviations of voltage, frequency and angles at the point of *generating unit's* connection to the *electric power system*, point of connection of two non-synchronous parts of the system, point of connection between two points of one system and the *interconnected* system. Usually it is added to the synchronization device.
system	Abbreviation for the *electric power system*.
system characteristic mode	It is a characteristic defining the method of calculating control fault of *active power secondary control* and *control area* or *electric power system* frequency, that *secondary control* reduces to zero. For interconnected operation, control fault G is calculated according to: $G = \Delta P + K^*\Delta f$ [MW]. In isolated operation, control fault is calculated according to: $G = K^*\Delta f$ [MW]. Where: ΔP = variation of exchange power [MW] Δf = frequency deviation [Hz] K = control constant [MW/Hz].
system for metering data retrieval	Computer system which via communication devices collects or receives data from *accounting points* in a predefined fashion.
system losses	Difference between the energy taken over in the *system* and that delivered from the system.
system management	Management of the (electric power) system is an activity performed by the *Transmission System Operator*, covering the functions of planning, management and monitoring of the *electric power system*.
system reliability	The probability that the *system* shall fulfill its tasks relating to supply.

system load shedding	Procedure whereby, in extraordinary conditions, *system* configuration is changed and predetermined *loads* are disconnected, while the supply of the rest of the *system* is maintained.
system services	The services of the (electric power) system are the following: *-electric power system management,* *-frequency control* *-voltage control* *-restoration of supply* and the *Transmission System Operator* secures those services.
system load	Sum of *powers of withdrawal* from the *transmission system* in a *control area* for consumption at a particular point in time.
tariff system	A system tariff items and consequently prices for tariff customers for the following: - *electric power generation*, - *electric power transmission* - *electric power distribution* - *electric power supply*. All charges required by law are included in the price.
technical operating requirements	Acts including directions, conditions, recommendations and rules, passed by energy undertakings in the course of performing their activity, which apply to third persons.
temporary outage	Single-pole or three-pole outage lasting up to 1.5 seconds. It is not considered *interruption of supply*.
tertiary (frequency) control	Control function of *active power* on the level of *electric power system* by which the *generating units'* schedule is automatically or manually corrected to secure required *secondary control reserve*.
total harmonic distortion factor	Total harmonic distortion factor THD is a measure of the share of sinusoid frequency members which is a multiple of the basic harmonic's frequency: $THD(\%) = \frac{100}{U_1}\sqrt{\sum_{h=2}^{40} U_h^2}$ where U_h is effective (maximum) value of the h-th harmonic, and U_1 is effective (maximum) value of the basic harmonic.
total initial short-circuit current	Calculated value of the alternating component of the *total initial short-circuit current* in a *system* node.
total transfer capacity	Total transfer capability is a starting value defining a certain *transfer capacity* between two adjacent connected *control areas*. It is maximum *permanent power of exchange* between the two areas, ensuring safe operation in both areas – yet without exceeding the value of this power. It is defined by thermal and voltage limit, as well as *stability* limit.

transfer capability	Transmission capability is given jointly for all *interconnecting lines* between two adjacent connected *control areas* for a certain period, and for both *transmission* directions. The following values and their relations determine *transmission capacity*: -*total transmission capacity* TTC -*transmission reliability margin* TRM -*net transmission capacity* NTC = TTC – TRM -*notified transmission flow* NTF -*available transmission capacity* ATC = NTC – NTF The amounts of these values depend on the period for which they are given. Transmission capacity can be accounted for two neighboring countries or between any other two adjacent areas.
transfer power	*Permanent power* that an *interconnecting line* between two neighboring *control areas* can withstand, and still secure safe operation in both areas. It is defined by thermal and voltage limitation and the *stability* limit.
transient phenomena	Transition from one system state into another, for example as at reclosure. If *limit values* are not violated and if *transient phenomena* are damped enough, the consequences are not great.
transient phenomena recorder	It is a multi-channel device for recording time flow of measurement analogous and binary signals in digital form. The information saving process shall automatically trip when appropriate changes of one or more signals occur.
transient stability	The capability of the *electric power system* to maintain synchronism after a *large-scale disturbance* (regarding the nature, location and duration of a *disturbance*). The system demonstrates *transient instability* only if one of its *generating units* loses synchronism during such a *disturbance*. In the system response in such a case there are major deviations from relative angles of the generator's rotors connected nonlinearly to moments and *active powers*. The occurrences are in the secondary area (3-5s, and for large systems even up to 10s following a *disturbance*). Typically the result of the first swing is the most important. Steady state following a *disturbance* may be identical to that prior to the disturbance, or may differ from it.
transmission facilities operator	Serving, authorized and competent person or persons for managing *transmission system* or its part.
transmission reliability margin	It is a value stating the *transfer capability* and represents a decrease of the *total transfer capability* between two adjacent connected *control areas* for the purpose of ensuring *system services* in emergency situations between *Transmission System Operators* (for ex. *power-frequency control and emergency reserve*), and in order to take precautions against *inadvertent interchanges*, incorrectness of data and incompleteness of the *system* calculation model.
transmission system center	A place wherefrom operation of a part of the *transmission system* is supervised, namely, the *transmission system operation management,* and coordination of operation management and maintenance services in the field.

transmission system operation management	A *transmission system* activity covering the following: – supervision of *system* operation, – monitoring of the status of primary and secondary equipment as well as of ancillary facilities of system units, – performing switching operations and giving control orders, – choosing control regime, locally and via remote control, – registration of operating measurement values, alarm and position signals, protection signals, and disturbance sizes, – coordination of operation of services for management and maintenance in the field, and – responding to the calls of the *transmission system users*.
transmission system services	Services in the transmission system are the following: – *procurement of system services,* – *wheeling,* – *exchange,,* – *transit and* – *loop flow* and the *Transmission System Operator* secures those services for the *system* users.
types of electricity transmission	Types of electricity transmission are the following: – *wheeling*, – *exchange*, – *transit*, – *loop flow*.
unit transformer	Connects the generator with *the system*.
violation of limit values	When the observed electrical variable leaves a value range defined as permissible.
voltage and reactive power control	The task of voltage and reactive power control is permanent *reactive power* management (and thus also *system* voltage), and adjustment to the changes in *reactive power* demand within the framework of general operating conditions. The changes in demand are caused by the *plant and apparatus*, the changes in network topology and by *disturbances* (e.g. *power station outages* or *loads*).
voltage control	It is a *system service* by which an acceptable voltage profile in the *system* is maintained. It is achieved by balancing *reactive power* depending on the *system's* or *plant and apparatus' reactive power* demand.
voltage stability	It is the capability of a system to maintain acceptable voltage levels in all nodes in *normal operation* even following a *disturbance*. Definition of voltage *stability* is a subgroup of the general *stability* definition.
wheeling	Wheeling is a type of *transmission* if the *withdrawal point* and *injection point* are in the system of one *Transmission System Operator*, in this t*ransmission* adjacent *transmission systems* do not participate (or their participation is negligible).
withdrawal and injection schedule	*Active power* contracted for an accounting interval to be withdrawn or delivered at an *accounting point*.

2 GENERAL PROVISIONS

2.1 Introduction

(1) For the purpose of supplying all customers with quality electricity, this Grid Code regulates rights and obligations of electricity market participants and their interrelations in the electricity market, and they are as follows:

- Electricity generators (hereinafter referred to as “generators”)
- Transmission System Operator,
- Distribution System Operator,
- Electricity suppliers (hereinafter referred to as «suppliers»),
- Market operator,
- Energy undertakings carrying out trading, mediation and represention on the electricity market,
- Electricity customers.

(2) The Grid Code is based on the following principles:

- The rules shall be equally applied to all system users,
- The application of the rules to equal events shall result in equal action throughout entire electric power system,
- Safety of the entire electric power system has priority, for this reason all participants may temporary suffer the consequences of disturbances (e.g. restrictions in the event of disturbance)
- Transmission system shall be controlled centrally to ensure safety, reliability and efficiency of the electric power system, all in the interest of all system users. Hierarchically this shall be realized through the Transmission System Operator.
- From the operational point of view, electric power system is considered to be an integral technical and technological system for electricity generation, transmission, distribution and consumption, independent of organizational and ownership relations.

2.1.1 Passing, implementing and amending the Grid Code

(1) Proposal for the Grid Code is set out by the Transmission System Operator in conjunction with the Distribution System Operator, and is passed by the Minister after having obtained the opinion of the Agency.

(2) The Transmission System Operator shall, in cooperation with the Distribution System Operator monitor the implementation of the Grid Code.

(3) The Transmission System Operator shall, in cooperation with the Distribution System Operator prepare the proposed amendments to this Grid Code.

(4) For the purpose of performing the above stated activities, Transmission System Operator shall establish a Grid Code Committee (hereinafter referred to as the «Committee»). The Committee shall be a permanent advisory body which shall:

- Monitor and consider implementation of the Grid Code,
- Consider the provisions of the Grid Code as regards imperative and desirable amendments,

- Give well-argumented recommendations to the Transmission System Operator as regards amendments to the Grid Code,
- Look for advice of market participants, and if necessary
- Give guidelines for implementation of the Grid Code.

(5) Decision on the number of representatives in the Committee shall be passed by the Transmission System Operator in conjunction with the Distribution System Operator, and shall comprise representatives of :

- Transmission System Operator,
- Distribution System Operator,
- Market Operator,
- Energy undertakings carrying our electricity generation,
- Energy undertakings carrying out electricity supply,
- Energy undertakings carrying out trading, mediation and representation on the electricity market,
- Electricity customers.

(6) A representative of the Transmission System Operator shall be the chairman of the Committee, while a representative of the Distribution System Operator shall be the Committee's vice-chairman.

(7) Electricity market participants may, at their own discretion, appoint or call off their representative.

(8) The Committee shall convene at least once a year, or as required.

(9) The Committee shall pass Procedural rules for its operation, after having obtained consent from both, the Transmission System Operator and the Distribution System Operator.

(10) Procedural rules shall set out the manner of operation and decision making of the Committee.

2.1.2 The contents of the Grid Code

(1) The Grid Code sets out operation and manner of management, development and construction, as well as connection to the transmission and the distribution network in the electric power system. It also sets out the metering code for accounting points.

(2) The Gird Code sets out the following:

- Technical and other conditions for customer and generator connection to the system,
- Technical and other conditions that need to be met for safe electric power system operation and thus for reliable supply with quality electricity,
- Technical and other conditions for interconnection and interaction of systems,
- Technical and other conditions for metering and settlement of electricity consumption.

(2) In addition to the conditions and procedures referred to in paragraph 2 above, the Grid Code sets out all other issues related to the operation and management of the transmission and the distribution system, including development planning and rights, obligations and interrelations of electricity market participants for the purpose of securing reliable and efficient electric power system operation.

2.1.3 Temporary suspension of the Grid Code

In a state of emergency or other situation the law provides for, the Minister may temporarily, partially or completely, suspend the Grid Code.

2.1.4 Data

2.1.4.1 Technical data

(1) The Transmission System Operator and the Distribution System Operator, each in its scope of activity, are responsible for managing the technical database on the following:

- The System,
- Electricity generators,
- Ancillary services providers,
- Tariff customers,
- Eligible customers,
- Energy undertakings carrying out electricity supply,
- Energy undertakings carrying out trading, mediation and representation.

(3) The Transmission System Operator and the Distribution System Operator shall in their acts set out the type, fashion, scope and dynamics of delivery of data referred to in the subparagraph above.

(4) The Transmission System Operator and the Distribution System Operator are responsible for constant updating of the technical data base.

(5) The Transmission System Operator and the Distribution System Operator shall warn about the mistakes and insufficiencies of the obtained data.

2.1.4.2 Operating data

(1) For planning, calculations, operation management and analyses of the electric power system – Transmission System Operator, electricity generators, Distribution System Operator – each in its scope of activity, shall keep updated records on:

- Voltage,
- Frequency,
- Active and reactive power
- Load,
- System switching status,
- Power flows,
- Operating events in the system.

(2) For the purpose of safe and reliable electric power system operation - Transmission System Operator, Distribution System Operator, electricity generators and eligible customers – shall submit and interchange required operating data.

(3) Distribution System Operator shall submit to the Transmission System Operator all data on the distribution system required for planning, operation and management of the electric power system.

(4) In keeping records on system users – the Transmission System Operator and the Distribution System Operator – each within its scope of activity shall:

- Collect and maintain the same data in the same way,
- Use equal method of data inclusion.

2.1.4.3 Reliability of data

Energy undertakings shall treat the data and information acquired from the system users in accordance with the effective regulations on reliability of data.

2.1.4.4 Confidentiality of data

(1) Data on the possibilities of the transmission and the distribution system use are public.

(2) Data on electric power system users are confidential and shall not be published, unless energy undertakings are under a special act or by a resolution of the Agency authorized or required to publish the data publicly, or deliver them to competent government bodies.

(3) Public data (for example system units parameters, net transfer capacity, available transfer capacity, results of the system capacity analysis, etc.) are exempt from the confidentiality clause.

(4) Data on management, calculation and settlement of system use, as well as data required for devising a balance, shall be exchanged among energy undertakings in accordance with the data reliability principle.

(5) Transmission System Operator shall store secret confidential business data obtained in the course of performing its activity, and shall make data on its own activities, which may present a commercial advantage, available in a non-discriminatory fashion.

2.2 Transmission System Operator

(1) Transmission System Operator is an energy undertaking performing the activity of electric power transmission.

(2) Croatian electric power system forms one control area run by the Transmission System Operator.

(3) Duties of the Transmission System Operator are set out in the Electricity Market Act, General conditions of electricity supply and this Grid Code.

(4) Transmission System Operator is responsible for the entire electric power system, namely:

- For safe and efficient electric power system management with as little impact on nature and the environment as possible, all for the purpose of supply with electricity of guaranteed quality,
- For securing regulated third party access to the system, in accordance with the international regulations, except in the event of limited technical or operating capability of the system,

- For checking technical feasibility of the Market Plan submitted by the Market Operator, and for devising and implementing System Operating Plan, pursuant to the Electricity Market Rules,
- For banning transmission, withdrawal or sudden increase/decrease of power station output or a large deviation from the agreed amount of injection/withdrawal, in the event when security of the electric power system is at risk.

(5) Transmission System Operator is responsible for the transmission system operation, namely:
- For switching operations in transmission system facilities,
- For operating measurements and network signalization,
- For the application of rules and measures regarding protection at work,
- For setting out transmission system connection conditions for new system users, and conditions for the increase of connection capacity for current system users,
- For contracting transmission system use with the users, and submitting the contracts to the Market Operator,
- For securing energy to cover system losses, analyzing losses and for the implementation of measures for their decrease,
- For securing system balancing energy and sending data on balancing energy to the Market Operator for settlement,
- For generation of reactive power,
- For giving required information and data to the Distribution System Operator and system users on the planned activities in the transmission system for the purpose of stable and secure system operation,
- For keeping statistics of operating events.

(6) Transmission System Operator is responsible for maintenance of the transmission system, namely:
- For maintaining operating availability of the transmission system,
- For taking care of the primary equipment of the transmission system,
- For taking care of protective devices of the transmission system,
- For taking care of the equipment in accounting points,
- For taking care of the process information devices in the management center (National Dispatching Center), control centers (transmission network centers) and transmission system facilities,
- For taking care of the telecommunication devices,
- For taking care of the auxiliary facilities in the stations,
- For coordinating processing system for generation, transmission and distribution,
- For taking care of the earthing systems and fire protection systems,
- For taking care of the construction and structural parts of the transmission system.

(7) Transmission System Operator is responsible for development and construction of the transmission system, namely:
- For stimulating economic system development, taking into account previous maximum load, as well as requests of the transmission system users, within the scope of the transmission system development plan,
- For preparation of construction and supervision of construction of the transmission system facilities,
- Coordination of the development plans with the Distribution System Operator.

(8) Transmission System Operator is also responsible for the following:
- Defining technical conditions, rules, recommendations and directions for devices and equipment in the transmission system,
- Defining technical conditions for system user connection to the transmission system,
- Defining technical conditions for accounting points in the transmission system,
- Other industry-related activities.

2.3 Distribution System Operator

(1) Distribution System Operator is an energy undertaking carrying out the activity of electricity distribution.
(2) Duties of the Distribution System Operator are set out in the Electricity Market Act, General conditions of electricity supply and this Grid Code.
(3) Distribution System Operator is responsible for the distribution system, namely:

- For safe and efficient distribution system management with as little impact on nature and the environment as possible, all for the purpose of supply with electricity of guaranteed quality,
- For continuity and reliability of electricity supply,
- For managing electricity flows in the distribution system,
- For securing regulated third party access, except in the event of limited technical or operating system capabilities,
- For giving required information to the Transmission System Operator to ensure safe and efficient operation and coordinated development, as well as to enable operation of interconnected systems,
- For setting out directions required for proper operation of the distribution system,
- For coordination with the Transmission System Operator and for implementation of operating rules and directions,
- For collecting required data on the planned activities in the distribution system, and for submitting the data to the Transmission System Operator where they are used in the design of the electricity withdrawal and injection schedule.

(4) Distribution System operator is responsible for the operation of the distribution system, namely:

- For switching operations in the distribution system facilities,
- For operating measurements and network signalization,
- For application of rules and measures for the protection at work,
- For contracting the use of the distribution system with system users and submitting those contracts to the Market Operator,
- For securing energy to cover system losses, analyzing the losses and implementing measures for their decrease,
- For giving required information and data to the Transmission System Operator and system users on the planned activities in the distribution system,
- For keeping statistics of operating events,
- For interruption or a change in the manner of operations and electricity supply of customers pursuant to the General conditions of electricity supply.

(5) Distribution System Operator is responsible for the maintenance of the distribution system, namely:

- For maintaining operating availability of the system,
- For taking care of the primary equipment of the system,
- For taking care of protective devices of the transmission system,
- For taking care of the equipment of the accounting points,
- For taking care of the process information devices and telecommunications,
- For taking care of the auxiliary facilities and installations,
- For taking care of the earthing systems and fire protection systems,
- For taking care of the construction and structural parts of the distribution system,
- For taking care of the devices for reception and transmission of accounting and operating measurements in the distribution system.

(6) Distribution System Operator is responsible for development and construction of the distribution system, namely:

- For securing long term availability of the distribution system for the purpose of meeting reasonable requests for electricity distribution,
- For a contribution to reliability of supply with appropriate distribution capacities and system reliability,
- For stimulating economic system development, taking into account previous maximum load and generation, as well as requests of the system users, within the scope of the system development plan,
- For preparation of construction and supervision of construction of the system facilities
- Coordination of the development plans with the Transmission System Operator.

(7) Distribution System Operator is also responsible for the following:

- Defining technical conditions, rules, recommendations and directions for devices and equipment in the distribution system,
- Defining technical conditions for system user connection to the distribution system,
- Defining technical conditions for accounting points in the distribution system,
- Other industry-related activities.

3 SECURING QUALITY, QUALITY AND EFFICIENT USE OF ELECTRICITY, ENVIRONMENTAL PROTECTION

3.1 Securing quality

All energy undertakings shall, within the framework of their activity, systematically implement the measures for securing quality, with the final aim of delivering quality electricity to end customers, pursuant to the General conditions of electricity supply.

3.2 Quality of electricity

(1) Quality of electricity is defined in the General conditions of electricity supply.

(2) Parameters of the quality of electricity are for the transmission system defined in Chapter 4.3, while for the distribution system they are defined in Chapter 5.3 of this Grid Code.

3.3 Efficient use of energy

(1) The Transmission System Operator and the Distribution System Operator shall, on their own initiative, or on the initiative of the Agency, prepare and monitor the execution of the Program for Incentivization of Efficient Use of Energy.

(2) The Transmission System Operator and the Distribution System Operator shall in their publications available to customers, publish the Program for Incentivization of Efficient Use of Energy.

3.4 Environmental protection

All energy undertakings shall, in planning, construction, operation and maintenance of electric power facilities, comply with the environmental protection criteria and secure permanent monitoring of the impact on the environment.

4 TRANSMISSION SYSTEM GRID CODE

This Chapter sets out minimum requirements for the electric power system management, for development planning, access, connection and use of the transmission system, as well as technical and organizational instructions respecting the specific characteristics of the transmission system operation.

4.1 Electric power system management

4.1.1 Introduction

(1) The electric power system management is a system service encompassing the functions of planning, management and monitoring of the system units and process parameters of the electric power system in real time, and securing ancillary system services. Transmission System Operator manages the electric power system pursuant to this Grid Code.

(2) Electric power system may be in the state of :

- Safe normal operation,
- Endangered normal operation,
- Disturbed operation,
- System collapse.

4.1.2 Transmission system operational planning

(1) The purpose of electric power system operational planning is maintenance of maximum security of supply and reliability of electric power facilities. There attention should be paid that the (n-1) criterion, and the system stability requirements are adhered to, and that the short-circuit current in the system node is maintained below the level of the circuit-breaker breaking current.

(2) For this reason, Transmission System Operator secures implementation of annual overhaul plans, revision and emergency action on all generating units and transmission system units of the electric power system, without disrupting security of supply.

(3) In interconnected operation, in accordance with the (n-1) criterion, system reliability requirements and short-circuit currents – Transmission System Operator is co-responsible for safety of supply and reliability of the interconnection as a whole. For this reason, when planning activities in its control area, it needs to take into account planned disconnections of interconnecting lines, which are being harmonized at least once a year.

(4) Transmission System Operator confirms the overhaul plan for generation and transmission facilities.

4.1.2.1 Meeting the (n-1) criterion in operational planning

(1) In accordance with the (n-1) criterion, Transmission System Operator shall, with the system configuration, secure that in all operating conditions single failure of any unit within the

system (generating unit, transformer, line, reactive power compensation unit, etc.) does not lead to operational limitations in its own and/or neighboring control areas (exceeding the value of currents, voltage, etc.), and that it does not cause interruptions in electricity supply.

(2) In case of an outage of a system unit, if such an outage occurrence does not disrupt system operation, Transmission System Operator shall synchronize system structure to meet the (n-1) criterion again, in as short time period as possible, since the outage of another unit during the intervention period after the first outage occurrence can impair the safety of supply and operational reliability.

(3) Transmission System Operator may occasionally deviate from the (n-1) safety criterion, if that should be necessary due to maintenance work and network modification work; however he will have given timely prior notice to the Distribution System Operator and the affected system users.

(4) In order to maintain the (n-1) security criterion during unplanned disconnections of system units, Transmission System Operator may terminate trading transactions and temporarily modify the generation schedule of power stations, with minimum additional generating costs caused by the reallocation.

(5) The (n-1) criterion can be maintained with the support of the adjacent systems, depending on the previous agreements between interested parties. This implies planning the disconnection of the facilities influencing the adjacent systems' operation, and interested areas in the interconnection have to arrange them in advance, as well as exchange the necessary information and data required to calculate the (n-1) criterion. Simultaneous loss of both systems on a two-phase line shall not be taken into account.

(6) When checking the maintenance of the (n-1) criterion Transmission System Operator shall take into account permissible loads and overloads of system units, as defined by the declared values of the protective devices of those units.

(7) When planning the measures to secure the (n-1) criterion, Transmission System Operator shall be governed by technical and economic factors, taking into consideration the probability of a considered event, its consequences, cost of its prevention, as well as the cost of launching protective measures to prevent the spreading of disturbances in the system.

(8) Transmission System Operator shall manage the entire system, including the interconnecting lines, so that sufficient transmission capacity is always available, for delivery of primary frequency control reserve power to secure bilateral solidary assistance in the interconnection.

(9) Transmission System Operator shall, securing the (n-1) criterion, meet the requirements as provided for in subparagraph 4.1.2.2 herein.

4.1.2.2 System stability

In order to maintain proper electric power system operation, Transmission System Operator shall secure that oscillations, temporary or permanent, have amplitudes sufficiently small or sufficiently damped, so that they do not impair system operation. This shall be supported by adequate calculations for planned system operation (minimum: three-pole short-circuit near all power stations).

4.1.2.3 Short-circuit current

(1) For proper electric power system operation, breaking current of a circuit-breaker shall not be lower than the total short-circuit current in the node where the circuit-breaker is located.
(2) Should the total single-pole short-circuit current exceed the total three-pole short-circuit current, the total single-pole short-circuit current shall be considered relevant.
(3) Short-circuit conditions are determined in the short-circuit calculations, with regard to the actual operating conditions, and taking into account the contributions of short-circuit currents from the adjacent systems.

(4) Transmission System Operator shall conduct short-circuit calculations in real time.

(5) If the breaking current of the circuit-breaker is lower than the short-circuit current in a system node, Transmission System Operator shall undertake all required measures to decrease the short-circuit current in the node. Short-term measures are, for example, sectioning the system or disconnection of transformers in parallel operation, while long-term measures are, for example, replacement of ta circuit-breaker and possibly other primary equipment.

4.1.3 Use of transmission system

4.1.3.1 Introduction

(1) Transmission System Operator provides the following transmission system services to system users:

- Wheeling,
- Exchange,
- Transit,
- Loop flow,
- Provision of system services.

(2) The transmission use of system charge is determined by the Agency, upon the proposal of the Transmission System Operator.

(3) Transmission System Operator estimates the availability of the transmission system for the purpose of fulfilling its obligations to the Market Operator, traders, suppliers, generators and the Distribution System Operator.

(4) Transmission system availability estimate is designed for the following day and for the upcoming week (short-term), as well as for a period of up to one year (long-term).

(5) Results of the estimate are published on the Transmission System Operator web pages.

4.1.3.2 Wheeling

(1) The wheeling of electricity between generators and customers in their own area is regulated by the transmission use of system agreement pursuant to the General conditions of electricity supply.
(2) Transmission System Operator, taking into account hourly schedule of power flows of the customers who already have an agreement or those covered by the public service obligation (tariff customers) and the results of the transmission system availability calculation detailed in 4.1.3.1., either approves or denies access to the system.

(3) Transmission System Operator shall preserve records on the transmission system status to have data available in the event of dispute for reason of termination of market transactions.

4.1.3.3 Exchange

(1) Exchange is defined based on the bilateral hourly exchange program, the constant exchange value of a time period of one hour or its multiple being assumed. When planning the exchange, the Transmission System Operator shall take into account all factors influencing the electricity exchange between control areas.

(2) Two conditions have to be met prior to actual realization of an exchange so that it be safe:

- available transmission capacity of interconnecting lines between the systems preparing to conduct exchange shall at least equal exchange capacity,
- in both systems the criterion of transmission system safety (n-1) shall be met. Exception from the (n-1) criterion is allowed:
  - for a fixed time period (of up to 6 hours) for the purpose of eliminating a fault or deficiency that may lead to a significant fault or a reduction of supply,
  - for the purpose of directing energy to a critical area in order to avoid reductions of supply.

(3) In cases when transmission capacity towards adjacent systems is not sufficient or is significantly impaired, Transmission System Operator shall immediately, based on the common analysis, undertake required measures in conjunction with the operators of adjacent systems.

4.1.3.4 Transit of electricity

(1) In providing transit services Transmission System Operator shall comply with the UCTE rules, as well as the rules of the European Transmission System Operators (hereinafter referred to as «ETSO»).

(2) If there is a legitimate reason to fear that the intended transit may impair system safety, Transmission System Operator has the authority to file a complaint against such a transit, and if necessary limit or prohibit the transit.

4.1.3.5 Loop flow

(1) Interconnected operation is associated with unintended transmission through loop flow which may in certain cases impair system operation. Transmission System Operator shall take this risk upon itself due to other advantages the interconnected operation offers. For the purpose of preventing disturbances Transmission System Operator shall monitor and follow, and if necessary undertake measures to suppress the unwanted consequences of loop flow transmission.

(2) Compensation of losses caused by unintended loop flow is dealt with in the international convention on the joint calculation of cross-border electricity transmission.

4.1.3.6 Accounting and compensation for inadvertent interchange

(1) The electric power system operation within the UCTE interconnection enables electricity exchange and trading with other control areas and control blocks. Due to imperfections of the

power/frequency control system inadvertent deviations from the planned electricity exchanges may occur, thus making it necessary to coordinate the settlement and calculations required for programs for compensating inadvertent interchange. The calculation of inadvertent interchange is performed by competent Accounting Coordination Centers.

(2) Transmission System Operator shall, on a daily basis, submit relevant data and reports to the Accounting Coordination Center for the purpose of calculation or compensation of inadvertent interchange. Transmission System Operator shall implement the compensation plan as agreed with the neighboring interconnection operators.

4.1.3.7 Transmission System Congestion

(1) Transmission system congestion in real time may occur:

- If operation criterion (n-1) cannot be met due to energy flows in the transmission system,
- If the Transmission System Operator legitimately expects that it will not be possible to satisfy the (n-1) criterion should all registered or forecasted transmission schedules be accepted,
- If unavailability of generation capacity currently being used or of that planned to be used should occur,
- If the (n-1) criterion cannot be met due to energy flows in the transmission system caused by the generator's obligation to deliver electric power and energy in accordance with the agreements signed with the eligible customers and electricity traders,
- In the event of a disturbance in the electric power system.

(2) Transmission System Operator shall assess congestions in import to, export from and transit through the transmission system. If a transit congestion should occur, or is expected to occur, Transmission System Operator shall notify the interested parties and the Accounting Coordination Center, and state the reasons for transit rejection.

(3) Transmission System Operator shall update and publish the following data in time:

- Transmission direction in which a congestion occurs,
- Forecasted duration of congestion,
- Method of dealing with congestion (short, medium, long term),
- Deadlines for registration and approval of transmission schedules referring to the congestion,
- Available transmission capacity of the relevant interconnecting line,
- Congestion elimination program.

(4) Transmission System Operator shall pass the system operation plan designed so as to avoid congestion in the transmission system. In the event of rejection of a plan Transmission System Operator shall state the reason for its rejection.

(5) Congestions occurring with a short term announcement shall be solved by the Transmission System Operator through switching operations, altered generation schedules of the generating units contracted to it, or with power purchase in order to restore operational security (n-1). Measures and procedures for electricity exchange in the area of system congestion shall secure that the needs of system users be met in a non-discriminatory manner, relative to the available transmission capacity in the congested area, that is on both sides of the congested area.

4.1.3.8 Transmission losses

Transmission System Operator is responsible for securing energy to cover the transmission system losses according to the minimum cost principle, for their monitoring, analysis and calculation, their decrease, if the above is possible, with regard to the electric power system safety.

4.1.4 Management of the transmission system and its operation

(1) Transmission system management encompasses all activities of the Transmission System Operator who, by influencing system elements - either directly, through operators in the transmission network centers, operators in the generating units or operators in the distribution system – attempts to realize safe and reliable electric power system operation, that is supply of customers with electricity of instructed quality.

(2) Management of the transmission system operation encompasses activities between operators in the transmission network centers and in the transmission system facilities for the purpose of:

- Monitoring system operation,
- Monitoring the status of primary and secondary equipment and ancillary facilities of system units,
- Performing switching operations and giving regulation orders,
- Choosing management regime, locally and via remote control,
- Registration of operating measurement values, alarm and position signals, protection signals and disturbance sizes,
- Responding to the calls of transmission system users.

4.1.4.1 Normal operation

(1) Normal operation is a system status in which all physical values in the system are maintained within tolerance limits given in paragraphs 4.3.2.1., 4.3.2.2. and 4.3.2.3., and the following criteria are met:

- all customers are supplied with electricity,
- voltages of the transmission system and on the interface with system users shall be maintained in the range between the maximum permissible and minimum voltage, pursuant to paragraph 4.1.6.5., loads of all system units and generating units shall be within limit values, short-circuit powers in all system nodes shall be lower than the switching capacity of the appurtenant switches,
- Transmission System Operator shall maintain balanced transmission system voltage profile as high as possible to reduce system losses and increase active power,
- there are sufficient reserves in power stations and in the transmission system,
- (n-1) criterion is met.

(2) Limit load values are, in principle, the following:

- for generating units – load between the minimum stable generation and available capacity of a generating unit,
- for power lines – load between the no-load condition and maximum permissible load determined based on thermal load, voltage conditions and stability limits, where for more heavily loaded lines in the system thermal load is taken in both, the summer and in the winter period, as well as for short-term power line overload (up to 20% of the permissible thermal load within 30 minutes).

- For transformers – load between the no-load condition and available transformer capacity (in principle: nominal transformer capacity), also short term transformer overload (up to 20% where duration depends on previous load and thermal time constant of the transformer),
- For bays – permanent permissible load of field connecting lines in the bay or switching or metering equipment in the bay,
- For busbars – permanent permissible load of busbar conductors,
- For units for reactive power compensation – unit load under actual operating voltage.

(3) Transmission System Operator shall coordinate the operation of primary frequency control devices in its own system, in order to provide and receive services without constraints even in the event of a system unit outage.

(4) If system safety (n-1) is lost, normal operation is impaired and the Transmission System Operator shall restore it as soon as possible through corrective action. For example, Transmission System Operator shall limit or end planned operations on system or generating units.

(5) Transmission System Operator is responsible for voltage/reactive power optimization taking into account data from the system and from the interface with customers, as well as the interface with the adjacent systems, securing reactive power reserves in its system.

(6) In the event of maximum or minimum system load, Transmission System Operator shall prevent voltage drops or increases with compensation equipment, by tapping the transformers, by reactive power generation, by line switching, and by disconnecting and connecting loads (e.g. by putting pumped-storage hydro power stations into operation).

(7) Transmission System Operator shall perform all of the above functions through direct management via remote control system or by giving orders to the operators of the transmission network centers, operators of transmission facilities, operators of generating facilities and operators of the distribution system. The above mentioned operators shall perform the orders of the Transmission System Operator without delay.

4.1.4.2 Balancing demand and supply

(1) Transmission System Operator is responsible for current balancing of supply and demand in the electric power system.

(2) Transmission System Operator shall, in conjunction with the Distribution System Operator, consider total expected hourly values of power demand, and plan the electricity supply of the system. Load distribution curves shall be determined by the Distribution System Operator.

(3) For the purpose of balancing demand and supply Transmission System Operator shall contract the planned balancing power and energy according to the principle of minimum cost.

4.1.4.3 Deviation from the contracted power

In the interest of maintaining safe system operation, and as regards deviation from the contracted power, the Transmission System Operator may undertake the following measures in decreasing priority:

- in case one or more system users engages power which according to the use of system agreement exceeds the tolerance range of ± 10% of the contracted value, Transmission System Operator shall secure power increase or power decrease for the duration of up to 1 hour,

- if the demand for power not contracted for should persist in circumstances where no shortages of replacement energy or congestion in the transmission system are expected, Transmission System Operator can secure required reserve power,
- if the Transmission System Operator is not able to secure sufficient quantity of replacement energy, it is allowed, by virtue of its responsibility for operation reliability and protection of other users, to prevent impermissible deviation of a system user by reducing its total demand for the amount of the impermissible deviation. This is possible only in cases when the responsible user can clearly be identified.

4.1.4.4 Operation under disturbance conditions

(1) Each deviation from normal operation is considered to be operation under disturbance conditions. Transmission System Operator is authorized for and in charge of implementation of all required measures for prevention of disturbance spreading. These are priority measures and supersede the interests of individual system users. This means that the Transmission System Operator is, in extreme cases, authorized for limitation of electricity supply, including disconnection of individual system users.

(2) Transmission System Operator shall design a program and plan of measures for operational management under disturbance conditions.

(3) In order to eliminate operation under disturbance conditions or limit the consequences, Transmission System Operator shall secure a sufficient number of generating units capable of operation, and frequency and voltage control under disturbance conditions for the period of at least one hour.

(4) Prior to the implementation of those measures Transmission System Operator shall identify the causes of operation under disturbance conditions, and system topology after the disturbance based on the information the system users are required to supply it with. Those are:

- selected switch position signals,
- selected measured values (current, voltage, active and reactive power, frequency),
- records of the transient events recorder (current, voltage, active and reactive power, frequency),
- selected alarm and status messages (breaker tripping, auto-reclosure),
- data on protection operation,
- manner of facility management (local and remote control).

(5) To prevent voltage collapse Transmission System Operator shall contract and if possible apply the following measures:

- reduce the set point values of the voltage controller and/or block voltage controllers on transformers in switching substations in transmission and distribution systems;
- shed load manually or automatically, according to voltage,
- monitor reactive power reserves,
- run operation at constant highest permissible voltage levels in the transmission system,
- run operation by enabling activation of the quickly effective rotating reactive power reserve,
- consider disconnection of distant generators to decrease load of heavily loaded transmission system lines,
- consider a decrease of active power generation to provide for higher reactive power generation,
- put into operation gas-turbine generating sets as quickly as possible,
- consider a decrease of power import from remote areas,

- prepare for the activation of plans for restoration of operation following system collapse,
- abandon voltage/reactive power optimization.

(6) If limit value or operating system variable (e.g. voltage, short-circuit power) of equipment loading (e.g. current loading) remain violated even after the corrective measures, and there is a risk that the disturbance might spread, Transmission System Operator may instruct, for the purpose of securing reliable system operation and/or quick restoration of supply, disconnection of those parts of the system in which the disturbance occurred.

(7) In order to avoid congesting parts of the system, Transmission System Operator may, during operation under disturbance conditions, temporarily adjust the power stations' schedule to the actual system topology.

(8) Transmission System Operator shall notify all system users and the Distribution System Operator about the onset and the duration of a disturbance in the electric power system, pursuant to the General conditions of electricity supply.

(9) Transmission System Operator shall keep all records of the disturbance.

(10) Upon his request, Transmission System Operator shall make the records on the disturbance that caused the system user consequences in the operation of his facilities, available to the system user.

4.1.4.5 Underfrequency load shedding program

(1) In interconnected operation, when the frequency drops to 49 Hz begins system operation under extraordinary conditions. If the frequency should drop even further, the interconnection may be divided into a series of separated networks which prevent further collapse by underfrequency load shedding. Without any prior notice load is shedded automatically in accordance with the underfrequency load shedding program referred to in paragraph 2 below.

(2) Complete or partial collapse of the Croatian electric power system in isolated operation is prevented with the following underfrequency load shedding program:

Level	Minimum frequency set point [Hz]	Amount dropped %	Total shedded %
I	49.20	10	10
II	48.80	15	25
III	48.40	15	40
IV	48.00	15	55
V	47.50		Disconnecting the power stations from the system and transition to isolated operation, to operation on auxiliary supplies or no-load condition

(3) Underfrequency load shedding program shall be defined by the Transmission System Operator in conjunction with the Distribution System Operator, and shall inform the customers connected directly to the transmission system about the plan.

4.1.4.6 Additional measures

(1) System operator shall avoid every intentional disconnection of interconnecting lines in order to enable solidary assistance of other control areas to the impaired control area through primary frequency control. Thus all lines between control areas shall be equipped with devices for auto-reclosure and a synchronism control device.

(2) The loss of telecommunication connections or remote metering between control centers of the Transmission System Operator and a generation or a transmission facility shall not obstruct the operation of its own system, nor interconnected operation.

(3) In the event of general loss of voltage, in the control center of the Transmission System Operator, in the transmission network centers, transformer stations, telecommunication and remote control system units uninterrupted supply systems shall remain operational to enable system restoration.

4.1.4.7 Limiting large-scale system disturbances

(1) Transmission System Operator is responsible for preventing the spreading of large-scale disturbances and shall undertake all necessary measures to keep large-scale disturbances within the limits of its control area. In order to do that, Transmission System Operator shall contractually secure a sufficient number of generating units capable of isolated operation, generating units capable of switching onto no-load condition, and securing auxiliary supplies, as well as generating units capable of black start.

(2) Transmission System Operator is responsible for coordination with adjacent system operators for the purpose of establishing effective protection measures and defense plans in the event of large-scale disturbances.

(3) For the purpose of effective defense in the event of a large-scale disturbance, Transmission System Operator shall pass a Plan for defense against large-scale disturbances, which shall cover the following:

- Method of announcing a large-scale disturbance,
- Method of activating the Plan for defense against large-scale disturbances,
- Giving instructions to transmission network centers, Distribution System Operator and power station operators,
- Notification of adjacent system operators,
- Guidelines for restoration of supply,
- Referral to operating procedures,
- Reporting on the large-scale disturbance,
- Analysis of the large-scale disturbance.

4.1.4.8 Disconnection and reconnection of system users

Disconnection and reconnection of system users is set out in the General conditions of electricity supply and this Grid Code.

4.1.5 Electric power system control

(1) In order to make appropriate decisions regarding safe and reliable electric power system operation, Transmission System Operator shall, at all times, through transmission network centers, be notified of the topology of the system as a whole, as well as of individual units of the system. Furthermore, it shall monitor system process parameters (voltages, power flows, current generating capacity of power stations, current electricity consumption, power deviations relative to the adjacent system, regulatory requirements, frequency, electric protection operation, etc.). Generators shall, periodically or upon the request of the Transmission System Operator, submit data on the electric power system operation (water flows, lake water levels by the power stations, fuel status in thermal power stations, etc.). Transmission System Operator shall keep statistics of operating events.

(2) Transmission System Operator shall, via transmission network center, also monitor all works performed on the network influencing its topology and transmission capacity.

(3) Transmission System Operator shall monitor process values of the electric power system by means of the process IT system, via transmission network centers.

4.1.5.1 Analysis of the transmission system operation

(1) Transmission System Operator shall perform daily analyses of the transmission system operation.

(2) Transmission System Operator shall devise annual report on the transmission system status, on operating data and events, as well as on system losses.

(3) Transmission System Operator shall devise appropriate report for each significant disturbance in the transmission system, and especially for those disturbances having an effect on contractual relations. A significant disturbance is one whose duration exceeds 10 minutes or one that has caused interruption of electricity supply which has resulted in failure to deliver at least 10 MW or more.

(4) Transmission System Operator shall submit the Report on significant disturbances in the transmission system to the Agency.

(5) Report on significant disturbances shall contain the following:
- Date, time and duration of the disturbance,
- Location and cause of the disturbance,
- Data on consumption decrease due to tripping of underfrequency protection,
- Total electricity undelivered,
- Estimate of equipment damage and time required for its repair,
- Timeline and all significant events preceding the disturbance,
- Reaction of generating units during the disturbance,
- Reaction of reactive power generating units,
- Method of breakdown repair,
- Method of operation and estimated operation of the protection and automatic regulation system,
- Estimate of the staff's quality of work.

(6) Transmission System Operator shall devise annual statistic report on operating events in the transmission system.

4.1.6 System services

4.1.6.1 Introduction

(1) System services are:
- Electric power system management,
- Frequency control,
- Voltage control,
- Restoration of supply

and Transmission System Operator shall secure those services by employing the ancillary services provided by those system users capable of doing so.

(2) Interconnected system operation obligates the Transmission System Operator to plan sufficient capacity to secure ancillary services pursuant to the *UCTE* operation rules in its own system or from other control areas.

(3) System services are attributable and/or non-attributable. System services are attributable if a provider of a certain ancillary service, or a user of a system service is recognizable, and the charges or costs can be allocated on this basis. Charges for non-attributable system services cannot be allocated, and are borne by all system users by paying the transmission use of system charge.

(4) Non-attributable services in the transmission system are the following:
- Electric power system management,
- Frequency control,
- Voltage control,
- Restoration of supply.

(5) Attributable services in the transmission system are the following:
- Securing reactive power outside the limits of permissible power factor,
- Securing non-standard services (securing quality of supply above the standard, securing other non-standard services).

(6) Special services in the transmission system are metering services.

4.1.6.2 Ancillary services

(1) Transmission System Operator manages all system services, and determines which ancillary services, to what extent, by whom and when shall be provided. Transmission System Operator shall contract the ancillary services with each individual system user pursuant to this Grid Code.

(2) All additionally required services the Transmission System Operator requires from a generator, which the generator does not have at the time of connection to the system, shall be regulated in a bilateral agreement.

(3) Based on operating plans Transmission System Operator shall bilaterally, with relevant system users (certain power stations and customers who have available required facilities and possibilities), contract the conditions for providing ancillary services. Providing ancillary services may contractually be linked to operation of certain facilities (e.g. for voltage control).

(4) System users who contract for providing ancillary services shall report to the Transmission System Operator on the state and availability of all generating units and facilities they shall use to provide contracted services. Based on these data and current demand for system services,

Transmission System Operator shall use required contracted ancillary services of system users. Transmission System Operator shall choose ancillary services provider based on the technical requirements, the principle of minimum system cost and reliable electricity supply.

(5) Within the scope of providing system services, Transmission System Operator shall, to the providers of attributable ancillary services, secure compensation in accordance with the contracted prices of ancillary services.

4.1.6.3 Electric power system management

Electric power system management is a non-attributable system service and is described in paragraphs 4.1.1. to 4.1.5.

4.1.6.4 Nominal frequency value and frequency deviation

(1) Nominal frequency value in Croatian electric power system is 50 Hz, except during the periods of synchronous time correction, when the frequency is adjusted to the set 49.99 or 50.01 Hz, by the order of coordination center operator or the Transmission System Operator.

(2) In normal operating conditions, in interconnected operation, permissible frequency deviation from the nominal value (50.00 HZ) is ±50 mHz.

(3) Maximum deviation from the set value, in temporary stationary state, in interconnected operation shall not exceed ±180 mHz.

(4) Momentary frequency deviation from the nominal value shall not exceed ±800 mHz.

(5) Frequency deviation from the set value exceeding ±20 mHz shall be corrected through the operation of primary regulation.

(6) Underfrequency load shedding as a measure of frequency maintenance shall be activated when frequency drops below 49.20 Hz.

(7) In interconnected operation Transmission System Operator shall comply with the *UCTE* rules regarding frequency stability maintenance. In case of a disturbance other interconnected control areas provide solidary assistance in frequency stability maintenance by employing their capacity.

4.1.6.4.1 Primary frequency control

(1) Primary frequency control covers the operation of turbine speed governors following a frequency deviation from the nominal frequency or the set value due to imbalance between generation and consumption in a synchronously connected system.

(2) Primary frequency control in isolated system operation shall:

- correct the maximum current variance between generation and consumption that equals the capacity of the largest active generating unit in the system,
- secure that the momentary frequency value during disturbance does not drop below 49.20 Hz,
- cover all available generating units,
- Transmission System Operator shall maintain the possibility of activating primary control power as in the Figure 4.1. even in case when the set frequency deviates from 50.00 Hz.

(3) Transmission System Operator shall assess the primary control operation in its area and take measures to harmonize it with the above mentioned requirements.

(4) In interconnected operation a control area shall contribute to the set primary control reserve in an interconnection in accordance with the share of its generation in the total *UCTE* generation.

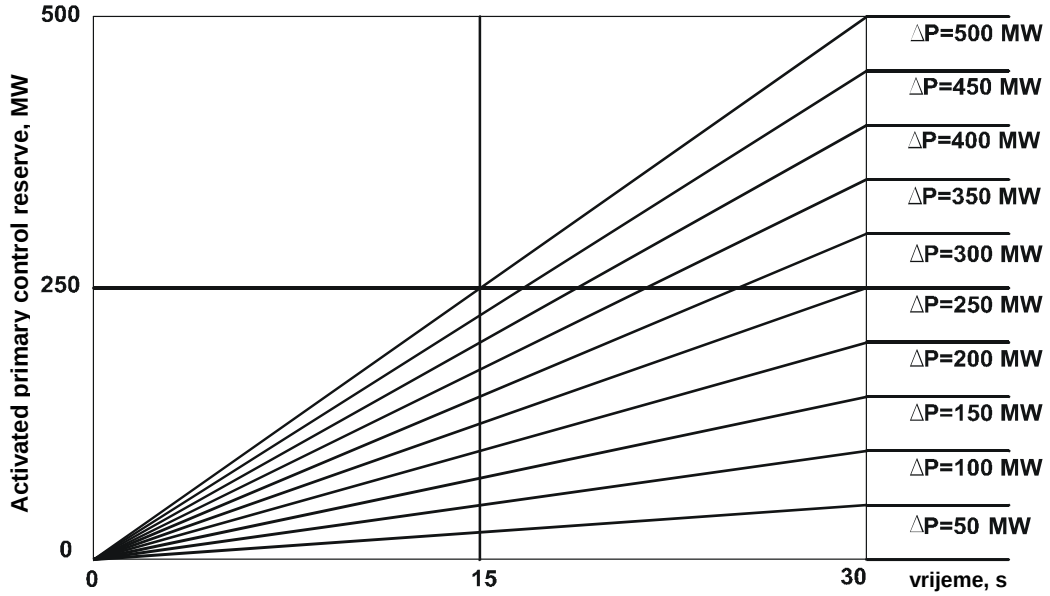

Figure 4.1. Minimum *UCTE* requirements for activating primary control reserves in relation to time, for different imbalances and consumption levels

(5) Primary control shall trip within seconds from the moment a disturbance occurrs. Primary control reserve of 0% to 50% shall trip within 15 seconds, while that of 50% to 100% shall trip within maximum activation time which changes lineary, with 0 seconds as a maximum.

(6) In the temporary stationary state, entire primary control reserve shall trip at the frequency value change of ±200 mHz or more.

(7) Primary control shall trip if frequency deviation from the set value exceeds ±20 mHz (sum of accuracy of frequency measuring and insensitivity of turbine control).

(8) Accuracy of frequency measurement in the rotation speed control of a generating unit shall equal 10 mHz or higher.

(9) Insensitivity of turbine control shall not exceed the value of ±10 mHz (sum of set insensitivity in the regulator and due to structural insensitivity).

4.1.6.4.2 Secondary frequency control/power exchange and minutes reserve

(1) The functions of secondary frequency control and power exchange in the Croatian electric power system, in interconnected operation are the following:

- realization of the established power exchange program between systems and all other interconnected adjacent systems,
- releasing the primary control reserve of the entire interconnection, whereby secondary control reserve from the area in which the disturbance occurred is activated,
- restoring the synchronous system frequency to a set value,
- synchronous time correction.

(2) In isolated operation of the Croatian electric power system the tasks of secondary frequency control are the following:

- Frequency restoration to a set value,
- Releasing primary control reserve of the Croatian electric power system,
- Synchronous time correction.

(3) Characteristics and parameters for secondary control in an isolated system are the following:

- secondary control shall take over from primary control at the latest 30 seconds after a variation between generation and consumption, that is after the primary control activation, even in most difficult conditions assumed for a particular disturbance;
- frequency and power restoration to a set value by secondary control shall be completed in 15 minutes at the most; all available sources shall be used in the process.

(4) In interconnected operation Transmission System Operator shall comply with the UCTE rules relative to secondary control.

(5) The accuracy of frequency measuring in the secondary control system shall be higher than 1.5 mHz.

(6) The accuracy class of active power metering for the purpose of secondary regulation shall be 0.5.

(7) Set system frequency value in the secondary control system is 50.00 Hz, except in the event of synchronous time correction.

(8) The secondary control/minutes reserve power shall be supplied by power stations which have, with the Transmission System Operator been contracted for the provision of secondary control/minutes reserve, and the Transmission System Operator shall require them to make that power available.

(9) In a bilateral agreement for the supply of secondary control/minutes reserve power control parameters shall be determined, control speed and other, that the power station shall comply with.

(10) Based on the generation schedule and bilaterally contracted conditions, Transmission System Operator shall determine which power stations shall be engaged in secondary control and minutes reserve maintenance, and in which time interval, using the minimum cost principle and securing reserve power availability in certain parts of the transmission system.

4.1.6.5 Voltage control and reactive power delivery

(1) Voltage control is a system service securing safe and quality electricity supply, for which the Transmission System Operator is responsible. In maintaining voltage stability power stations, transmission and distribution systems, and customers are included when necessary.

(2) Borderline areas of the adjacent systems are included in voltage stability maintenance in an interconnection. Therefore system operators of the adjacent control areas shall synchronize voltage on both ends of the interconnecting lines.

(3) Transmission System Operator is responsible for balanced reactive power management in its system in order to maintain voltage within the acceptable limits in all system nodes. For that purpose Transmission System Operator shall have available facilities for reactive power compensation in the system, and the capacity for reactive power generation in the connected power stations, which is secured contractually. Those facilities shall be sufficiently dimensioned and shall have required characteristics (switching/control capability) to secure adequate consistence with the set limit values and contracted parameters of operational voltage.

(4) Each power station shall, in accordance with its technical possibilities, operate at the requested power factor when so requested by the Transmission System Operator. If a power station, according to the request of the Transmission System Operator, delivers power with cos φ < 0,95 (inductively or capacitively), the power station is entitled to remuneration of costs incurred due to increased losses of active power (I^2R). Each power station shall submit to the Transmission System Operator current operating chart of all generating sets and set values of all limiters as well as other excitation characteristics.

(5) Conditions for reactive/power energy withdrawal below power factor referred to in paragraph 4 of this Article, shall be set out in bilateral agreements concluded between system users, ancillary service providers and the Transmission System Operator. System users who have contracted reactive power delivery, shall notify the Transmission System Operator on the status and availability of all generating units and facilities that can supply reactive power.

(6) Customers contract reactive power and energy supply outside the permissible limits of the power factor as an attributable system service with the Transmission System Operator.

(7) Based on data referred to in paragraphs 5 and 6 of this Article, and on current demand, Transmission System Operator shall use required ancillary system services pursuant to the contract. The choice of reactive power supplier is based on technical requirements, minimum cost principle and the principle of securing the availability of reactive power reserves in individual parts of the transmission system.

(8) If during daily operational planning it should so occur that the reactive power requirements cannot be balanced with available resources, Transmission System Operator shall instruct supplementary generating units to supply reactive power.

(9) This service is used by all system users and is thus, typically, not attributable. The exception to the rule are certain eligible customers, where Transmission System Operator is authorized to charge for the costs incurred during the provision of the service, in accordance with the conditions contracted for at the point of delivery.

(10) In the transmission network of the Croatian electric power system standardized nominal voltages are used, in accordance with NRN IEC 60038:1998 «IEC standardized voltages». The table below presents standardized voltages over 1kV:

Nominal system voltage (kV)	3[(1)]	6[(1)]	10	20	35(30)[(3)]	110	220	(400)[(2)]
Highest equipment voltage (kV)	3,6[(1)]	7,2[(1)]	12	24	38	123	245	420

Notes:
[(1)] The use in the public distribution network not allowed. Can be used as generator voltage and in industrial and mining facilities.
[(2)] It is not standardized, since on voltages higher than 220 kV, only the highest voltage for equipment is standardized.
[(3)] Although it is not standardized, it is still being used in some parts of the network.

(11) In normal operating conditions voltage level is maintained within the limits given below:
- In the 400 kV network: 400 -10% +5% = 360-420 kV,
- In the 220 kV network: 220 ±10% = 198-242 kV,
- In th 110 kV network: 110 ±10% = 99-121 kV.

(12) In operation under disturbance conditions voltage level can be within the limits given below:
- In the 400 kV network: 400 kV ±15% = 340-460 kV,
- In the 220 kV network: 220 kV ±15% = 187-253 kV,
- In the 110 kV network: 110 kV ±15% = 94-127 kV.

(13) Permissible deviation from nominal value in normal operating conditions, except for deviations that occurred due to a disturbance and interruption of supply, shall be determined within a week, so that 95% of 10-minute average effective voltage values shall have to be within the above given values.

4.1.6.6 Restoration of supply

(1) Transmission System Operator shall secure measures for prevention of system collapse and restoration of electricity supply. The operators of adjacent systems shall provide assistance. Pursuant to the contract, the ancillary services providers shall be prepared for restoration of supply when the Transmission System Operator so requires.

(2) Transmission System Operator shall develop adequate plans for measures and intervention for restoration of supply after a large-scale disturbance, taking into account potential assistance from the adjacent control areas. In that case Transmission System Operator shall develop such plans in conjunction with the operators of adjacent control areas.

(3) In order to provide this service, Transmission System Operator shall contractually obtain the right to resort to isolated operation and black start of relevant facilities of the system users from its system and other control areas.

(4) all system users, directly or indirectly connected to the transmission network benefit from the restoration of supply service, which is thus non-attributable.

4.1.7 Technical and other prerequisites for interconnection and interaction of systems

(1) Transmission System Operator collaborates with other operators on two levels:
- In its own control block for the purpose of settlement of inadvertent interchange in relation to the interconnection,
- With other control blocks for the purpose of safe interconnection operation.

(2) Transmission System Operator shall, in conjunction with adjacent operators, secure harmonized voltage control at borderline parts of the interconnection for the purpose of reactive power exchange.

(3) Transmission System Operator shall monitor the realization of the planned exchange in conjunction with other operators. Transmission System Operator shall manage operation so as to have the least possible deviation between the agreed and the actual exchange.

(4) Transmission System Operator shall, for primary control, secure sufficient power flow through the transmission lines in the event of outage in its own system or in the adjacent systems. In normal operation interconnecting lines shall have sufficient transmission reserve for the purpose.

(5) Transmission System Operator shall perform primary and secondary frequency control as well as reactive power control, pursuant to the *UCTE* rules.

(6) At the borderline with the adjacent systems Transmission System Operator shall, in conjunction with adjacent operators harmonize the following:
- Available local reactive power reserve,
- Minimum and maximum voltage levels in permanent operation and their short-term disruptions,
- Scope of reactive power exchange and procedures in the event of its disruptions,
- Isolation coordination.

(7) In normal operation Transmission System Operator shall meet the following framework criteria for the area adjacent to the interconnecting lines:

- Minimum and maximum permissible voltage,
- coordinated operation with other operators performing voltage and reactive power optimization,
- agree with the adjacent operators reactive power demand in relation to the amount of lines operating under maximum or minimum load in the area adjacent to the interconnecting lines.

(8) Settlement and compensation of inadvertent interchange shall be performed pursuant to paragraph 4.1.3.6. of this Grid Code.

(9) Transmission System Operator shall, in conjunction with adjacent operators, coordinate the development of plans and the construction of the transmission system.

(10) Transmission System Operator is responsible for installation of protection systems to facilitate satisfactory interconnected operation by securing that equipment in the neighboring systems is not at risk.

(11) Transmission System Operator shall exchange data which enable monitoring of electricity transmission across the borders of control areas with other operators:

- Planned disconnections of individual system units, such as interconnecting lines, transformers or power stations,
- Data on voltage levels for certain time periods,
- System equivalents,
- Short-circuit current contribution from adjacent systems,
- Plans for exchange across the borders of control areas,
- Expected congestion points,
- Data required for coordinated operation monitoring.

4.1.8 Protection adjustment

In planning and managing the transmission system operation, care must be taken to adjust the protection at the transmission system – system users/distribution system interface so as to comply with the requirements set out in paragraphs 4.3.2.5. and 4.3.6. of this Grid Code, as well as other additional requirements depending on the operating state of the electric power system.

4.1.9 Operating instructions

In managing the electric power system Transmission System Operator and other energy undertakings shall pass operating instructions in accordance with their areas of responsibility.

4.2 Planning transmission network development

4.2.1 Tasks in development planning

(1) In planning transmission network development Transmission System Operator shall fulfill the following tasks:

- plan transmission network development so that it is appropriately dimensioned to perform contracted for or forecasted transmissions of electricity, and so as to secure reliable electric power system management and cost-effective supply at a voltage the quality of which corresponds with the standards,
- System spare capacity shall be dimensioned in accordance with generally accepted (n-1) criterion. Due to uncertainties in forecasting, it is imperial to observe the minimum requirements posed on the transmission network. The effects of multiple disturbances, and multiple faults occurring in the transmission network which, for economic reasons, cannot be allowed for in transmission network development planning, shall be limited by appropriate large-scale failure and restoration of supply strategies
- design plans for transmission network development shall take into account current loads and output from power stations, as well as the planned demand of the distribution system, and of the transmissions system users already connected, or those who shall be connected to the transmission network in the short, medium or long term,
- in devising transmission system development plans the solution fully meeting three technical criteria shall be selected, respecting the principle of minimum cost,
- initiate procedures for obtaining consent and licenses for the construction of facilities in time.

(2) In planning of the facilities under shared authority of the Transmission System Operator and the Distribution System Operator, the provisions of this Grid Code shall apply. Those facilities shall be given separately from other transmission system facilities in the development plan.

4.2.2 The (n-1) criterion in development planning

(1) The (n-1) criterion is applied in transmission network planning at voltage levels of 400 kV, 220 kV and 110 kV.

(2) The application of the (n-1) criterion in transmission network planning represents a technical framework for limiting transmission with regard to reliability, permissible transmission system load, as well as in the event of unacceptable disturbances and effects upon customer supply in case of a single failure in the transmission system (described in greater detail in paragraph 4.2.2.1.).

(3) The (n-1) criterion represents a technical framework for evaluation of the proposed connection of a customer's facility pursuant to Chapter 4.3 herein.

(4) With the application of the (n-1) criterion in transmission network planning and construction, appropriate reliability of supply of all customers, and reliable transmission are realized, and the provision of system services is secured.

4.2.2.1 General provisions on meeting the (n-1) criterion

(1) The (n-1) criterion in the transmission system is met, if following a single outage of a one-circuit overhead line, cable, network transformer, interconnecting line and a generator connected to the transmission system the following effects are excluded:

- permanent violation of limit values of operating parameters in the transmission system (voltage, frequency, current loading), impairing secure electric power system operation or causing equipment damage, and impermissible reduction of equipment life span,
- modification, or interruption of contracted long term transmissions,
- interruption of supply of system users,
- further disconnection of remote electric power system units not directly affected by the disturbance, by protective devices.

The (n-1) criterion shall not take into account outage event on both phases of a two-phase line.

(2) It shall be considered that the (n-1) criterion is met if it is possible to exclude the effects referred to in paragraph (1) by reallocation of electric power generation.

(3) The transmission function in the network extending over a wide area can be maintained in the event of fault on busbars or multi-phase lines (e.g. overhead lines common mode failure) only with the assistance of the adjacent transmission systems.

4.2.2.2 Special provisions relative to the transmission network

(1) In evaluating safety of supply through the transmission system, the (n-1) criterion is applied in observed time periods with the expected generation schedule of power stations. The (n-1) criterion is, in transmission system planning, applied based on hypothetical outage of the largest generating unit having the greatest influence on safety of electricity supply.

(2) It is possible to additionally consider the (n-1) criterion, taking into account the possibility of simultaneous unavailability of system parts due to planned or forces outages.

(3) The (n-1) criterion is met if the total possible output from power stations can be transferred in the event of fault on one of the transmission system units, and without consequences referred to in subparagraph 4.2.2.1.

(4) Distributed generating units connected at lower voltage levels are in the evaluation of the transmission system safety of supply considered in accordance with the contracted dynamics of generation and availability.

4.2.2.3 Special provisions for user connection to the network

In planning user connection to the network, the (n-1) criterion can be deviated from, with the consent of the system user.

4.2.2.4 Special provisions for transmission – distribution system interface

(1) Generally, (n-1) criterion shall be met in the interface between the transmission and the distribution system.

(2) In a radial connection to the transmission system via one line, the (n-1) criterion may be deviated from, if supply from the neighboring medium voltage networks is secured.

4.2.3 Electric power system stability

4.2.3.1 General stability requirements

(1) Stable synchronous operation of generating units is a prerequisite for secure and reliable interconnected operation and electricity supply of customers. Dynamic behavior of the electric power system is the result of physical interaction between generating units, transmission system and system users with their control equipment, and can thus in its entirety only be defined by the Transmission System Operator. Transmission System Operator shall have precise information on dynamic behavior of the connected facilities, as well as those about to be connected to the transmission system. Transmission system user shall, upon request of the Transmission System Operator, submit all required data and technical information about its facility, as provided for in paragraph 6.1 (Minimum requirements regarding technical documentation).

(2) Stabile operation shall be secured for all relevant conditions by appropriate dimensioning, of primary and secondary devices for control in power stations, transmission system and user facilities. In determining stability and the resulting system, network and technical requirements steady-state and transient stability shall be differentiated, and the resulting technical requirements for the transmission system shall be set.

(3) In the event of a material change of technical or operational parameters on the user facilities, or in the event a new connection of user facilities to the transmission system, Transmission System Operator shall specify the measures required for stability maintenance. Generating units connected to the system shall meet the minimum technical requirements pursuant to the Chapter 4.3. herein.

4.2.3.2 Special requirements for steady-state stability

(1) Steady-state stability is an essential prerequisite of electric power system operation and it has to be secured at all times, and in each operating point as well as in the steady state of the electric power system. Steady state stability is not secured if, in the course of normal operation, minor changes in the system state occur (e.g. due to variations in power transfers, switching operations) during which steady-state operation cannot be maintained and self-induced oscillations occur. The consequences are the electric power system collapse in a wider area or possible damage to customer's facilities.

(2) As a prerequisite for steady-state stability on the side of the transmission system, during generating units' operation the following minimum requirements shall be met:

- In transmission system design, Transmission System Operator shall secure, even in the event of constrained network, the maintenance of minimum short-circuit power values on the transmission system – generating unit interface, and system voltage in accordance with the values referred to in subparagraph 4.3.4.10. herein (steady-state stability). If there is more than one generating unit in operation through the same interface, the sum of generator's active powers shall be taken into account when determining the minimum short-circuit power,
- Transmission System Operator shall also additionally examine the possibility to purchase or inject electricity from users without risking steady-state stability between transmission areas, even in the event of constrains in the transmission system. The changes in load and injection situations (e.g. low-load operation with underexcited generators), as well as changes in the transmission system switching state that effect operation shall not impair electric power system's steady-state stability. Steady-state stability limit may also be reached, depending on the distance the electricity is being

transmitted to, although the equipment in the (n-1) case is current loaded far below the permissible thermal current-carrying capacity.

4.2.3.3 Special requirements for transient stability

(1) Transient stability does not exist anymore if upon clearance of the short-circuit in the transmission system one or more generating units loose synchronism with respect to the electric power system. Major changes in voltage and frequency, as well as high transient currents occurring between the transmission system and generators in asynchronous operation may seriously impair the electric power system operation.

(2) As a prerequisite for transient stability on the side of the transmission system the following minimum requirements shall be met:

- In the course of system design, Transmission System Operator shall secure that minimum short-circuit power values in the transmission system, as provided for in subparagraph 4.3.4.10. herein (transient stability), are not violated in the event of a short circuit close to the power station on the transmission system – generating unit interface, upon fault clearance by protection. If there is more than one generating unit connected to the transmission system through the same interface, the sum of active generator powers is taken into account when determining minimum system short-circuit power,
- If upon a short circuit in the transmission system it is not possible to avoid generating unit's slipping, the unit shall be disconnected from the transmission system so as not to impair the system and operation of other power stations. Disconnection of a generating unit from the transmission system may be caused by tripping of the generator protection. Transmission system shall be capable of withstanding the effects occurring during these dynamic processes.

4.2.3.4 Requirements regarding the protection of user facilities

(1) Basic requirements regarding the selectiveness of protection in user facilities on the interface with the transmission system enable disconnection of equipment subject to disturbances and prevention of their spreading.

(2) For secure operation of user facilities without significant influence on the transmission system, every transmission system user is required to install a protection system in its network:

- a system that corresponds to the technology and operating conditions of its network,
- a system that corresponds to the conditions on the interface with the transmission system.

(3) Protective devices shall not uncontrollably trip during quick transient events in voltage and frequency, and shall function properly with permanently permitted voltage and frequency deviations.

(4) Conditions on the interface between the Transmission System Operator's facilities and user facilities shall be bilaterally agreed upon, so that they do not impair the operation of adjacent facilities.

(5) Transmission System Operator sets out the scope, the elements and the schedule of the primary and back-up protection system according to the specific transmission system circumstances. This includes defining parameters for current and voltage measurement transformers to which the protection is connected.

(6) If reliable tripping of protective equipment cannot be guaranteed in the event of switch failure or protection after a fault occurring in a user facility, installation of protection against switch failure or appropriate reserve protection shall be required.

(7) Primary control equipment of the facility and secondary control equipment connected to it shall be matched and adjusted to the permissible load of the protected equipment.

4.2.3.5 Coordination of protection at the interface between the transmission and the distribution network

In planning the transmission network construction, protection at the interface between the transmission and the distribution network shall be so designed to secure implementation of requirements referred to in paragraphs 4.3.2.5. and 4.3.6. herein.

4.3 Connection to the transmission system

4.3.1 Connection conditions

4.3.1.1 General provisions regarding the connection conditions

(1) The aim of connection conditions is to secure reliable operation of the electric power system as a whole and of system user's facility defined in subparagraph 4.3.1.2., at the same time avoiding unacceptable detrimental effect of the system user's facility on the system, and that of the system on the system user's facility. Transmission System Operator shall in an appropriate manner publish the transmission system connection procedure.

(2) Transmission System Operator shall make the following available to all potential system users:

- Conditions the system secures in the user connection point,
- Technical requirements posed by the system on a system user's facility,
- Prescribed procedures to exercise the right to a connection and a connection realization, as well as procedures required for future modifications at the user's facility,
- Procedures for checking compliance with the conditions and requirements of the electric power system posed upon the system user's facility.

(3) Each electric power system unit (generating set in a power station, line, transformer, plant and apparatus etc.) has specific parameters which shall be so selected as to be adjusted to the system characteristics within which they operate. Transmission System Operator shall make requirements regarding the parameters of individual units in order to secure system functionality in normal operation as well as in the event of a disturbance, all in accordance with the plans for construction, rehabilitation and development of the electric power system. Transmission System Operator shall also make sure that the set requirements be met, and that the required characteristics of the system units be verified at takeover and acceptance, or at connection to the transmission system or in maintenance of those characteristics during use.

(4) Transmission System Operator shall define a point of connection to the transmission system.

(5) Transmission System Operator shall designate a device for user disconnection from the system.

(6) Transmission System Operator shall check the possibility of user connection taking into account reliability of supply and unacceptable detrimental effect on the system.

(7) If technical and operating conditions in an accounting point correspond with the parameters according to which user's facilities can operate, Transmission System Operator shall propose adequate technical solution for user connection to the transmission system.

(8) In the course of the procedure for issuing the connection approval, system user shall secure minimum technical documentation and data pursuant to Chapter 7 herein.

(9) If technical and operating conditions in an accounting point in the system do not correspond with the parameters according to which user's facilities can operate in the given conditions, Transmission System Operator shall provide proof of that in form of a calculation and measuring. In such case, Transmission System Operator shall propose measures to be taken to enable user connection to the system, pursuant to the system development plan.

(10) Transmission System Operator shall connect a user to the system pursuant to the General conditions of electricity supply.

(11) A component part of the application for the connection of generator's and customer's facilities where facilities are managed by employees that are required by law to be specifically trained and their facility management skills tested, shall be operating instructions. Operating instructions are proposed by the system user and approved by the Transmission System Operator.

(12) Transmission System Operator concludes connection agreements with generators or customers who wish to connect to the transmission system pursuant to the Rules, General conditions of electricity supply and the Regulations on the system connection charge and the increase of connection capacity.

4.3.1.2 Application of connection conditions

(1) Connection conditions define relations between the Transmission System Operator and generators, or customers directly connected to the transmission system and the Distribution System Operator.

(2) Connection conditions apply to new and refurbished transmission, generation, distribution, and generally speaking, user facilities in the electric power system.

(3) New facilities are considered to be those that shall be designed and constructed after this Grid Code comes into force.

(4) Refurbished facilities are considered to be those the refurbishments of which shall be designed and conducted after this Grid Code comes into force, yet only if the refurbished part had an impact on the parts of the facility influencing the electric power system.

(5) System user shall, during preparatory activities, and prior to obtaining required licenses obtain a written opinion of the Transmission System Operator regarding the obligation of complying with this Grid Code, where he has to enclose reference material and data required for setting parameters determining the influence upon the system. Transmission System Operator shall provide the required opinion in the required form and in time, no later than a month after the submission of all reference material and data.

4.3.2 Basic characteristics in the user connection point to the transmission system

Transmission System Operator shall secure minimum basic technical characteristics in the point of user connection to the system.

4.3.2.1 Frequency deviation

(1) Nominal frequency in the Croatian electric power system is 50.00 Hz.

(2) In normal operating conditions and in interconnected operation of the Croatian system, frequency is maintained within the range of 49.50 Hz to 50.50 Hz.

(3) In normal operating conditions in isolated operation of the Croatian electric power system, frequency is maintained within the range 49.50 Hz to 50.50 Hz.

(4) In operation under disturbance conditions the frequency may be within the range of 47.50 Hz to 51.50 Hz.

4.3.2.2 Voltage deviation

(1) Nominal voltages in the transmission network of the Croatian electric power system are 400 kV, 220 kV and 110 kV.

(2) In normal operating conditions voltage level in the point of user connection to the transmission network is maintained within the limits stipulated in paragraph 4.1.6.5., subparagraph 11.

(3) In operation under disturbed conditions voltage levels in the point of user connection to the transmission network may be within the range stipulated in paragraph 4.1.6.5., paragraph 12.

(4) Larger or smaller permissible voltage deviation from the nominal value in the point of connection may be agreed for an individual connection in the special provisions of the system user connection agreement and system services.

4.3.2.3 Voltage waveform quality

(1) In normal operating conditions the total harmonic distortion factor (THD) caused by either generator or user connection at the withdrawal and injection point shall typically amount to at most:

- 1.5% at 400 kV and 220 kV,
- 3.0% at 110 kV.

The above given values refer to the 95% of the 10-minute averages of effective voltage values for the period of one week.

(2) Transmission System Operator may equip points of connection with the device for measuring electricity quality parameters.

(3) Planned values of flicker severity index in the transmission system shall not exceed 0.8 for short term flickers, and 0.6 for long term flickers.

4.3.2.4 Neutral earthing

(1) In the network of the nominal voltage of 110 kV or more, envisaged is the earthing with the Earth Fault Factor of less than 1.4.

(2) Transformer windings connected on the high voltage side, to the voltage level of 110 kV or higher, shall be star connected with the star point suitable for connection to earth.

4.3.2.5 Protection characteristics

(1) The fault clearance times for faults in the transmission system and in the system user's facility due to protection operation in the primary tripping zone (calculating the time from the fault occurrence until complete interruption of power flow), except for faults with a high share of active resistance in the fault impendence, are typically the following:

- 80 ms at 400 kV,
- 100 ms at 220 kV,
- 120 ms at 110 kV.

The fault clearance time by protection operation is approved by the Transmission System Operator, and for each individual connection of the system user's facility to the electric power system they shall be regulated between the Transmission System Operator and system user, based on the results of the analyses (e.g. transient stability analysis, analysis of selectivity and coordination of protection operation).

(2) In the Croatian electric power system the auto-reclosure method is typically applied as follows:

- in the 400 kV network: single-line auto-reclosure with no-load break of up to 1500 ms, and three-phase auto-reclosure of 700 ms,
- in the 220 kV network: single-line auto-reclosure with no-load break of up to 1000 ms, and three-phase auto-reclosure with no-load break of 300 ms,
- in the 110 kV network: single-line auto-reclosure with no-load break of up to 700 ms, and three-phase auto-reclosure with no-load break of 300 ms,

where the Transmission System Operator can approve different duration.

(3) Three-phase auto-reclosure for voltage levels of 220 kV and 400 kV shall be allowed only with a device with face rotation sequence control and undervoltage control, and frequency, voltage angles and amplitudes deviations.

(4) Deviations are possible due to specific conditions in the electric power system and the conditions in the system user's facility. They are approved by the Transmission System Operator based on the results of concrete analyses.

4.3.2.6 Operating events monitoring

For the purpose of analysis and defining the cause of disturbance in the system user's facility and in the electric power system, each user connection point shall be equipped with a fault recorder. The functional specification of the instrument and the rights of access to the fault recorder shall be regulated in a connection agreement.

4.3.3 General conditions for the connection of system user's facilities to the transmission system

(1) The point of connection of the system user's facility to the transmission system (a part of the interface between the system and the system user's facility) is typically located at the point

of injection/withdrawal. The specifics of the interface shall be contractually regulated between the Transmission System Operator and system user.

(2) Transmission System Operator shall, upon system user's request, examine whether the system conditions prevalent at the existing or planned transmission system node are satisfactory (acceptable power available at supply terminals, short-circuit power, reliability, voltage quality, frequency, etc.) so that the system user's facility can be connected to the transmission system without impairing the operation of other system users' facilities or that of the system.

(3) System user shall supply the Transmission System Operator with all technical and operating data required for setting and checking the compliance with the connection conditions (e.g. initial supplier, power gradients, cosφ, operation under frequency and voltage deviation, higher harmonics, and other) and shall collaborate in partnership in search for the optimum technical solution.

(4) The connection of system user's facility, and provision of long term power transmission service require the transmission system to be dimensioned according to at least the (n-1) criterion for transmission system units availability. This minimum requirement may be waived at the request of the user on conditions that unacceptable effects under (n-1) transmission system unavailability conditions, that cannot be tolerated, are avoided (see subparagraph 4.2.2.1.).

(5) When all the technical conditions in the user connection point have been met, and the operation of a system user's facility can be realized under the defined conditions, Transmission System Operator shall approve user connection to the transmission system.

(6) In the event that not all technical requirements for the system user's connection to the transmission system have been met, Transmission System Operator shall prove this with the relevant calculations and analyses. Transmission System Operator shall bear the cost of those calculations and analyses.

(7) In the event that the technical conditions in the user connection point to the transmission system have not been met (e.g. power at supply terminals, system short-circuit power, reliability of power supply or dissipation of injected power, negative effect of the electric power system upon the system user's facility), Transmission System Operator may propose to the system user the minimum adjustment measures at system user's facility.

(8) If construction, transmission system enforcement, or special technical modifications are required (e.g. modification of the protection scheme or of the remote control and telecommunications system) in the electric power system, Transmission System Operator shall determine the scope and manner of modification in order to achieve the final aim of correct operation of the planned system user's facility, having in mind the transmission system development plans.

(9) Transmission System Operator shall, upon user's request give the user proposal for the connection to the transmission system and explain the possibilities for connection realization. The connection to the transmission system is defined according to the (n-1) criterion of availability of transmission system units. Possible deviation from the (n-1) criterion is bilaterally corrected by the Transmission System Operator and system user.

(10) Transmission System Operator shall, based on the system user's request and the technical data attached to it, as well as this Grid Code, submit to the system user basic technical data important for the dimensioning of the system user's facility:

- possible network connection capacity,
- elements for insulation coordination,
- protection scheme,
- maximum and minimum short-circuit power,
- parallel operating conditions,

- the higher harmonic component and flickers according to the principles for determining detrimental effect on the transmission system,
- breaking capacity for the corresponding nominal voltages of the transmission system,
- method of neutral point connection,
- maximum and minimum continuous operation voltage, duration and level of short-term violations of the maximum and minimum voltage limits,
- characteristic load curves,
- type and volume of reactive power interchange, and installed local reactive power reserve in the user's facility:
    - on customer location without contractual provisions maintaining the cosφ ± 0,9 inductive is required,
    - for generating units as provided for in subparagraph 4.3.4.8,
    - involvement in the voltage control concept (reference voltage value, accuracy, velocity, fault mode operation),
- involvement in system defense plan (underfrequency load shedding, undervoltage control, manual and automatic control),
- involvement in securing system services,
- procedure during large-scale disturbances,
- measurement and calculation technique,
- integration into the remote control system,
- integration into the telecommunication system.

Transmission System Operator shall send the above data free of charge, within 30 days from the date of reception of system user's request.

(11) System user shall dimension its facility according to the requirements defined in this Grid Code for connecting system user's facility to the transmission system, as well as technical recommendations and standards based on the principles of identifying negative effect onto the electric power system (e.g. emission of higher harmonic components into the transmission system, flickers, asymmetry and other effects).

(12) Agreement on the system user's connection to the transmission system, agreement on system services and agreement on managing the system user's facilities are required for the connection to the transmission system.

(13) Agreement on the connection to the transmission system is concluded between the Transmission System Operator and system user in accordance with the General conditions of electricity supply.

(14) Agreement on system services, concluded between the Transmission System Operator and system user, sets out the procedure and method of securing system services (frequency control, voltage control, reactive power compensation and restoration of supply) and settlement for the services used, as well as duration of the agreement, period of notice, guarantee, etc.

(15) Agreement on managing system user's facility operation, concluded between the Transmission System Operator and a system user, shall contain the following:

- appointment of the persons responsible for the use of the facility and operators on duty,
- competences of the Transmission System Operator concerning the mode of operation of the system user's facility, and regarding the switching operations,
- administration of operators on duty,
- regulations on application of protection at work,
- authorization of access to the system user's facility,
- facility maintenance procedure,
- procedures in the event of a fault, disturbance or defects,
- method of communicating and the obligation of notifying about the changes on the user's facility,

- referring to the Glossary as reference and determining Croatian as the language of communication.

(16) Contractually defined characteristics of the system user's facility shall be confirmed by tests when connecting it to the electric power system. System user shall submit the testing protocols, proving contractually defined characteristics of the facility, to the Transmission System Operator.

(17) The system user's staff working in high voltage facilities shall be properly qualified and equipped with personal protection devices and working equipment pursuant to effective technical rules and regulations on protection at work. Documents on professional qualifications and system user's staff competence shall be available upon request of the Transmission System Operator.

(18) All technical and operational changes on the system user's facility deviating from the provisions of the connection and system services agreement shall be treated as a new connection which shall have to be contractually regulated.

(19) Customers connected to the 110 kV network or more shall provide the Transmission System Operator with technical data and a specification of plant and apparatus that can be included in the electric power system defense plan. The method of managing the plant and apparatus within the scope of the defense system (underfrequency load shedding, undervoltage control, manual and automatic control …) shall be agreed and contractually regulated by the Transmission System Operator and the customer.

(20) Generating units in a user facility connected to the transmission system shall meet special, and if required, additional requirements specified in paragraph 4.3.4. For each generating unit system services agreement between the Transmission System Operator and a customer shall be signed.

4.3.4 Special requirements governing the connection of a generating unit

4.3.4.1 General

(1) Connection of generating units to the transmission system is conducted pursuant to the general conditions referred to in paragraphs 4.3.2 and 4.3.3 herein.

(2) Special conditions shall apply to all generating units directly connected to the transmission system, as well as other generating units that the Transmission System Operator identifies as units of specific importance for the electric power system. Specific conditions for generating units shall be regulated in the agreement on the connection to the transmission system and the system services agreement concluded between the Transmission System Operator and a generator.

(3) All generating units in normal operation shall comply with the specific requirements referred to in paragraphs 4.3.4.2. to 4.3.4.10. In order to secure reliable system operation even in the conditions deviating from normal operation, Transmission System Operator may require a portion of generating units to be capable of meeting additional requirements referred to in paragraph 4.3.4.11.

(4) Generator shall meet additional requirements imposed by the Transmission System Operator referred to above, and provide system services when so required by the Transmission System Operator. Provision of ancillary services shall be regulated in a separate agreement.

(5) The cost of meeting additional requirements in the existing generating units shall be borne by the Transmission System Operator. System services agreement shall take into account the settlement of that cost.

(6) UCTE recommendations on the expected behavior of generating units during operation, as well as rules of primary and secondary frequency and reactive power control serve as recommendations for meeting individual requirements.

4.3.4.2 Connecting a generating unit to the transmission system

(1) All equipment for connecting a generating unit shall be dimensioned according to the effective technical regulations, standards, recommendations and this Grid Code, as well as additional requirements of the Transmission System Operator.

(2) Depending on the method of connection of a generating unit to the electric power system, the obligation of executing a system unit connection and creating preconditions in the transmission system for its connection shall be regulated in the connection agreement.

(3) Technical requirements for the connection of generating units to the transmission system shall be passed by the Transmission System Operator.

4.3.4.3 Synchronizers

(1) Connecting a generator to the transmission system is allowed only upon having obtained prior consent of the Transmission System Operator. On the interfaces between the transmission system and generating units synchronizers shall be installed, that is automatic synchronizers, enabling the connection of a generator to the system in the following cases:

- normal operation (generating unit start-up),
- synchronization of a unit to the electric power system from no-load operation, following tripping on auxiliary supply or isolated operation on local consumption,
- bringing a unit onto load in a dead subsystem in order to place the system section under voltage.

(2) Synchronization systems of generating units shall have two ways of synchronization: manually and automatically, with independent synchro check function active during both ways of synchronization.

4.3.4.4 Electrical protection of a generating unit and synchronization with network protection

(1) Electrical protection of a generating unit shall request disconnection from the transmission system in the event of:

- internal faults on the generating unit,
- failure or irregular operation of network protection devices in the event of network faults and faults in the electric power system,
- deviations from system voltage and frequency from the set limitations and stability loss (see paragraph 4.3.4.9.).

(2) Settings of the electrical protection of a generating unit the operation of which was caused by system disturbances, shall be harmonized between the Transmission System Operator and a generator based on the selectivity study and coordination of the protection system operation.

(3) Protections referred to in subparagraph 2 shall disconnect a generating unit from the system by disconnecting the unit switch, upon which the generating unit shall transfer into no-load condition or trip onto auxiliary supply, in order to prepare for resynchronization.

(4) In the study on selectivity and coordination of the generating unit's protective equipment functioning referred to in subparagraph 2 and network protection devices, at least the following shall be taken into account:

- external symmetrical and asymmetrical short-circuits,
- unbalanced load,
- stator and rotor overload,
- unacceptable underexcitation,
- overfrequency and underfrequency,
- magnetic overload,
- asynchronous operation,
- torsional strain,
- drive failure (operation as motor).

(5) When harmonizing protection settings of the generating unit and the system, Transmission System Operator and the generator shall pay special attention to the following:

- measures against breaker failure,
- back-up protection,
- schedule for protection tripping (protection coordination),
- type of synchronous generator excitation system.

(6) A generator shall supply the Transmission System Operator with all relevant technical data for the generating unit and for the facility, required for producing an analysis referred to in subparagraph 4. Transmission System Operator shall send to the generator results of the analysis referred to in subparagraph 4 where they concern his generating facilities.

4.3.4.5 Adjusting to the remote control system

(1) A generator shall install devices for real time process information exchange.

(2) From the generator to the control center (transmission network center) and the Transmission System Operator's control center (National Control Center) at least the following information shall be passed:

- the position of the circuit-breaker/disconnector/earthing disconnector/step switch settings, required for operation or calculation (analysis) of the system status,
- measured values of the current operating variables (voltage, frequency, active and reactive power).

(3) From the transmission network center to the Transmission System Operator's control center and on to the generator at least the following information shall be passed:

- active power reference values, orders for control method (primary and secondary control activation and deactivation) and instantaneous demand value of secondary control,
- reactive power reference value in the form of a schedule or instantaneous value (for voltage/reactive power control at the electric power system level).

(4) Other required signals and information exchange between the Transmission System Operator and a generator shall be contracted separately for each individual case.

4.3.4.6 Active power supply

(1) Basic requests for active power a generating unit shall be capable of delivering, during permanent deviation of electric power system operational frequency and voltage on the high voltage side of unit transformers are made on the assumption of normal operating conditions and are defined in the Figures 4.2. (for 110 kV), 4.3. (for 220 kV), and 4.4. (for 400 kV).

(2) Normal operating conditions:

- Frequency rate gradient: ≤ 0,5% per minute,
- Voltage rate gradient: ≤ 5% per minute.

(3) For thermal generating units continuous changes of a generating unit's active power of at least 2% P_n/min (P_n = nominal active power) between minimum stable generation and nominal active power shall be secured.

(4) For hydro generating units continuous changes of a generating unit's active power of at least 1% P_n/s (P_n = nominal active power) between the minimum stable generation and nominal active power shall be secured.

(5) Each generating unit shall be capable of permanent operation at minimum safe output. The level of minimum safe output shall be bilaterally agreed between the generator and the Transmission System Operator when setting requirements for a generating unit. Typically minimum stable generation for thermal generating units shall not exceed 50% of nominal active power.

(6) Generating unit shall not reduce active power supply, not even if it operates at nominal capacity, if, in the process, the frequency in a short time interval is above the full line in the Figure 4.5.

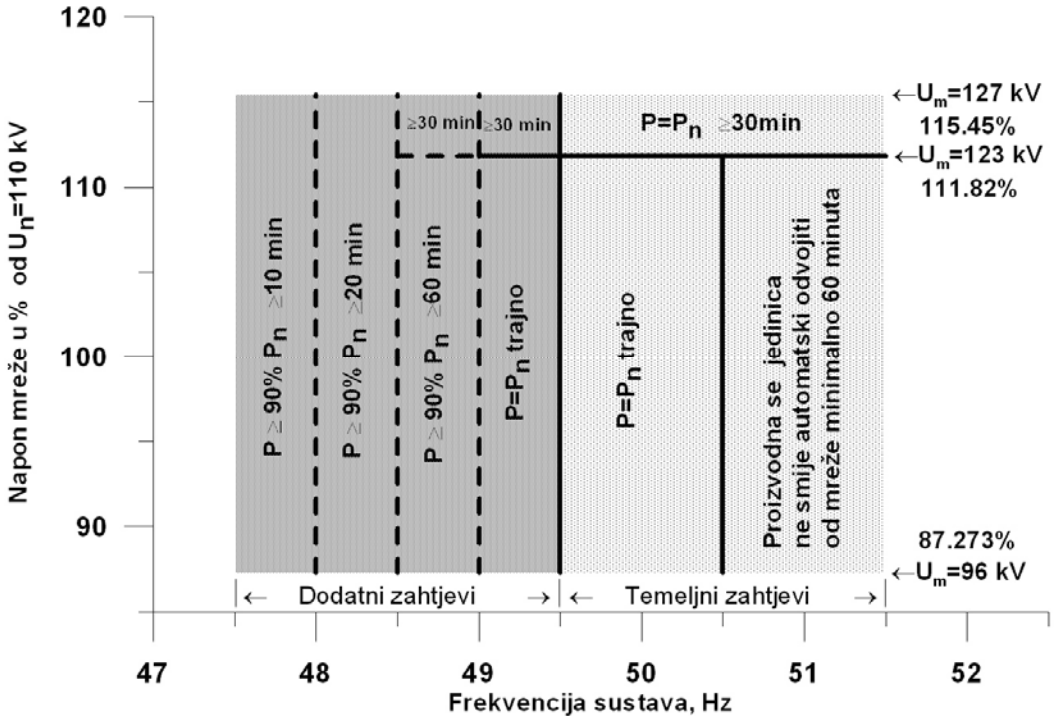

Figure 4.2. Guaranteed power a generating unit delivers into the transmission system in a certain time period in relation to the electric power system frequency and voltage for the nominal level of 110 kV

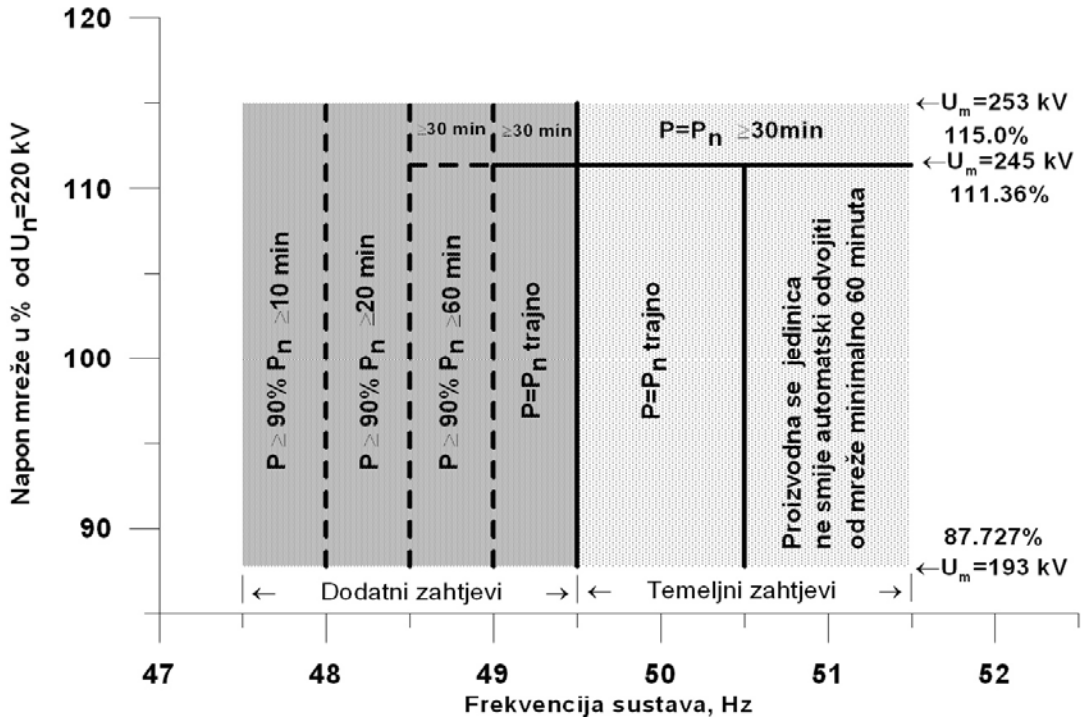

Figure 4.3. Guaranteed power a generating unit delivers into the transmission system in a certain time period in relation to the electric power system frequency and voltage for the nominal level of 220 kV

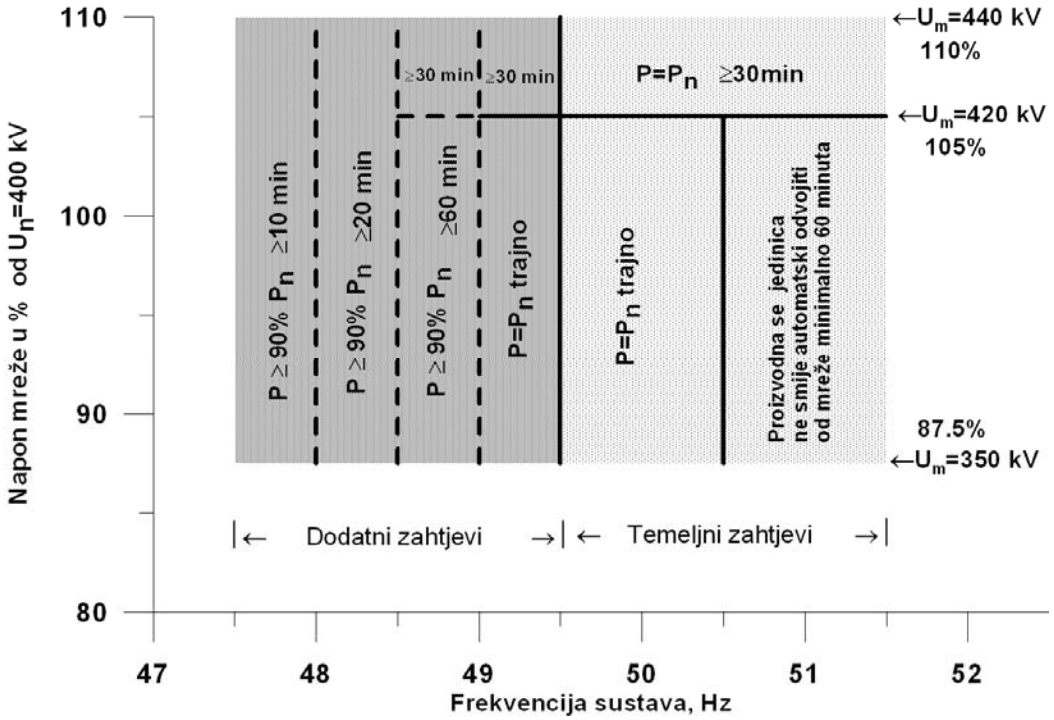

Figure 4.4. Guaranteed power a generating unit delivers into the transmission system in a certain time period in relation to the electric power system frequency and voltage for the nominal level of 400 kV

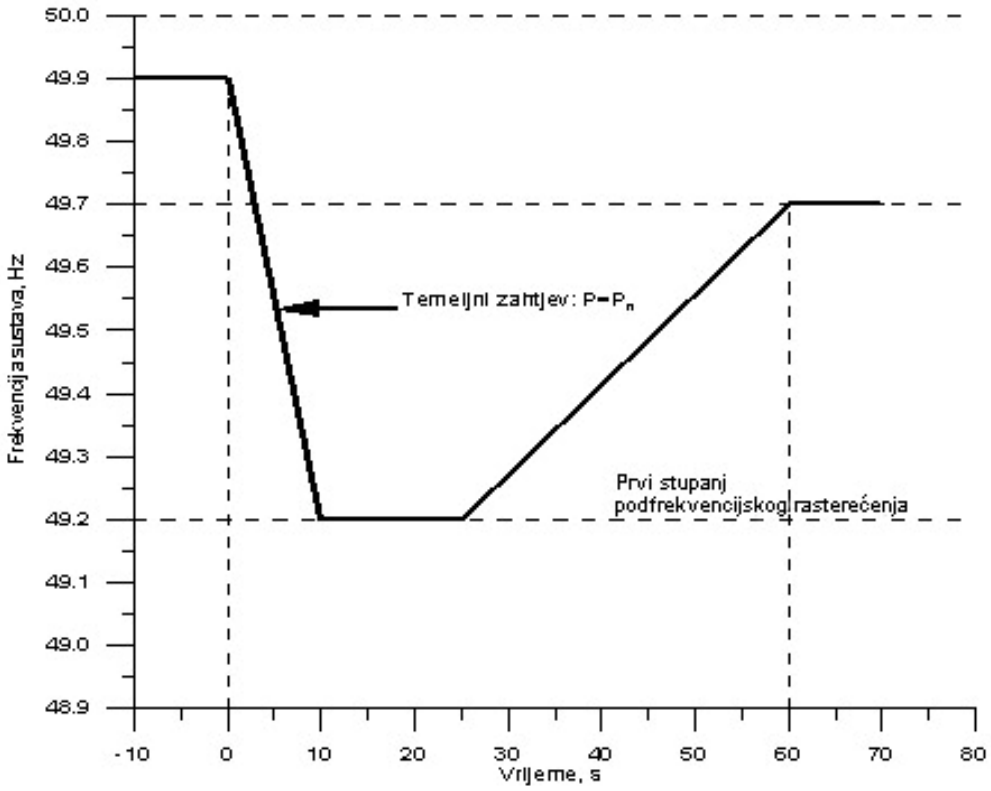

Figure 4.5. Guaranteed power a generating unit shall supply in a short time interval

4.3.4.7 Frequency control

4.3.4.7.1 Primary control

(1) Each thermal generating unit with a capacity of over 30 MW and each hydro generating unit of a capacity of over 10 MW shall be capable of primary frequency control. This is a precondition for a connection to the electric power system.

This requirement applies to the generating units in the distribution system and to the facilities of customers connected to the transmission system directly.

(2) Thermal generating units of a capacity of less than 30 MW, and hydro units of a capacity of less than 10 MW may, by arrangement with the Transmission System Operator, also be capable of primary frequency control.

(3) The following applies to thermal generating units referred to in subparagraphs (1) and (2):

- The primary control band shall be at least ± 2% of the nominal capacity and shall be adjustable upon the request of the Transmission System Operator,
- The permanent droop of the speed control system shall be adjustable upon request of the Transmission System Operator within the range of 5% to 8%,
- Total requested primary control power of a generating unit shall be activated linearly at quasisteady frequency deviation of ± 200 mHz within 30 s and the supply shall be maintained for at least 15 minutes,
- Fifteen minutes upon primary control power activation, and under the assumption that the reference frequency has been attained again, primary control power shall be available again,
- In case of minor frequency deviations the same rate of primary control power change shall apply until the required power is reached,
- The neutral zone of the primary control system shall be within 20 mHz for new and refurbished generating units.

(4) The following applies to hydro generating units referred to in subparagraphs (1) and (2):

- The permanent droop of the speed control system shall be adjustable upon the request of the Transmission System Operator within the range of 2% to 5%,
- Neutral zone of the primary control system shall be 20 mHz for new and refurbished generating units.

4.3.4.7.2 Secondary control and minutes reserve

(1) Transmission System Operator and generator shall define the secondary control reserve, the secondary control band, the rate of power change, the rate of occurrence of power changes, stand-by duration and technical availability.

(2) By agreement with the Transmission System Operator new and refurbished generating units shall be so equipped as to be able to make available secondary and minutes reserve to the Transmission System Operator.

(3) Thermal generating units intended for secondary control shall be capable of changing their active power output continuously in the entire range between its minimum active power and rated active power, with the rate of exchange not less than:

- 8% P_n/min (P_n=nominal active power) for thermal generating units fired by liquid and gaseous fuel,
- from 2% to 4% P_n/min for hard coal fired thermal generating units,
- from 1% to 2% P_n/min for brown coal and lignite fired thermal generating units,
- from 1% to 5% P_n/min for nuclear generating units.

(4) Hydro generating units shall be capable of changing their active power output continuously with the rate of change of 1.5% to 2.5% P_n/s (P_n = nominal active power) between the minimum and nominal active power.

(5) A generating unit shall deliver into the system the agreed minutes reserve at the latest 5 minutes upon receipt of a request.

4.3.4.8 Voltage control and reactive power compensation

4.3.4.8.1 Voltage control

(1) New and refurbished generating units shall have automatic voltage controllers capable of controlling the reference voltage within the ± 0,5 % of the nominal voltage(U_n).

(2) The range of generator voltage control shall be at least ± 0,5 % U_n. The range of control for each individual case is determined separately by the Transmission System Operator and generator based on appropriate studies.

(3) New and refurbished generating units shall typically have unit transformers with on-load transmission control and automatic voltage controllers. The scope and step of control for each individual case is determined separately by the Transmission System Operator and a generator based on appropriate studies.

4.3.4.8.2 Reactive power compensation

(1) Power factor for new and refurbished generating units shall typically be 0.85 inductively and 0.9 capacitatively. For each individual case of a new or refurbished generating unit Transmission System Operator and a generator shall define a request for the amount of the power factor (cos φ_n) of the synchronous generator in inductive, as well as in capacitive generator operation range. For reversible hydro power stations Transmission System Operator shall define a request for cos φ_n separately for motor operation.

(2) Each thermal generating unit of nominal power exceeding 30 MW and each hydro generating unit exceeding 10 MW shall, as required by the Transmission System Operator, meet requirements for reactive power supply in accordance with Figure 4.6. for connection to nominal voltage level of 110 kV, in accordance with Figure 4.7. for nominal voltage level of 220 kV, and in accordance with Figure 4.8. for nominal voltage level of 400 kV.

(3) Generator shall be so dimensioned that it will, at nominal active power, be able to move through the entire power factor design range within few minutes. The process shall be repeatable without limitations.

(4) If necessary, and by agreement between the Transmission System Operator and a generator additional equipment (e.g. reactive power controller of a generating unit/power

station) may be installed enabling the use of a generating unit for voltage/reactive power control of the electric power system.

(5) For each generating unit a generator shall supply the Transmission System Operator with the generator output diagram with tripping characteristics of the loss of excitation of a synchronous generator, the characteristics of all control limitations and all design limitations of the prime-mover and synchronous generator. Output diagram shall be given at generator terminals and the high-voltage side of the unit transformer. For control limitations with time dependant characteristics those characteristics shall be supplied.

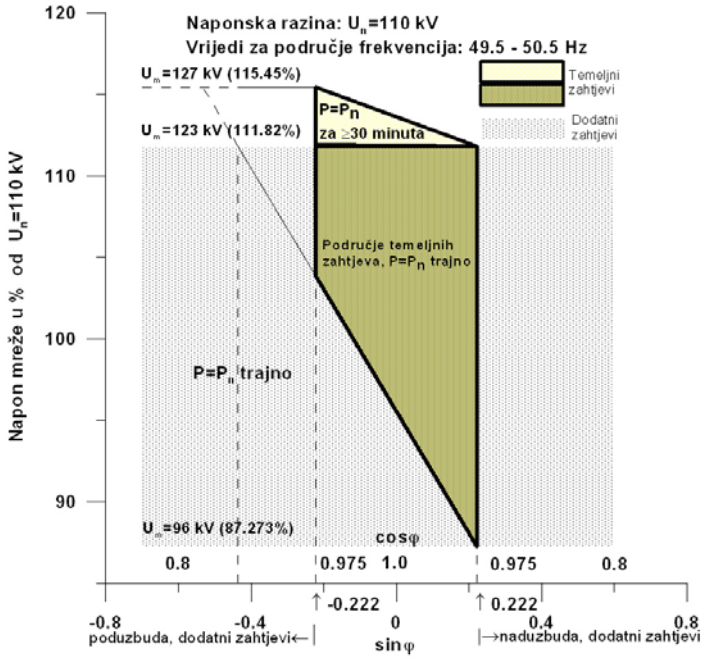

Figure 4.6. Requirements for reactive power supply by the generating unit to the electric power system when connected to nominal voltage level of 110 kV

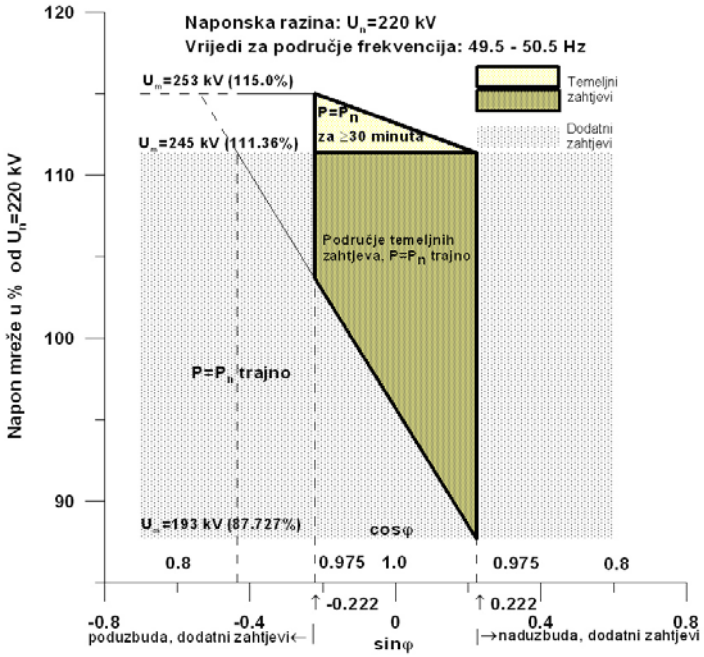

Figure 4.7. Requirements for reactive power supply by the generating unit to the electric power system when connected to nominal voltage level of 220 kV

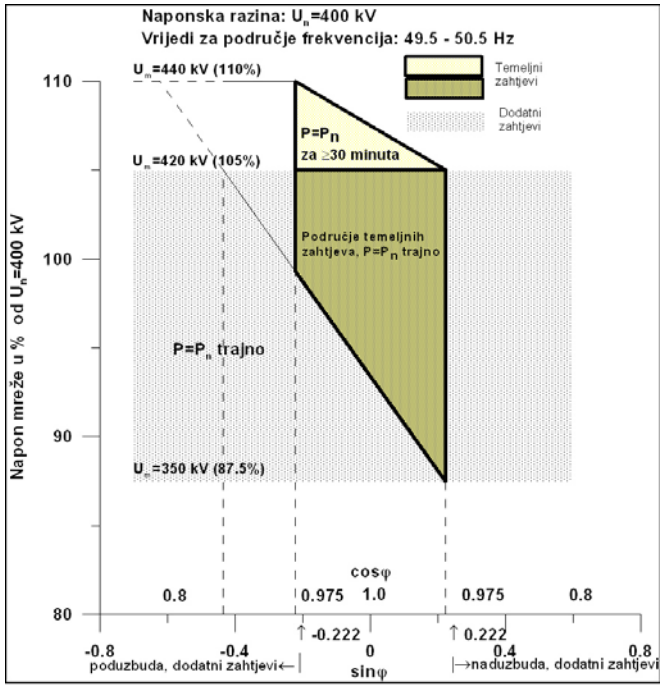

Figure 4.8. Requirements for reactive power supply by the generating unit to the electric power system when connected to nominal voltage level of 400 kV

4.3.4.9 Disconnecting a generating unit from the network for reasons of system security

The specification of a generating unit's protection required for reasons of system security and its control values shall be defined by the Transmission System Operator.

4.3.4.9.1 Criteria for automatic disconnection from the network

(1) In the event of violation of upper or lower limits of frequency deviation, a generating unit may automatically be disconnected from the network.

(2) In the event of stability loss a generating unit shall automatically be disconnected from the network.

(3) If system voltage limit values are exceeded, a generating unit may automatically be disconnected from the network.

4.3.4.9.2 Frequency deviation

At frequencies lower than 47.50 Hz a generating unit may be disconnected and may switch to no-load condition, or trip onto auxiliary supply, ready for resynchronization, if it is so agreed in a separate agreement with the Transmission System Operator. At frequencies in the range of 47.50 Hz to 51.50 Hz disconnecting a generating unit from the network is not allowed.

4.3.4.9.3 Stability loss

At steady state or transient stability, repeated rotor slipping (asynchronous operation) of a generator shall be avoided by automatically disconnecting it from the network. For that purpose a protection from rotor slipping shall be provided pursuant to subparagraph 4.3.4.4. hereinabove.

4.3.4.9.4 Network voltage decrease

At temporary steady system voltages lower or equaling 80% of the nominal voltage (400 kV, 220 kV and 110 kV) at high voltage side of a unit transformer a unit shall be disconnected from the network in order to secure a safer transition of a unit to no-load condition.

4.3.4.10 Unit behavior during system disturbance

Transmission System Operator and generator shall harmonize the characteristics and parameters of excitation control system and speed/active power control system of a generating unit important for system stability.

4.3.4.10.1 Transient stability (short-circuits)

(1) Short circuits close to the power station during proper protection system operation, if they are eliminated within 150 ms, shall not lead to instability in the entire operating range of a generator, nor to a disconnection of a unit from the network. This is also true if on the interface

between the electric power system and a generating unit a close three-pole short-circuit power, upon fault clearing, exceeds six times the nominal active power of a generating unit (which at cosφ ≈ 0.85 and load factor of 1 means that equivalent impendence of the system from the point of connection of a generating unit amounts to 20% of the nominal generator impendence at most). In the process generating unit's auxiliary supply shall not be redirected automatically to reserve supply connections. If a generating unit cannot meet the requirements referred to herein, it can proceed with operation only upon having obtained approval of the Transmission System Operator.

(2) A generating unit shall not be disconnected from the transmission system as long as system voltage at the high voltage side of a unit transformer is above the curve shown in the Figure 4.9. This requirement applies to generating units connected at voltage levels lower than 110 kV, and centrally monitored by the Transmission System Operator.

(3) In the event of a short circuit remote from the power station, if the fault is cleared by network protection operation within 5 seconds, there shall be no redirection to auxiliary supply, nor preventive disconnection of the generating unit from the network due to unfavorable influence of system voltage onto auxiliary supply voltage.

(4) New and refurbished synchronous generator excitation systems shall function properly, the voltage at generator terminals being 20% of the nominal value.

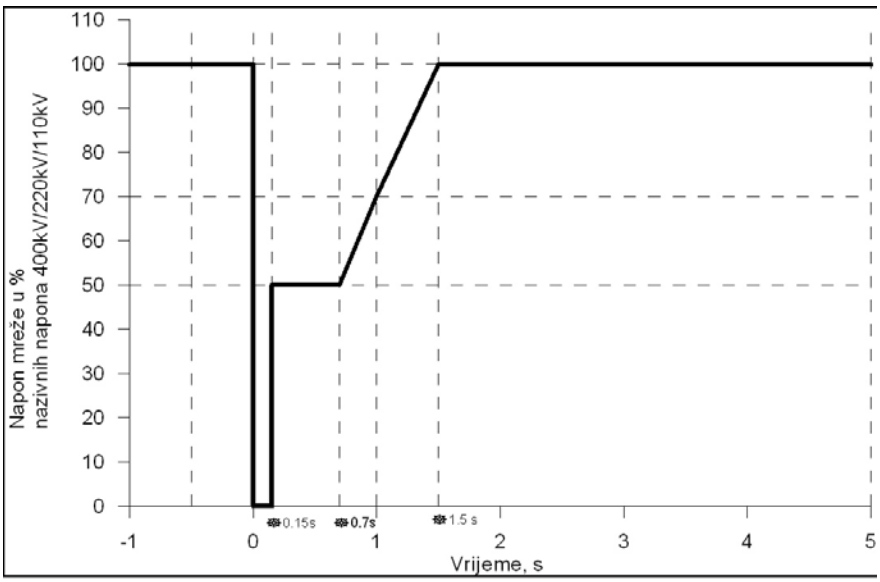

Figure 4.9. Limit curve of the permissible transmission system voltage at the high voltage side of a unit transformer

4.3.4.10.2 Steady-state stability

(1) Based on previous experience, electromagnetic swings of a generating unit (their own electromagnetic swings) and system electromagnetic swings in the Croatian electric power system amount to 0.2 to 3 Hz. They shall not lead to disconnection of a generating unit with the tripping of protection, or to the reduction of the unit's active power.

(2) The relative damping of the least damped oscillatory component of electromagnetic swings, the predominant source of which is in the Croatian electric power system, shall not be lower than 0.05. Exceeding of the value shall not lead to disconnection of a generating units with the tripping of protection, not to the reduction of the unit's active power.

(3) Generator of the generating units, based on the request of the Transmission System Operator, shall have the capacity to damp their own electromechanical and inter-area oscillations with a Power System Stabilizer (PSS). The purpose of this measure is to secure steady-state stability of a generating unit operation in the entire range of the generator output diagram, under the assumption that the three-pole short-circuit power on the high voltage side equals at least four times the nominal active power, and that voltage equals at least the nominal system voltage (which at $\cos\varphi \approx 0.85$ and voltage factor of 1 means that the equivalent system impendence observed from the point of connection of a generating unit amounts to at least 30% of the generator's nominal impendence). All characteristic parameters important for the stability of a generating unit shall be coordinated between the Transmission System Operator and a generator.

(4) Speed/power control system on new and refurbished generating units shall be set and synchronized with other control systems of a generating unit so that damping of local mode and inter-area electromechanical oscillations in all operating regimes shall be within the permissible limits as referred to in subparagraph (2).

4.3.4.11 Additional requirements for the connection of a generating unit

In order to secure reliable system operations even in the conditions deviating from normal operation, Transmission System Operator may require that a portion of generating units be capable of meeting the following additional requirements:

- Generating unit's transition to no-load condition and securing tripping onto auxiliary supply,
- Capability of isolated operation,
- Black start capability.

4.3.4.11.1 Transition of a unit to no-load condition and tripping onto auxiliary supplies

(1) In the event that, when defining the requirements for the connection to the transmission system, the Transmission System Operator so requires, the generator shall secure capability of a new or a refurbished generating unit to switch to no-load condition or trip onto auxiliary supplies, pursuant to a separate agreement.

(2) Rotation speed and excitation control system of a generating unit shall be so designed and constructed that a generating unit can, following a disconnection from the network reliably switch to no-load condition in any operating point.

(3) Reliable transition to no-load condition shall, as well, be secured in the event of disconnection of a generating unit from the network by tripping of network protection during system disturbances.

4.3.4.11.2 Capability of isolated operation

(1) Electric power producer shall enable new or refurbished generating unit to provide the service of isolated operation, if system operator should so require when defining connection conditions, as provided for in a separate agreement.

(2) If so the following requirements shall be met:

- When forming asynchronous subsystems (synchronous interconnection), the new load of generating units in isolated part of the electric power system typically differs from previous loads. Therefore it is imperative to design the speed and active power control system, and excitation control system of a generating unit so that the unit can safely transfer to any partial load above the auxiliary and general supply requirement. Such isolated operation shall be maintainable for a number of hours,
- When operating with the loading of the auxiliary supply or with partial load, a generating unit shall be capable of regulating sudden load equaling 10% of the nominal active power.

4.3.4.11.3 Black start capability

Should the Transmission System Operator, defining the requirements for the connection to the transmission system, request new or refurbished generating units to be capable of black start, the generator shall grant the request, pursuant to a separate agreement.

4.3.4.12 Monitoring compliance with the Transmission System Operator's requirements

(1) Transmission System Operator and a generator shall have available technical documentation of a generating unit proving compliance with the requirements from the connection agreement. The scope and content of the technical documentation shall be determined in a connection agreement. The proposed minimal scope of documentation is given in paragraph 7.1.

(2) Facility characteristics set out in the connection agreement shall be checked during verification testing. The scope of testing shall be set out in the connection agreement. The program and method of conducting acceptance and verification testing shall be proposed by the generator and approved by the Transmission System Operator. The generator shall supply the Transmission System Operator with the reports on the acceptance and verification testing. The procedure in the event of deviation of plant characteristics from those contracted for is also regulated in the connection agreement.

(3) During generating unit's exploitation, Transmission System Operator shall, by arrangement with the generator, program the testing to check the generating unit's characteristics. The generator shall supply the Transmission System Operator with the reports on the performed tests.

(4) In the event of a change in plant characteristics, generator shall sign an appendix to the current connection agreement or a new connection agreement with the Transmission System Operator.

4.3.5 Special requirements for the distribution system connection to the transmission system

(1) All conditions and requirements referred to in subparagraph 4.3.2. and 4.3.3. hereinabove shall apply to distribution system connected in one or more points at voltage level of 110 kV or at 35(30) kV of the transformer of upper voltage level of 110 kV.

(2) Distribution System Operator shall supply the Transmission System Operator with the specification containing technical data for the distribution system user (transmission line bays) which can be included in the plan of electric power system defense. The strategy of user management within the plan of system defense (underfrequency load shedding, undervoltage relief, manual and automatic management...) is agreed and contractually regulated between the Transmission System Operator and the Distribution System Operator.

4.3.6 Electric protection requirements at the user facility/distribution system and transmission system interface

(1) Electric protection system in the environment of user's facility/distribution system and transmission system interface shall be specified and set so as to minimize negative effect of the user's facility/distribution system to the transmission system in the event of a fault in the user's facility/distribution system, and negative effect of the transmission system onto the user's facility/distribution system in the event of a fault in the system.

(2) Installation of protective equipment in the facility of every user and in the distribution system is required in accordance with the following:

- the topology and operating conditions of his facility/distribution system, and
- conditions on the interface with the system.

Protection devices in the user's plant/distribution system shall not uncontrollably trip during transient phenomena in voltage, currents and frequency, and shall function properly during permanent deviations from those values within the limits referred to in subparagraph 4.3.2. hereinabove.

(3) Selectivity and coordination of protection in the transmission system and protection in the user's facility/distribution system shall be coordinated between the Transmission System Operator and system user/distribution system. For the connection of each system user's facility/distribution system a study on selectivity and coordination of protection operation shall be developed.

(4) When synchronizing protection settings of the facility of the system user/distribution system and the transmission system, the following shall be taken into account:

- measures in the event of a circuit-breaker failure,
- stand-by protection,
- schedule of protection tripping (protection coordination),
- equipping facilities with devices for registration of faults, disturbances and transient events (fault recorder).

(5) Conditions on the interface between the transmission system and system user's facility/distribution system shall bilaterally be agreed so as not to impair the surrounding facilities.

4.3.7 Information interchange at the interface

4.3.7.1 General provisions

(1) Scope, method and procedure of the information interchange (e.g. glossary, forms, protocols, schedule) shall be set out in the connection agreement.

(2) Transmission System Operator shall have available appropriate data on the system user's facility and the distribution system.

(3) Transmission System Operator is responsible for keeping records on active and reactive power set point values. System user and the Distribution System Operator shall submit to the Transmission System Operator detailed technical information on their system for the purpose of explaining operating events in the transmission system. The same is required of the Transmission System Operator in relation to the system user or the Distribution System Operator, when they analyze operating events in their facility/system triggered by those occurring in the transmission system.

(4) On the interface between the Transmission System Operator and the distribution system real time interchange of the following information is required:

- the position of the circuit-breaker/disconnector/earthing disconnector/step switch settings, required for operation or calculation (analysis) of the system status,
- measured values of the current operating variables (voltage, frequency, active and reactive power),
- selected information on the effect of protection and operating events at the interface,
- selected parameters of electricity quality,
- other information.

(5) At the Transmission System Operator – system user interface interchange of all information referred to in paragraph (4) shall be enabled, as defined in the procedure of issuing connection approval which is a component part of the connection approval and use of system agreement.

(6) Information shall be exchanged and used in accordance with the principle of confidentiality and transparency.

4.3.7.2 Special provisions regarding the exchange of information on the generating units' operation

(1) The generator shall communicate the current schedule of the generating units to the Transmission System Operator pursuant to the Electricity Market Rules.

(2) The generator shall immediately inform the Transmission System Operator of all cases in which there are constraints in power supply to the transmission system or incapacity of providing appropriate system service, and shall state the reasons and the predicted duration of the constraint.

(3) Transmission System Operator shall immediately inform the generator of all changes in the switching state influencing a power station's operation (e.g. changes in short-circuit power). The measures shall be coordinated with the generator in the planning process.

4.3.8 Measures to be taken in the event of modifications to the Transmission System Operator's network, system user facilities and the Distribution System Operator's network

(1) The changes in the electric power system topology or basic system parameters influence the safety of system operation and reliability of supply. In certain circumstances such changes may have a detrimental effect on the system and generating units connected to the transmission system.

(2) System users, the Distribution System Operator and the Transmission System Operator shall inform each other of the nature, scope and duration of the change extending beyond the limits set out in the connection agreement in time. If necessary the agreement shall be modified accordingly as well.

(3) Transmission System Operator shall analyze the effects of the change referred to in subparagraph (1) on system operation, including security of supply and voltage quality, as well as define appropriate measures pursuant to paragraph 4.3.2.

(4) Transmission System Operator shall not approve a required change until the effects of the change on the system by appropriate analysis can be unambiguously defined.

(5) Transmission System Operator shall not approve changes that endanger electric power system operation; their implementation shall be conditioned by appropriate measures.

4.3.9 Training the staff of energy undertakings for procedure in the event of large-scale disturbances

Every energy undertaking shall, in conjunction with the Transmission System Operator, devise special instructions and rules regulating the behavior of staff in the event of large-scale disturbances, which shall form a component part of the system defense plan in the event of large-scale disturbances. The staff of energy undertakings shall have underwent routine exercises to become trained for the procedure in the event of large-scale disturbances.

5 DISTRIBUTION SYSTEM GRID CODE

Distribution system Grid Code sets out the distribution system management, development planning, and minimum requirements for connection to and use of the system.

5.1 Distribution system management

5.1.1 Introduction

(1) Distribution system management is a procedure encompassing the functions of planning, management and monitoring of the distribution system. It secures distribution system services and appropriate quality of electricity supply.

(2) System operation and management shall be technically and economically optimal, reliable and safe. In order to perform the above mentioned tasks distribution system development planning, construction and maintenance shall be planned.

(3) Distribution System Operator shall be responsible for operational planning and distribution system management from the accounting points in the transmission system to all relevant accounting points of the system users.

5.1.2 Planning distribution system operation

(1) Planning distribution system operation is a procedure of maintaining maximum security of supply and system reliability, realizing maintenance, and connecting new generators' facilities and customers to the system.

(2) Distribution System Operator shall, with other system users, coordinate the execution of plans, reconstructions, maintenance and emergency interventions in the system.

(3) Distribution System Operator shall execute plans; perform construction and reconstruction, maintenance and emergency interventions in the system, concurrently securing reliable distribution system operation.

(4) Distribution System Operator shall operate its system in accordance with the agreed work plans.

(5) Planned interruptions in system operation shall be conducted with a timely prior notice to the affected users and other energy undertakings, pursuant to the provisions of the General conditions of electricity supply.

5.1.2.1 Meeting the (n-1) criterion in operational planning

(1) The (n-1) criterion in the 110 kV network, which falls under the responsibility of the Distribution System Operator, is met, if following a single outage of a 110 kV line, or a transformer with upper limit voltage of 110 kV, it is possible to prevent the following effects:

- permanently exceeding the distribution system units' load which may impair safety, increase the likelihood of faults and reduce the units' life span,

- further disconnection of the distribution system units not directly affected by the disturbance by tripping of protective equipment, and disturbance spreading in the system.

(2) The (n-1) criterion in medium voltage networks, is met if following an outage of a medium voltage line or a transformer, the following effects are prevented:

- permanently exceeding the load of medium voltage distribution system units,
- further interruption of electricity supply outside the fault area in the ring connected medium voltage network.

(3) The (n-1) criterion does not encompass the low voltage network, except in the event of a separate agreement between the Distribution System Operator and system user.

(4) The (n-1) criterion encompasses outage of a single distribution system unit (line or a transformer) only.

(5) In the event of outage of a distribution system unit, if such an outage occurrence does not disrupt system operation, Distribution System Operator shall synchronize system structure to meet the (n-1) criterion again, in as short time period as possible.

(6) Distribution System Operator may deviate from the (n-1) criterion should that be required due to system construction, maintenance and modification.

(7) The (n-1) criterion may be maintained with the support of the adjacent distribution systems. This implies planning the disconnection of the facilities influencing the adjacent distribution systems' operation, and interested areas in the interconnection have to arrange them in advance, as well as exchange the information and data required to design the operating plan. All notices shall be submitted in written form or in a manner commonly employed in the area.

(8) In planning the medium voltage system operation, simultaneous loss of both phases on a two-phase line shall not be taken into account.

(9) When planning measures to secure the (n-1) criterion, Distribution System Operator shall be governed by technical and economic factors, taking into consideration the probability of a considered event, consequences, cost of their prevention, as well as the cost of launching protective measures to prevent the spreading of disturbances in the network.

(10) Distribution System Operator shall, securing the (n-1) criterion, take into account the requirements for providing distribution system services and securing electricity quality.

5.1.3 Use of distribution system

5.1.3.1 Preconditions for the use of the distribution system

(1) Distribution System Operator shall, to all distribution system users, secure preconditions for the use of system. Precondition for the use of system is that all technical and operating requirements have been met pursuant to this Grid Code and General conditions of electricity supply.

(2) The use of distribution system is a process whereby electricity flow in the distribution system is realized, as well as electricity exchange with other connected systems.

(3) Electricity customers and generators have the right to use the system, except in cases when the Distribution System Operator withholds access due to technical or operating limitations of the system.

(4) Use of system, disconnection and reconnection of a system user is set out in the General conditions of electricity supply and this Grid Code.

5.1.3.2 System overload

(1) In order to avoid overload of parts of system Distribution System Operator shall plan and manage system operation taking into account the actual system structure and available system capacity, the schedule of electricity withdrawal from the connected power stations, contracted power and consumption estimate. This, typically, does not refer to eligible customers.

(2) Distribution System Operator may, irrespective of the agreed schedules, limit energy and power use in the event of an overload.

(3) In the event of an overload in the distribution system endangering safe system operation, Distribution System Operator shall implement measures for restoration of normal operation. The measures shall be transparent and non-discriminatory.

(4) Distribution System Operator shall implement required switching operations for the purpose of restoring normal operation for as many users as possible in as short time period as possible.

5.1.3.3 Losses in the distribution system

Distribution System Operator shall secure energy to cover the electricity losses in the distribution system, as well as for their monitoring, analysis and calculations, their decrease to the lowest degree possible, taking into account safety of system operation.

5.1.4 Distribution system management

(1)Distribution system management encompasses all activities of the Distribution System Operator which, by managing system elements, realizes optimum, safe and reliable distribution system operation, that is the supply of customers with electricity of required quality, in conjunction with the Transmission System Operator.

(2) Distribution system may operate:
- Under normal conditions,
- Under disturbed conditions,
- Under extraordinary conditions.

(4) Disconnection and reconnection of a system user is set out in the General conditions of electricity supply.

5.1.4.1 Normal operation

(1) Normal operation of the distribution system is a system state of which the following is true:
- all customers are supplied with electricity;
- voltages of the distribution system and on the interface with distribution system users are maintained in the range between the maximum permissible and minimum voltage,

- loads of all distribution system units are below limit values,
- short-circuit currents in all distribution system nodes are lower than the switching capacity of the appurtenant switches,
- there is sufficient reserve in the transmission system and power stations connected to the distribution system,
- all services and planned works in the distribution system are realized.

(2) Limit load values are, in principle, the following:

- for generating units – load between the minimum stable generation and available capacity of the generating unit,
- for power lines – load between the no-load condition and maximum permissible load determined based on thermal load and voltage conditions, where exceptionally for heavily loaded lines thermal load is taken in both, the summer and in the winter period,
- For transformers – load between the no-load condition and available transformer capacity (in principle: nominal transformer capacity),
- For bays – permanent permissible load of field connecting lines in the bay or switching or measuring equipment in the bay,
- For busbars – permanent permissible load of busbar conductors,
- For units for reactive power compensation – unit load under actual operating voltage.

5.1.4.2 Operation under disturbance conditions

(1) Deviation from normal operation is considered to be a disturbance.

(2) Distribution System Operator is authorized and responsible for the implementation of all required measures for elimination of faults and prevention of disturbance spreading, as well as securing efficient restoration of quality and secure supply of system users following a partial or a complete system collapse.

(3) Reliable system operation supersedes special and individual interests of certain system users. This means that the Distribution System Operator is, in extreme cases authorized for limitation of electricity supply, including a disconnection of a system user.

(4) Prior to the implementation of measures in the event of a disturbance, Distribution System Operator shall identify the causes of disturbance, and distribution system topology following the disturbance, based on the information available to it through the remote control system, or those supplied by the Transmission System Operator and system users. System users shall, upon the request of the Distribution System Operator send the Operator appropriate available data.

(5) Distribution System Operator shall notify system users of the onset and duration of the distribution system operation under disturbance conditions pursuant to the General conditions of electricity supply.

(6) Distribution System Operator shall keep all records on the operation under disturbed conditions.

(7) Upon system users' request, Distribution System Operator shall make the records on the disturbance that caused the system user consequences in the operation of his facilities, available to the system user.

5.1.4.3 Operation under extraordinary conditions

(1) Operation under extraordinary conditions is one in which, due to an outage of a system unit, operating values limits are exceeded, and especially one in which the frequency in the

electric power system dropped below 49.00 Hz or one in which equipment was overloaded and there is a risk of disturbance spreading.

(2) In the event of operation under extraordinary conditions, in order to secure reliable system operation and restoration of supply in the distribution system, Distribution System Operator may without prior notice disconnect individual system users or part of the distribution system in which the disturbance occurred.

(3) In the event of a frequency drop below 49.20 Hz automatic underfrequency load shedding is activated pursuant to paragraph 4.1.4.5.

5.1.4.4 Limiting disturbances

(1) Distribution System Operator shall devise a program and a plan of measures for operation management under disturbance conditions and under extraordinary conditions.
(2) Distribution System Operator shall, with the Transmission System Operator and generators connected to the distribution system, coordinate the plan for operation management during disturbances.
(3) Distribution System Operator retains the right to implement required voltage control measures. They include system load shedding in cooperation with the Transmission System Operator.
(4) According to the Transmission System Operator's instructions and operating instructions for operation under disturbance conditions, Distribution System Operator shall limit power and energy delivered to customers if reliability of operation is impaired or if there is a risk of system collapse in the following cases:

- during overloads,
- during frequency drops,
- during outages of large generation units,
- due to lack of electricity.

5.1.5 Distribution system operation

5.1.5.1 Introduction

(1) Distribution system operation management enables the implementation of planned operation, as well as overcoming and limiting the effect of disturbances and faults within available operating possibilities.
(2) Distribution system operation management covers the following tasks as well – switching operations, voltage control, control of protective and telecommunication devices, as well as other devices for transmission of data.
(3) Distribution System Operator is responsible for coordination of control and maintenance services in the field, as well, and for communication with distribution system users and with other entities.

5.1.5.2 Analysis of the distribution system operation

(1) Distribution System Operator shall perform analyses of the distribution system operation on a daily basis.

(2) Distribution System Operator shall compile annual report on the status of the distribution system, and operating data and events in the system.

(3) Distribution System Operator shall compile annual statistical report on disturbances in the distribution system.

(4) Based on the results of the daily, monthly and annual reports Distribution System Operator undertakes measures for improvement of distribution system operation safety.

5.1.5.3 Data exchange that facilitates distribution system operation management

Distribution System Operator shall exchange the following data with the generators, customers, and the Transmission System Operator in the respective interfaces:

- selected switch position signals,
- selected measured values (current, voltage, active and reactive power, frequency),
- selected alarm from the users part of the facility,
- data on protection operation,
- selected parameters of electricity quality,
- other data of importance for operation management.

5.1.5.4 Agreement on user facility operation management at the interface with the system

(1) Operation management shall be contracted between the Distribution System Operator and an individual system user.

(2) Operation Management Agreement shall contain at least the following:

- the responsibilities of the signatories,
- Distribution System Operator's authorization for issuing operation orders,
- special provisions relating to safety at work,
- authorizations and manner of access to the facility,
- method of mutual notification,
- list of persons responsible for operation management.

(3) Eligible customer and generator shall, upon request of the Distribution System Operator, under the provisions of the Operation Management Agreement, submit the following operating data:

- selected switch position signals
- selected measured values (current, voltage, active and reactive power, frequency)
- selected alarm and status messages,
- data on protection operation,
- operating events on the interface,
- selected parameters of electricity quality.

In addition to the above, the execution of the order for the disconnection of user facility from the system shall be rendered possible.

5.1.6 Distribution system services

5.1.6.1 Introduction

(1) Distribution system services are services indispensable for secure and quality electricity supply, as well as other services that the Distribution System Operator provides the system users. Distribution System Operator, in conjunction with the system users who have available required devices and possibilities for the provision of services, shall secure those services to all system users.

(2) Distribution system services can be attributable and non-attributable. System services are attributable if a provider of a certain ancillary service, or a user of a system service in a known range is recognizable, and the charges or costs can thus be allocated.

(3) Unattributable distribution system services are the following:
- Distribution system operation management,
- Frequency control,
- voltage control that determines active power withdrawal within the prescribed limits,
- restoration of supply following a disturbance,
- standard tariff management,
- standard plant and apparatus management (directed consumption),
- standard lighting management.

(4) Attributable distribution system services are the following:
- Securing reactive power outside the limits of the permissible power factor,
- Securing quality of supply above standard,
- Securing other non-standard services.

(5) Special services in the distribution system are metering services.

(6) Distribution System Operator shall provide standard tariff management, standard consumption management and standard lighting management pursuant to special regulations and instructions, as well as technical and operating conditions.

(7) Distribution System Operator shall, for reasons of reliability of operation, monitor attributable services in the distribution system and determine who used the service, when he used it and to what amount.

(8) Pursuant to annual plans, Distribution System Operator shall contract conditions for the provision of individual attributable services with suppliers and customers.

(9) Distribution System Operator shall contract required ancillary services with individual system users based on current needs. The choice of system user shall be conducted pursuant to the principle of minimum cost of system operation.

5.1.6.2 Distribution system operation management

(1) Distribution system operation management services shall be secured for the distribution system users pursuant to paragraphs 5.1.4. and 5.1.5.

(2) Distribution system operation management shall operationally be implemented by the distribution dispatching centers and operation management centers.

5.1.6.3 Frequency control

(1) Frequency control is an electric power system service for which the Transmission System Operator is responsible.

(2) Frequency control through distribution system load shedding is the task of the Distribution System Operator realized through coordination with the Transmission System Operator.

5.1.6.4 Distribution system voltage control

(1) Distribution system voltage control is a service whereby voltage levels are maintained within declared limits. Distribution System Operator and Transmission System Operator are responsible for voltage control. Generators and customers that have contracted voltage control as an ancillary service provision participate in it as well.

(2) Distribution System Operator shall, in a Use of System Agreement, define the conditions of compensation of reactive power to generators and customers so as to secure voltage within declared limits, at relevant voltage levels and in accounting points.

(3) All system users benefit from the voltage control service which determines reactive power withdrawal within the declared limits. The service is thus considered to be non-attributable.

(4) Referential control voltage and control method at medium voltage side of the 110/x kV transformer shall be determined by the Distribution System Operator in conjunction with the Transmission System Operator.

(5) In order to secure declared voltage deviation limits in the distribution system 110/x kV transformers shall be automatically controlled, at least with degrees ± 10 x 1.5%, while the transformers in the medium voltage network shall have control in no-load conditions in the range of at least ± 2 x 2.5%.

(6) Declared limits of deviation from the nominal voltage level in normal operation are the following:

- For low voltage: +6%/–10% (by 2010), and ±10% (after 2010) pursuant to the Regulation on standardized voltages for low voltage electricity distribution systems and electrical equipment,
- For medium voltage (10 kV, 20 kV, 30 kV, 35 kV): ±10%.

(7) Permissible deviations from the nominal value in normal operating conditions, except for deviations occurring due to a disturbance or interruption of supply, and for individual cases of current system users in remote areas with long lines, are the following:

- For low voltage: for a period of one week, 95% of 10-minute averages of effective voltage levels shall be within the range of U_n+6%/-10% (by 2010), and U_n ±10% (after 2010). All 10-minute averages of effective voltage levels shall be within the range of U_n +10%/ -15%.
- For medium voltage: for a period of one week, 95% of 10-minute averages of effective voltage levels shall be in the range of U_n ± 10%.

5.1.6.5 Restoration of supply following a disturbance

Distribution System Operator shall, within its scope of responsibility, secure reliable distribution system operation and its restoration following a large-scale disturbance or

distribution system collapse. In order to do that Distribution System Operator shall devise appropriate organizational provisions and preventive and corrective measures to be taken in the event of disturbance.

5.1.6.6 Standard tariff management

(1) Distribution System Operator shall perform standard tariff management by employing the tariff management system in accounting points.

(2) Distribution System Operator is responsible for the development, construction and maintenance of the tariff management system.

5.1.6.7 Standard consumption management

(1) Distribution System Operator shall perform standard consumption management by employing the system of consumption management in accounting points.

(2) Distribution System Operator is responsible for the development, construction and maintenance of the consumption management system.

5.1.6.8 Standard lighting management

(1) Lighting management is a service covering the management of lighting system in a standard way and at a specific time.

(2) Distribution System Operator shall secure the service by employing the lighting management system.

5.1.6.9 Securing reactive power outside power factor tolerance limits

(1) The task of the Distribution System Operator is balancing and compensating reactive power and energy use in the distribution system.

(2) System users shall contract reactive power and energy supply outside the power factor tolerance limits with the Distribution System Operator individually, and the Distribution System Operator shall contract reactive power and energy supply with the provider of the system service.

(3) Reactive power and energy supply system service is contracted by the Distribution System Operator with prior consent of the Transmission System Operator.

5.1.6.10 Securing electricity quality above the standard

In the event that electricity quality above the standard is demanded, Distribution System Operator and system user shall define such requirements in the Use of System Agreement.

5.1.6.11 Securing other non-standard services

Distribution System Operator and system users shall define other non-standard services which shall be a component part of the Use of System Agreement.

5.2 Distribution System Development Planning

(1) Distribution System Operator is in charge of distribution system development with the aim of securing safe and reliable system operation.

(2) Distribution System Operation shall continuously monitor and analyze data on the level of system capacity engagement, and all other parameters, and pass development plans.

(3) The safety and reliability concept shall take into account technical and operating conditions of the distribution system, especially in the points of connection with user installations and facilities, transmission system and adjacent systems. When planning system development Distribution System Operator shall comply with the relevant criteria relating to the quality of electricity supply.

(4) System of protection against faults and disturbances shall especially take into account the points of separation of distribution and transmission system, and user installations and facilities.

(5) Distribution System Operator shall define the following: type of protection, gradation of back-up and basic protection, type and method of data transmission and type of automatic devices.

(6) In planning the 110 kV network which falls under the authority of the Distribution System Operator, the provisions of this Grid Code relating to the transmission system shall apply.

(7) In planning distribution facilities under joint authority of the Transmission System Operator and the Distribution System Operator the provisions of this Gird Code shall apply. In the Construction Development Plan those facilities shall be given separately from other distribution system facilities.

(8) In system planning on medium voltage level, the (n-1) criterion is adhered to where it is economically justified (with reference to the cost of non-supplied electricity), and upon the request of the Agency.

(9) In other cases referred to in paragraph 8 of this Article the system is radially planned. Upon the request of a system user, the (n-1) criterion shall be adhered to in system planning, and system user shall bear the cost.

(10) Meeting the (n-1) criterion in medium voltage system planning shall be realized in the same way as in system operation planning (paragraph 5.1.2.1.).

(11) Low voltage distribution system is typically realized radially, without taking into account the (n-1) criterion, unless it is so required due to user demand for supply quality above the standard. The cost of meeting the (n-1) criterion in low voltage system shall be borne by the user.

(12) Distribution system users shall, upon request, submit to the Distribution System Operator, data required for system development planning such as:

- Data on development plans for specific time periods, containing forecasted consumption, peak loads, and changes in output capacity of generating units,
- Plans for additional construction and reconstruction of user facilities,
- Plans for installing devices for the compensation of reactive power and energy,
- Other information of importance for system development planning.

5.3 Connection to the distribution system

5.3.1 General

(1) Technical and operating conditions for the connection to the distribution system are set out in this Grid Code with the aim of securing normal distribution system operation, prevention of the detrimental effect on the system and the existing user network.

(2) Special and additional technical and operating conditions shall take into account specifics of generating units' operation and technical characteristics.

5.3.2 Basic technical characteristics in the point of connection to the distribution system

Legal or physical person requesting to connect to the distribution system shall meet the following minimal technical requirements at the point of connection:

- frequency deviation,
- voltage deviation,
- voltage waveform quality,
- voltage asymmetry,
- operational and earthing for work,
- short-circuit level,
- level of insulation,
- protection from faults and disturbances,
- power factor.

5.3.2.1 Frequency deviation

Nominal frequency value and permissible voltage deviation are set out in paragraph 4.1.6.4.

5.3.2.2 Voltage deviation

Permissible deviation from the nominal voltage level at the point of withdrawal or injection in normal operation shall be set out in paragraphs 5.1.6.4, subparagraphs 6. and 7.

5.3.2.3 Voltage waveform quality

(1) Planned value of the Total Harmonic Distortion factor caused by generator and/or customer connection in the withdrawal and/or injection point shall amount to at most:

- at 0.4 kV voltage level: 2.5%,
- at 10 and 20 kV voltage level: 2.0%,
- at 30 and 35 kV voltage level: 1.5%.

The above given values refer to 95% of 10-minute averages of effective voltage levels for a period of one week.

(2) The values of flicker severity index caused by generator and/or customer connection in the connection point shall amount to at most:

- for short term flickers: 0.7,
- for long term flickers: 0.5.

5.3.2.4 Voltage asymmetry

Voltage asymmetry in the withdrawal and/or injection point caused by a generator and/or customer connection shall not exceed 1.3% of the nominal voltage. The value refers to 95% of 10-minute averages of effective voltage levels for a period of one week.

5.3.2.5 Operational and earthing for work

(1) User shall perform earthing of its facility and installations taking into account effective technical regulations and industry standards. User shall take into account requests resulting from the distribution system neutral point earthing to which one is connected.
(2) Distribution System Operator shall supply the user with data on the method of distribution system neutral point earthing to which a user is connected, as well as on the anticipated future state.

5.3.2.6 Short-circuit level

(1) Equipment in a user facility or installations shall be so dimensioned to withstand all effects of the short-circuit current for the current state, and the anticipated future state.

(2) Distribution System Operator shall supply the user with data on the anticipated short circuit currents which should be taken into account when dimensioning user's facility and installations.

(3) Maximum (three-pole) short circuit currents shall not exceed the amount the Distribution System Operator has supplied the user with.

5.3.2.7 Level of insulation

(1) Insulation of equipment in user facilities and installations shall be dimensioned in accordance with the voltage level to which it is to be connected.

(2) Distribution System Operator shall supply the user with data on the voltage level and coordination of insulation.

(3) Level of insulation of equipment to be installed in the 10 kV system, unless otherwise contracted for in the System Connection Agreement, shall meet the level of insulation of 20 kV.

5.3.2.8 Protection from faults and disturbances

(1) User shall synchronize its protection from faults with a corresponding protection in the distribution system, so that the faults in its facility or installations shall not cause impermissible disturbances in the distribution system or at other system users. This specifically refers to the following:

- fault clearance time shall be within the limits determined by the Distribution System Operator,
- securing selective operation of protective devices in a user facility and installations with the distribution system protection.

(2) Distribution System Operator shall inform the user of the effects on the user facility and installations due to tripping of protection in the distribution system, and especially the effect of auto-reclosure.

(3) Distribution System Operator may change the technical requirements set for protection in user facilities and installations if it is so required due to new operating circumstances or system development.

(4) User shall submit to the Distribution System Operator all required data on its protective devices, including reports on the tests performed.

(5) Distribution System Operator may demand to be present at the testing of the user's protective devices.

5.3.2.9 Power factor

Unless otherwise agreed, the power factor value for user installations and facilities shall be $\cos\varphi = 0.95$ inductively, to $\cos\varphi = 1$.

5.3.3 General conditions for user facility connection to the distribution system

(1) Distribution System Operator shall define a connection point of user facility and installation to the distribution system.

(2) Point of connection of user facility and installation to the distribution system is typically at the electricity withdrawal/injection point.

(3) Distribution System Operator shall define a device for user disconnection from the system.

(4) Distribution System Operator shall, upon system user's request, check if the conditions in the existing or in a planned distribution system node are satisfactory (permissible connection capacity, short-circuit current, earthing method, reliability, voltage quality, etc.), so that user facility and installation can be connected to the system without endangering system user facility and installation and without causing impermissible effect on system operation.

(5) If technical and operating conditions in an accounting point meet the technical parameters within which user installations and facility can operate in accordance with the above stated conditions, Distribution System Operator shall propose appropriate technical solution for the connection to the distribution system. System user shall provide the Distribution System Operator with all technical and operating data required for defining and testing of distribution system connection conditions and shall cooperate, in a partnership relationship, in seeking out the optimum technical solution.

(6) If technical and operating conditions in an accounting point do not meet the parameters within which user installation and facility can operate in accordance with the above stated conditions, Distribution System Operator shall prove this based on calculations and measurements. In that case, Distribution System Operator shall propose measures that shall enable user connection to the system, in accordance with the system development plan.

(7) In the event that construction, system reinforcement or special technical changes in the system are required, Distribution System Operator shall define the scope and method of implementation of such changes.

(8) System user shall dimension his facility and installations in accordance with the requirements set out in this Grid Code, as well as technical recommendations and standards based on the principle of defining negative return effect on the system (for example; emission of higher harmonics, flickers, asymmetry, etc.), pursuant to the General conditions of electricity supply.

(9) A component part of the connection request shall be operating instructions for those system users or customers whose total connection capacity exceeds 5 MW or for those system users or customers whose facility is managed by staff that has to be specifically trained and their competence in facility management tested.

(10) Distribution System Operator shall connect a user to the system pursuant to the General conditions of electricity supply and this Grid Code.

(11) Distribution System Connection Agreement shall be concluded between the Distribution System Operator and system user pursuant to the General conditions of electricity supply.

5.3.4 Detrimental return effect on the system

(1) User facility and installation shall be so designed and constructed that the detrimental effect of their operation on the system (flickers, asymmetry, higher harmonics, etc.) does not exceed the prescribed values.

(2) User facility and installation shall be so designed and constructed to secure their resistance to the disturbances and effects from the system.

(3) Prior to the first connection or replacement of user facility and installation possible detrimental effect on the system shall be determined.

(4) It shall be possible to consider connection to the system without a detailed evaluation of the detrimental effect on the system, in case of small connection capacity or a limited share of non-linear plant and apparatus at a customer, however, if the following requirement has been satisfied:

- $S_K/S_P \geq 1000$ for medium voltage and
- $S_K/S_P \geq 150$ for low voltage.

Where S_K is short-circuit power at a connection point, and S_P is connection capacity.

(5) For greater connection capacity or nominal capacity of non-linear plant and apparatus a calculation shall be made which shall reveal that the planned values of voltage distortion shall not be exceeded due to the detrimental effect on the system.

(6) The detrimental effect analysis is the responsibility of the system user who shall present calculations and measurements as proof that his facilities shall not exceed the acceptable range of the detrimental effect to the Distribution System Operator during a trial run.

(7) User facility and installation shall not impair the transmission of information and control signals through the distribution system.

(8) Should a system user cause unacceptable detrimental effect, Distribution System Operator shall instruct about the manner and deadline for restoring the required values or values contracted for. System user shall decrease the detrimental effect within the required values or values contracted for.

(9) If the detrimental effect of the system user facility and installation produces damage to the equipment of the Distribution System Operator and other users for a time period exceeding a given deadline, Distribution System Operator has the right to temporarily disconnect a system user.

(10) Distribution System Operator shall, to the owners of generating sets for auxiliary supply, issue a special connection approval where the technical conditions for the set's operation shall be defined. The owner of the generating set for auxiliary supply shall secure protection from return supply.

(11) If the owner of the generating set for auxiliary supply does not implement the required measures, Distribution System Operator shall have the right to temporarily disconnection him.

(12) In the event that generating sets for auxiliary supply produce damage in the distribution system, user installations and facilities, the owners of the generating sets for auxiliary supply shall be responsible for all the damage incurred.

5.3.5 Special requirements for the connection of generating units

(1) In addition to the general requirements referred to in paragraphs 5.3.1. to 5.3.4 above, special, and if required additional requirements for the connection of generating units to the system shall be met.

(2) Connection point, connection voltage level, technical and operating conditions shall be defined by the Distribution System Operator in accordance with the General conditions for electricity supply and this Grid Code.

(3) Connection of a power station shall not increase short-circuit currents above the permissible level of breaking current of equipment in the system.

5.3.5.1 Categories of generating units

(1) Generating units, that is power stations to be connected to the distribution system pursuant to this Grid Code are divided into the following categories:

- According to the nominal connection level:
  - Connected to the low voltage network,
  - Connected to the medium voltage network,
- According to the nominal capacity of the power station:
  - Power stations the capacity of which exceeds 5 MW,
  - Power stations with the capacity below or equal to 5 MW,
  - Micro power stations,
- According to the type of primary source of energy:
  - Hydro power stations,
  - Solar power stations,
  - Biomass fired power stations,
  - Communal waste fired power stations,
  - Wind farms,
  - Other power stations and CHPPs.

(2) Power stations of the total capacity of up to and including 500 kW are connected to the low voltage network. They can be connected to the low voltage line or low voltage busbars of the

10(20)/0.4 kV transformer station. Power station of the total capacity of up to and including 100 kW can be connected to the low voltage network.

(3) Power stations of the total capacity in the range of 500 kW up to and including 10 MW are connected to the medium voltage network (10, 20, 30 and 35 kV). Power stations of lower capacity can be connected to the medium voltage network as well.

(4) Power station limit value is defined based on the following criteria:
- Installed capacity of the transformer supplying the appurtenant network,
- Short-circuit current in that part of the network,
- Parameters for the line which the power station is to be connected to,
- Network status and its expected development, and
- Other technical and operating conditions in the system.

5.3.5.2 Parallel operation with the system

(1) Power station shall be equipped for parallel operation with the distribution system in normal, as well as extraordinary operating conditions, without unacceptable detrimental effect on the distribution system and other system users.

(2) Parallel operating conditions shall be secured by mutually coordinated protection of the power station and that of the distribution system. In the event of deviation from the required prerequisites for parallel operation, protection shall disconnect a power station from parallel operation. Protection tripping values shall be so set as to enable stable operation of both, the distribution system and the power station, even after the disconnection (if the power station is specified for island operation).

(3) Connecting a power station with synchronous generators in parallel operation with the distribution system requires the use of synchronizers, under the following conditions:
- Voltage difference below ±10% of the nominal voltage,
- Frequency difference below ±0,5 Hz (for wind farms: ±0,1 Hz), and
- Difference of phase angle below ±10 degrees.

Wind farms with asynchronous generating sets shall, prior to connection to the distribution system, achieve rotation speed within the range of $\pm$ 5% in relation to the synchronous speed.

(4) At the power station – distribution system interface a disconnector shall be installed, which shall enable disconnection of the power station facility from parallel operation with the distribution system. Disconnector management shall be under the exclusive competence of the Distribution System Operator, and the access to the disconnector and the appurtenant equipment and devices shall be made available to the operating personnel of the Distribution System Operator.

(5) Asynchronous connection of the power station to the distribution system shall be rendered impossible via the disconnector.

(6) In addition to active power generation and supply, a power station shall generate a sufficient quantity of reactive power and inject it in the system. Reactive power generation shall be within the range of $\cos \varphi = 0{,}85$ inductively to $\cos \varphi = 1$, except for solar power stations of which this is not required, and for wind farms with asynchronous generating sets which have been dealt with in the additional requirements (paragraph 5.3.6.3., subparagraph 4).

(7) Distribution System Operator shall permit a generator isolated operation provided that the requirements for such operating mode have been satisfied. In this case, Distribution System Operator and a generator shall conclude an operation management agreement.

(8) In power stations of the total capacity above 100 kW, power/frequency regulator shall be so equipped and adjusted to maintain sudden power change during load and load shedding below 10% of the capacity.

(9) If during power station operation circumstances should occur that would result in voltage deviation of over ±10% of the nominal voltage and/or frequency of above 51 Hz or below 48 Hz, power station shall immediately be disconnected from the distribution system.

(10) In the event that a power station is connected to the system with auto-reclosure, power station shall have a technical solution for protection from potential asynchronous operation.

(11) Power station and its connection to the system shall secure limited detrimental effect of the power station in parallel operation with the system, specifically regarding the following:

- Short term voltage change at power station connection and disconnection,
- voltage oscillation (flickers),
- higher harmonics in current and voltage,
- disruption of the remote control system, and
- disruption of the sound frequency management.

(12) Detrimental effect shall be in the acceptable range at all times. If it is above the acceptable values, Distribution System Operator has the right to terminate parallel operation of the power station with the system by opening a disconnector.

(13) For parallel operation of a power station with the system a power station shall have the following:

- Protection securing parallel operating conditions,
- Protection from disturbances and faults in the power stations,
- Protection from disturbances and faults in the system.

5.3.5.3 Connection and operation of a generating unit

(1) Supervision of the management of the parallel operation of a power station and the system is defined in the Use of System Agreement and/or Operation Management Agreement.

(2) Generator is responsible for the functionality of a power station, and especially for the system that secures parallel operation with the network. In the event of a disturbance in a power station operation, or temporary inability to operate, generator shall notify the Distribution System Operator.

(3) Protection equipment that guarantees parallel operation with the system, as well as accounting point equipment, shall be sealed by the Distribution System Operator.

(4) In the course of power station operation the following data shall be made available to the Distribution System Operator:

- Power station operating status,
- Electricity injection in the system,
- Electricity withdrawal from the system,
- Position of disconnecting switches,
- Implemented earthing and short-circuiting,
- Other data (depending on the power station capacity and importance).

The above state data shall be made available to the Distribution System Operator either over the telephone or via the remote control system. Distribution System Operator may require that remote data transfer and remote control via disconnector be secured for power stations connected to the medium voltage system.

(5) Distribution System Operator shall notify a generator about the interruption or a limitation of electricity withdrawal from a power station.

(6) Following each change in the system or a power station, which may have an effect on parallel operation, analysis of protection operation shall be made, and protection shall be coordinated and adjusted anew if necessary. Once a year inspection, testing and calibration of protection equipment and devices securing parallel operation shall be conducted. Generator shall send the reports on the conducted inspection, tests and calibration to the Distribution System Operator.

(7) Generator shall file a written request to the Distribution System Operator requiring first connection of a power station in parallel operation with the system, for the purpose of testing the station in actual operating conditions. In addition to the request, generator shall enclose reports on the implemented functional testing proving proper operation of all operation and protection management functions, as well as previously agreed testing program during trial run.

(8) During a trial run of the power station the following tests shall be conducted:
- Testing the entry into parallel operation with the distribution system,
- Testing the exit from parallel operation and switching onto island operation (if it is so specified),
- Testing the tripping of protection at deviation from parallel operating conditions,
- Testing power station operation at borderline operating values,
- Testing the active and reactive power flows (generation and power station – system interchange),
- Checking the contracted nominal values at the gate of the power station, especially for active and reactive power,
- Testing power station operation as regards meeting the requirements for limited detrimental effects,
- Testing the impact of supplementary power station facilities (if there are any) and the system on parallel operation and limited detrimental effect,
- Testing the system of operating and accounting measurements, status monitoring, signalization, local and remote (if there is one) control and regulation,
- Other testing foreseen by the equipment supplier or the testing program.

(9) Tests of the power station operation with regard to meeting conditions for limited detrimental effect on the system and electricity quality shall be conducted on the interface with the system, and shall encompass the following parameters:
- Frequency,
- Voltage change depending on load change,
- Short-term and long-term flickers,
- Switching overvoltages,
- Voltage asymmetry,
- signal damping in system sound-frequency management
- higher harmonics in power and current,
- total harmonic distortion factor for current and voltage,
- power factor.

(10) Following the implementation of tes tsin trial run, a report on the testing shall be devised, where observed flaws or limitations in operation management shall be listed, as well as the obligation of their elimination. The final report on functional testing of parallel power station operation shall unambiguously state a power station's readiness for permanent operation.

5.3.6 Additional technical requirements for the connection of generating units

5.3.6.1 Additional technical requirements for the connection of power stations of up to 5 MW of capacity

Technical requirements for the connection of generating units, that is power stations of the total nominal capacity below of equal to 5 MW, shall be passed by the Distribution System Operator.

5.3.6.2 Additional technical requirements for the connection of power stations with the capacity exceeding 5 MW

(1)Technical requirements for the connection of power stations with the capacity exceeding 5 MW shall be passed by the Distribution System Operator, after having obtained prior consent of the Transmission System Operator.

(2) Power stations in the distribution system that the Transmission System Operator defines as important for system operation, shall meet special criteria, and if required additional criteria specified in paragraph 4.3.4. as well. For each such power station a system services agreement shall be signed between the Transmission System Operator and generator.

5.3.6.3 Additional technical requirements for the connection of wind farms of up to 5 MW of capacity

(1) Emissions of flickers P_{st} and P_{lt} caused by wind farm operation shall not violate permissible limitations, neither in the short-term (st) nor in the long-term (lt) period, in accordance with the expressions below:

$$P_{st} \leq 0.35$$

$$P_{lt} \leq 0.25$$

(2) Relative voltage changes d caused by the wind farm operation shall be limited in accordance with the following expression:

$$d \leq \frac{\Delta U_{dyn}}{U_n}$$

Permissible limit values of voltage change for the nominal value of 35 kV and lower are the following:

r (1/hour)	$\Delta U_{dyn} / U_n$ (%)
$r \leq 1$	4
$1 < r \leq 10$	3
$10 < r \leq 100$	2
$100 < r \leq 1000$	1.25

(3) Emission of odd harmonic currents shall not exceed the values below:

Odd harmonics, *h*	Limitation of the emission of harmonic currents with regard to nominal current
h < 11	4.0 %
11≤ h <17	2.0 %
17≤ h <23	1.5 %
23≤ h <35	0.6 %
35≤ h <50	0.3 %
Total harmonic distortion factor (THD)	5.0 %

Within the same frequency range, emission of even harmonic currents shall not exceed 25% of the above values.

(4) Power factor of wind farms with synchronous generating sets shall be within the limits given in paragraph 5.3.5.2., subparagraph 6, while wind farms with asynchronous generating sets shall be self-compensated, by having the average power factor of 1, with maximum deviation of 0.1, both, inductively and capacitatively.

(5) Wind farms of up to 250 kW of capacity shall be connected to the low voltage system.

(6) Island operation of wind farm with a part of the distribution system to which it is connected shall not be allowed.

5.3.6.4 Additional technical requirements for the connection of micro power stations

(1) Technical requirements for the connection of micro power stations shall be passed by the Distribution System Operator.

(2) Micro power stations are those power stations that meet the following criteria:
- Connected to the low voltage system (single-phase and three-phase),
- Connected within a customer facility,
- Electricity generation intended for auxiliary consumption,
- Electricity surplus is injected in the system,
- Total nominal capacity of up to and including 5 kW for a single-phase connection,
- Total nominal capacity of up to and including 30 kW for a three-phase connection.

(3) A micro power station shall meet the following minimum criteria at the interface with the system:
- Measuring peak load in direct measuring,or measuring load curve, including the possibility of remote data collection in semi-direct metering,
- Active and reactive power metering in both directions,
- Possession of a disconnector.

(4) Other technical and operating conditions shall be defined by the Distribution System Operator depending on the primary energy form, micro power station technology, as well as the consuption type and category.

5.3.7 Information interchange at the interface

(1) In the procedure of issuing connection approval, system user shall secure minimum technical documentation and data pursuant to Chapter 7 of this Grid Code and General conditions of electricity supply.

(2) Information interchange at the interface set out in the connection approval pursuant to paragraph 5.1.5.3. of this Grid Code is a component part of the Use of System Agreement and/or Operation Management Agreement.

(3) Information shall be used and exchanged in accordance with the principle of confidentiality and transparency.

6 METERING CODE

(1) Metering Code sets out minimum requirements for metering, collection and exchange of the metered electricity parameters in accounting points in the transmission and the distribution system for the purpose of enabling transparent and non-discriminatory relations among electricity market participants in the Republic of Croatia.

(2) Metering Code applies to the following accounting points:
- Of generators,
- Of eligible customers,
- At the interface between the transmission and the distribution system,
- Of interconnecting lines.

(3) Metering Code sets out the following:
- Responsibility of energy undertakings,
- Technical and operating characteristics of metering equipment,
- Metering devices' accuracy,
- Approval and certification of metering devices,
- Provision of metering services.

6.1 Responsibilities of energy undertakings

(1) The Transmission System Operator and the Distribution System Operator are responsible for the performance of metering services.

(2) Transmission System Operator is in charge of the following metering services:
- On interconnecting lines,
- In all accounting points of customers connected to the transmission system,
- In all accounting points of generators connected to the transmission system, procurement and installation of accounting point's equipment excluding,
- In accounting points at the interface with the Distribution System Operator.

(3) Distribution System Operator is in charge of the following metering services:
- In accounting points of customers connected to the distribution system,
- In accounting points for the supply of the Transmission System Operator's and generators' auxiliary consumption,
- In all accounting points of the generators connected to the distribution system, procurement and installation of accounting point's equipment excluding.

(4) Responsibility of a generator as regards metering services is limited to procurement and installation of metering equipment at the interface with either the Transmission System Operator or the Distribution System Operator, and to meeting the requirements pursuant to the General conditions of electricity supply, this Grid Code and Technical requirements of either the Transmission System Operator, or the Distribution System Operator.

6.2 Accounting point

(1) Energy undertaking responsible for metering services shall, in the connection approval cover all requirements referred to in the General conditions of electricity supply, this Grid Code and Technical requirements for an accounting point.

(2) Metering equipment located on customer's site is the property of either the Transmission System Operator, or the Distribution System Operator.

(3) Metering equipment located on generator's site is the property of the generator.

(4) Accounting point shall be accessible and located as close as possible to the point of connection to the system.

(5) Customer with more than one accounting point in a building unit, can have simultaneous recording of power in accordance with the requirements referred to in the connection approval.

(6) In addition to the accounting points this Metering Code provides for a collective accounting point wherein data from a number of accounting points is processed and expressed in figures resulting from special agreements closed between market participants, and relating to the settlement/exchange of data.

(7) Should inaccuracy be observed or should a suspicion in the proper equipment operation in an accounting point arise, system user or a supplier shall act pursuant to the General conditions of electricity supply and this Grid Code.

6.2.1 Metering equipment

(1) The structure and characteristics of metering equipment shall be defined by either the Transmission System Operator or the Distribution System Operator as authorized, and shall be established by Technical requirements for accounting points.

(2) Energy undertaking responsible for metering services shall take care of the accounting point's records.

(3) Metering equipment shall be located either in metering cabinets or elsewhere, but its location shall meet the requirements. Equipment shall be so located to be protected from inappropriate temperature conditions, humidity and dust, as well as damage, vibration and other effects.

(4) Meters, tariff control devices, fuses connecting clamps and type plates of measurement transformers, as well as other system users' equipment that may have an impact on metering and/or settlement of electric energy/power shall be sealed.

(5) Energy undertaking responsible for metering services shall seal and/or lock metering cabinets.

(6) Each sealing procedure shall be recorded in an official document issued by either the Transmission System Operator or the Distribution System Operator and shall be signed by the responsible person of the operator and the user.

(7) The seal shall be so placed as to prevent any influence on metering and/or settlement of electric energy and/or power, provided it remains intact.

(8) On the chance of unauthorized direct or remote computer access to metering data, access to equipment in the accounting point shall be protected by special passwords and safety controls as follows:

- For reading metering data,
- For changing time and date,
- For programming display, tariff programs and other functions,
- For setting communication parameters.

(9) Metering equipment consist of the following:

a) Metering devices:
   - Electricity meters,
   - Measurement and current transformers,
   - Timers.

b) Measurement and connecting lines and sockets.

c) Fuse devices:
   - Main current limitation device (fuses or automatic switch-disconnectors),
   - Fuse elements for the protection of metering, control and communication devices,

- current load limiter.

d) Tariff management devices:
   - Timers,
   - Remote tariff control devices,
   - Computer equipment for tariffing.

e) Communication devices and media:
   - Devices for remote transmission of measured values,
   - Communication media (one's own and/or rented twisted pairs, fiber optic cable, radio link, GSM and other links).

f) Overvoltage protection devices and communication devices.

g) Other devices:
   - Medium power recorders,
   - Total settlement value recorder,
   - Auxiliary relays,
   - Feeding units,
   - Feeding or disconnecting transformers,
   - Indicators,
   - Metering cabinets.

6.2.1.1 Electricity meters

(1) The value of maximum meter current of electricity meters for direct metering at low voltage shall be equal or higher than that of the connecting capacity current.
(2) Electricity meters for indirect and semi-direct metering shall enable metering of secondary measruement values of measurement transformers.
(3) Meters shall have energy direction indicators.
(4) In accounting points where bi-directional metering is required, meters shall meter and show energy flows in both directions.
(5) Induction meters for both, active and reactive power metering shall have a rotor lock installed to prevent it from spinning in the opposite direction.
(6) Electricity meters differ:

a) according to type of electricity they measure:
   - Active power meters,
   - Reactive power meters,
   - Active and reactive power meters.

b) Technologically:
   - electro mechanic,
   - electronic.

c) According to measurement of primary and/or secondary metering values:
   - For direct metering,
   - For semi-direct metering via current transformers,
   - For indirect metering via current and voltage transformers,
   - For universal metering (semi-direct or indirect).

d) According to metering direction:
   - For active power metering:
     - Uni-directional,
     - Bi-directional,
   - For reactive power metering:
     - Uni-directional,

- Bi-directional,
- in 4 quadrants.

e) According to accuracy class:
- For active power metering:
  - 2 or higher for direct metering,
  - 1 or higher for semi-direct metering,
  - 1 or higher for indirect metering,
- for reactive power metering:
  - 3 or higher.

f) According to a meter connection type:
- Four-wire, three-phase,
- Three-wire, two-phase,
- Two-wire, single-phase.

g) According to tariff control method:
- With external control,
- With a timer or a remotely controlled receiver.

h) According to a type of communication:
- Via optical interface,
- Via wire interface.

i) According to other characteristics:
- Measuring peak load as a medium power value of an accounting interval,
- Storing a set of measured values for integration in the load curves,
- Cyclical presentation of basic accounting values and meter parameters on the display,
- Subscription function,
- Meter self checks (Watch-dog),
- indication of phase asymmetry or defective connection,
- indication of impermissible operations,
- storing electricity quality parameters (number and duration of interruptions of supply, total harmonic distortion factor, etc.).

(7) Remote meter reading and parametring can be conducted via:
- Analogous telephone network (PSTN),
- Digital telephone network (ISDN),
- Digital mobile telephone network (GSM),
- Digital network (LAN/WAN),
- Energy network (PLC).

(8) Interval meter and/or other metering equipment with the function of storing and processing measured values shall, especially in load curve design, secure the following:
- Appropriate capacity for storing records of medium active and reactive power values,
- In the event of voltage loss the device shall store all data and keep recording time and dates even with no electricity supply, for at least 30 days,
- The logger reading procedure by the system for the collection of metering data shall not delete nor alter logged data,
- Collection of all data stored in the device, upon request of the system for the collection of metering data,
- Metering data shall be stored in the interval meter or a logger,
- Meters shall send metering data to the logger via impulse outlets, and shall have an outlet for each value measured.

(9) Only electricity meters with type approval and effective verified seal shall be installed in accounting points of the system operated by the Transmission System Operator and the Distribution System Operator.

6.2.1.2 Current and voltage transformers

(1) Current transformers are used in semi-direct and indirect electricity metering, while voltage transformers are used in indirect electricity metering only.
(2) In semi-direct and indirect measurement current transformers shall be unswitchable and primarily switchable.
(3) Secondary nominal current of the current transformer shall be 5 A or 1 A.
(4) Accuracy class of voltage transformers' measurement core or winding shall be 0.5 or higher, and the safety factor of current measurement cores shall be 10 or below.
(5) If additional devices (ampere meters, watt meters etc.) are connected to current transformers measurement transformers with multiple measurement cores shall be installed, where one core shall be used for measurement of accounting values, while others shall be used for additional devices.
(6) Only accounting values metering devices shall be connected to the voltage transformers at system user's site.
(7) Access to measurement transformers performing accounting measurements shall be protected from misuse by primary switching, fuse removal, opening of the measurement field disconnector or distribution of secondary circuits influencing measurement accuracy.
(8) Only measurement transformers with type approval and effective verified seal shall be used in the accounting points of the network operated by the Transmission System Operator and the Distribution System Operator.

6.2.1.3 Tariff control devices

(1) Tariff control devices in interval meters shall be synchronized and set on Central European Time.

(2) Timers in other meters shall be set on Central European Time, and shall not be moved one hour forward with the beginning of Daylight Savings Time.

(3) Outlet contact of the tariff control device shall not be managed by other devices.

(4) Tariff control device with single outlet contact may exceptionally be managed by other devices, however only through the auxiliary relay, that shall have to be sealed for protection by either the Transmission System Operator or the Distribution System Operator.

(5) Meter control outlets may exceptionally be used for management of other devices provided that neither the Transmission System Operator, nor the Distribution System Operator need them, and provided it is agreed with the system user.

(6) Timers shall have type approval and effective verified seal.
(7) Other tariff control devices shall be in accordance with technical requirements for accounting points.

6.2.1.4 Data loggers

Data logger shall have the following characteristics:

- Installed unit for correct time keeping and the possibility of remote synchronization,
- Possibility of data storage in the chosen accounting interval,
- Possibility of storing medium power or meter face status in the chosen accounting intervals,
- Shall have a logger unit for data storage for the period of at least 30 days,

- Possibility of remote and local communication (parametering and logger reading, knowledge of the password as a prerequisite),
- Possibility of data storage and correct time keeping for a period of at least 30 days after the loss of auxiliary supply,
- Possibility of data collection through impulse outlets and/or direct communication with the meter,
- Shall contain time and date display,
- Possibility of local parametering of devices, acceptance and deleting of alarms,
- Shall have a logger unit for its own alarms and alarms retrieved through direct communication with meters,
- Shall contain standard interfaces for simultaneous remote and local communication.

6.2.2 Characteristics of metering devices

(1) Meters in an accounting point at the system user location shall have at least the following standard characteristics and shall be of the following accuracy class:

a) At low voltage level for all customers with connection capacity of up to 30 kW:
   - Direct metering,
   - Active power meter, accuracy class 2.

b) At low voltage for all customers with connection capacity exceeding 30 kW in direct metering:
   - Active power meters, accuracy class 1; reactive power meters, accuracy class 3,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

c) At low voltage for all customers with connection capacity exceeding 30 kW in semi-direct metering:
   - Current transformer, accuracy class 0.5, safety factor 5,
   - Active power meter, accuracy class 1, reactive power meters, accuracy class 3,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

d) At medium voltage for all customers with annual consumption of up to 25 GWh:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.5,
   - Current transformers, accuracy class 0.5, safety factor 5,
   - Active power meters, accuracy class 1; reactive power meters, accuracy class 2,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

e) At medium voltage for all customers with annual consumption exceeding 25 GWh:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.5,
   - Current transformers, accuracy class 0.5, safety factor 5,
   - Active power meters, accuracy class 0.5S; reactive power meters, accuracy class 1,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

f) At high voltage for all customers:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.2,
   - Current transformers, accuracy class 0.2, safety factor 10 or less,
   - Active power meters, accuracy class 0.5S; reactive power meters, accuracy class 1,
   - Storing load curves,

- Data collection via system for the collection of metering data.

(2) Meters in accounting points at generator site shall have at least the following standard characteristics, and shall be of the following accuracy class:

a) At low voltage, direct metering:
   - With peak capacity metering,
   - Active power meter, accuracy class 1 with bi-directional metering, reactive power meter, accuracy class 2 with bi-directional metering in four quadrants.

b) At low voltage, semi-direct metering:
   - Current transformer, accuracy class 0.5, safety factor 5,
   - Active power meters, accuracy class 1 with bi-directional metering, reactive power meters, accuracy class 2 with bi-dimensional metering in four quadrants,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

c) At medium voltage for all generators with connection capacity of up to and including 5 MW:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.5,
   - Current transformers, accuracy class 0.5, safety factor 5,
   - Active power meters, accuracy class 1 with bi-directional metering, reactive power meters, accuracy class 2, with bi-dimensional metering in four quadrants,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

d) At medium voltage for all generators with the connection capacity exceeding 5 MW:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.5,
   - Current transformers, accuracy class 0.5, safety factor 5,
   - Active power meters, accuracy class 0.5S with bi-directional metering, reactive power meters, accuracy class 1, with bi-dimensional metering in four quadrants,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

e) At high voltage for all generators:
   - Indirect metering,
   - Voltage transformers, accuracy class 0.2,
   - Current transformers, accuracy class 0.2, safety factor 10 or less,
   - Active power meters, accuracy class 0.2S with bi-directional metering, reactive power meters, accuracy class 1, with bi-dimensional metering,
   - Storing load curves,
   - Data collection via system for the collection of metering data.

(3) Equipping accounting points at the interface between the Transmission System Operator and the Distribution System Operator at medium and high voltage:

- Indirect metering,
- Voltage transformers, accuracy class 0.2,
- Current transformers, accuracy class 0.2, safety factor 10 or less,
- Active power meters, accuracy class 02.S with bi-directional metering, reactive power meters, accuracy class 1, with bi-dimensional metering,
- Storing load curves,
- Data collection via system for the collection of metering data.

6.3 Approval and certification

(1) Metering devices in an accounting point shall have a valid official sign, valid certification seal or valid certificate of meeting the metering requirements. The seal of the year of certification shall be either for the current or the preceding year. Measurement transformers shall have only the first certification.
(2) Energy undertaking responsible for metering services shall use metering devices in accordance with the standards and technical regulations.
(3) Energy undertaking responsible for metering services shall keep a report on the testing of metering devices in accounting points on high and medium voltage until its expiry.
(4) Energy undertaking responsible for metering services shall, upon written request of a supplier or a system user, submit a report on the testing of metering devices in accounting points on medium and/or high voltage.

6.4 Metering services

(1) Metering services provided by either the Transmission System Operator or the Distribution System Operator to system users are the following:
- Equipment maintenance in accounting points, including replacement,
- Certification of metering devices in accounting points,
- Collection of metering data from accounting points,
- Verification and validation of metering data,
- Management and storage of metering data,
- Keeping records from accounting points.

(2) Metering services provided by either the Transmission System Operator or the Distribution System Operator to generators are the following:
- Equipment maintenance in accounting points, the cost shall be borne by the generator,
- Certification of metering devices in accounting points, the cost shall be borne by the generator,
- Collection of metering data from accounting points,
- Verification and validation of metering data,
- Management and storage of metering data,
- Keeping records from accounting points.

(3) Metering services at the interface between the transmission and the distribution system provided by the Transmission System Operator are the following:
- Equipment maintenance in accounting points, including replacement,
- Certification of metering devices in accounting points,
- Collection of metering data from accounting points,
- Verification and validation of metering data,
- Management and storage of metering data,
- Keeping records from accounting points.

(4) System users shall pay adequate use of metering services charge to either the Transmission System Operator or the Distribution System Operator.

6.4.1 Procurement, installation and replacement of metering equipment

(1) Procurement, installation and replacement of metering equipment is defined in the General conditions of electricity supply, Regulations on the connection charge and connection capacity increase and the provisions of this Grid Code.

(2) Transmission System Operator or Distribution System Operator shall procure and install the metering equipment in the process of customer connection to the system.

(3) Replacement, including procurement, of metering equipment on customer's location in the period of its use, shall be performed by either the Transmission System Operator or the Distribution System Operator.

(4) Customer may require installation of a meter with a greater number of functions and/or better performance characteristics in relation to the standard meters installed by the energy undertaking responsible for metering services. Energy undertaking responsible for metering services shall install required equipment, pursuant to the General conditions of electricity supply and technical requirements for accounting points.

(5) Accounting point shall be so constructed to enable access to persons responsible for its testing, adjustment, maintenance, repair, replacement or reading, and the user shall create that access.

(6) Metering equipment shall be installed in accordance with the technical requirements for accounting points.

6.4.2 Maintenance

Energy undertaking responsible for metering services shall maintain metering equipment in accordance with relevant regulations, General conditions of electricity supply, this Grid Code and equipment status.

6.4.2.1 Defectiveness and repair

(1) Customer and/or his supplier, as well as a generator shall, as soon as possible, notify energy undertaking responsible for metering services, of the observed connection damage, damage to, defectiveness or theft of a meter and/or other metering equipment, removal of or damage on the seal, or damage on the metering cabinet.

(2) Should the energy undertaking responsible for metering services detect defectiveness of metering equipment he shall either repair or replace it as soon as possible, and shall notify the supplier and the system user of it in writing.

(3) System user is responsible for connection damage, damage to, defectiveness or theft of a meter and/or other metering equipment, removal of or damage on the seal, or damage on the metering cabinet installed on the system user's location. In such cases system user shall bear the cost of repair or procurement of new devices.

6.4.2.2 Control testing

(1) Customer and/or its supplier as well as generator may require control testing of metering device and/or other metering equipment from the energy undertaking responsible for metering services in writing or electronically, if doubting the accuracy of electricity metering, pursuant to the General conditions of electricity supply.

(2) Should control testing establish that the deviation of the metering device and/or other metering equipment of the system user exceeds the values permissible pursuant to effective

regulations or that they are defective, energy undertaking responsible for metering services shall bear the cost of control testing and device replacement in the accounting point.

(3) Should control testing establish that the deviation of the metering device and/or other metering equipment of the generator exceeds the values permissible pursuant to effective regulations or that they are defective, energy undertaking responsible for metering services shall bear the cost of control testing, while the cost of procurement and installation of replacement equipment in the accounting point shall be borne by the generator.

6.4.3 Certification

(1) Energy undertaking responsible for metering services shall provide periodical certification of metering devices.

(2) Certification can either be conducted so as the entire metering device is covered, or by employing the stochastic method, based on the prescribed conditions.

6.4.4 Collection of metering data

(1) Energy undertaking responsible for metering services shall be responsible for the collection of metering data from accounting points.

(2) Energy undertaking responsible for metering services shall set up a system for the collection of metering data in accordance with the dynamics of the electricity market opening and pursuant to the Electricity Market Act (*Official Gazette*, no. 177/04).

(3) Energy undertaking responsible for metering services shall undertake all required measures for timely collection of metering data in appropriate accounting intervals.

(4) Energy undertaking responsible for metering services shall collect metering data for system users by reading meters in accounting points, by employing:

- indirect meter reading,
- remote reading of metering data.

Accounting intervals following meter reading in an accounting point are defined in the General conditions of electricity supply, Electricity Market Rules and electricity supply agreements.

(5) System for the collection of metering data shall be synchronized and set on Central European Time.

6.4.5 Checking and confirming the validity of metering data

(1) Energy undertaking responsible for metering services is responsible for checking the data retrieved, and confirms their validity by storing them in the metering data base. Data thus stored are considered to be final and are used for settlement and other purposes.

(2) A check of metering data retrieved via direct meter reading covers the following:

- Checking of the accounting point's identification code,
- Comparison of data retrieved with the previously stored metering data for the purpose of checking the acceptability of metering data,
- Use of automatized calculation procedures to check and confirm metering data,
- Confirmation of the validity of metering data by storing them in the metering data base.

(3) A check of metering data retrieved via remote meter reading covers the following:

- Inspection and analysis of the retrieved metering equipment status alarms,
- Procedure for checking validity of measurements,

- Confirmation of the validity of metering data by storing them in the metering data base.

(4) Collection of data referred to in subparagraph 3 herein is not valid if any of the following is true:

- accounting point's identification code is not correct,
- data from the data logger cannot be retrieved,
- communication with the data logger is not possible,
- it was established that the data logger parameters are different from the initially set parameters.

(5) In the event of invalid remote collection of metering data referred to in subparagraph 4 herein, energy undertaking responsible for metering services shall collect the metering data through direct meter reading as soon as possible.

(6) In the event there are differences between data stored in the accounting point's equipment and data in the metering data base retrieved via meter reading, data stored in the accounting point's equipment shall supersede those stored in the metering data base.

6.4.6 Metering data management

(1) Energy undertaking responsible for metering services is responsible for managing the retrieved and confirmed metering data.

(2) Management of the metering data covers the following:

- Storing and keeping confirmed metering data in the metering data base,
- Validation and replacement of metering data,
- Processing of confirmed metering data for the purpose of settlement and collection,
- Securing availability of processed metering data for the purpose of settlement and collection,
- Securing availability of metering data for the purpose of analysis, planning as well as other purposes.

6.4.6.1 Accounting point's database

(1) Accounting point's database shall contain metering data, general data on the accounting point, data on metering equipment and data on communication equipment.

(2) Data from the accounting point's database shall be stored for at least two years and shall be in a filing format for at least the following five years. In the event of a dispute, data shall be stored until it is settled.

6.4.6.1.1 Metering data

(1) Metering data base shall enable the following:

- Insight into records of accounting points,
- Checking and confirmation of metering data validity,
- Marking of changed data,
- Processing of retrieved metering data,
- Data exchange.

(2) Metering data consist of all measured and estimated data, and the resulting values.

(3) Metering data cover the following:

- Metered, time-dependant values of active and reactive power retrieved from the accounting point's equipment
- Values calculated from the metered data, processed by the energy undertaking responsible for metering services,
- Estimated or replaced data in the event of missing or incorrect data,
- Data used for settlement and other purposes.

(4) Metering data shall be retrieved, processed and stored so as to remain safe and confidential.

6.4.6.1.2 Data collected in accounting points

(1) General data collected in accounting points are the following:
- Data on system user,
- Address and position,
- Number of connection approval,
- Connection capacity,
- Data on metering values,
- Data on the user's responsible person,
- Other general data.

(2) Data on metering equipment contain the following:
- Administrative data (identification code, etc.),
- Name of manufacturer,
- Type, serial number, year of manufacturing, and accuracy class,
- Data from the technical specification (nominal and maximum values, nominal auxiliary voltage, ratio of voltage and current transformers, current transformer's connection, etc.),
- Impulse contact values of the impulse outlet,
- Data on the set device parameters,
- Year of certification,
- Official mark for the meter type,
- Other data.

(3) Data in the communication equipment contain the following:
- Equipment name,
- Name of manufacturer, type, serial number and technical specification,
- Title of communication protocol,
- Telephone numbers,
- User identification and access clearance,
- Passwords for reading and/or data input,
- Other data.

6.4.6.2 Identification code

(1) Each accounting point is assigned an identification code in accordance with the identification scheme of a corresponding European association.

(2) Each market participant is assigned a special sign, within the identification code, for its identification on the electricity market.

6.4.6.3 Estimating and replacing data

(1) Should the energy undertaking responsible for metering services detect equipment damage or defectiveness above the permissible value, or unauthorized electricity use, metered data shall be estimated, and data retrieved shall be replaced by the estimated data.
(2) Estimate and replacement of data shall be performed by the energy undertaking responsible for metering services, pursuant to General conditions of electricity supply.
(3) Following the data estimate and replacement influencing electricity accounting at user location, energy undertaking responsible for metering services shall notify the supplier or system user on the amount of estimated data and their replacement, in writing or electronically.
(4) All appurtenant documentation in the data estimation and replacement procedure, as well as the sent notices, shall be filed for at least two years, and in the event of a dispute, until it is settled.

6.4.6.4 Access to data

(1) Energy undertaking responsible for metering services shall secure access to data pursuant to General conditions of electricity supply, Electricity Market Rules and this Grid Code.

(2) Distribution System Operator has the right to access metering data located with the Transmission System Operator, and relate to the accounting points on the interface between the transmission and the distribution system.

(3) Distribution System Operator shall, to the Transmission System Operator, secure access to metering data relating to the generators connected to the medium voltage distribution system.

6.4.6.5 Confidentiality and safety of data

(1) Energy undertaking responsible for metering services and Market Operator shall undertake reasonable measures for the protection of confidentiality and safety of metering data.

(2) Giving or enabling access to the metering data is allowed only under the conditions and for the purpose stated in this Grid Code, as well as other laws regulating the confidentiality and safety of metering data or upon the approval of a system user.

6.4.7 Ownership of data

Retrieved metering data, as well as the metering data base are the property of the energy undertaking responsible for metering services.

7 Technical documentation and the interchange of technical data (tabular presentation)

7.1 Minimum technical documentation for the connection to the transmission system

Facility / documentation	Beginning of negotiations on the transmission system connection agreement	Beginning of power station and switchyard construction	Beginning of the commissioning program	Power station/switchyard acceptance by the Transmission System Operator
1. Power station				
Basic technical data on a power station: - nominal active power - nominal apparent power - power station type	Concept description First issue of the technical documentation	Revised technical documentation	Revised technical documentation	Revised technical documentation
Location of power station facilities on site	First issue of the technical documentation	Revised technical documentation		Revised technical documentation
Single line diagram: - connection to transmission system - power station's auxiliary consumption with basic data on generator, unit transformer and auxiliary supply transformers	First issue of the technical documentation	Revised technical documentation	Revised technical documentation	Revised technical documentation
Generator output diagram		First issue of the technical documentation		Revised technical documentation
Chart of generating unit protection with settings and block diagram of the generating set control system		First issue of the technical documentation	Revised technical documentation	Revised technical documentation
All information required for analysis of steady and dynamic system states		First issue of the technical documentation	Revised technical documentation	Revised technical documentation
Power station-network communication devices		First issue of the technical documentation	Revised technical documentation	Revised technical documentation
Power station operation - basic/mean/peak load - planned active power schedule - planned reactive power schedule - deduction of heat for district heating Operation during network unavailability - safe tripping onto auxiliary supplies - black start capability	First issue of the technical documentation	Revised technical documentation	Power station commissioning program	1. Revised technical documentation 2. Acceptance testing 3. Monitoring and evaluating unit behavior under disturbance conditions
-Participating in frequency maintenance -Primary/secondary control - Minutes reserve -Power station participation in restoration of supply	First issue of the technical documentation		Power station commissioning program	Revised technical documentation Acceptance testing

2. Network				
Basic data on the network	First issue of the technical documentation	Revised technical documentation	Revised technical documentation	Revised technical documentation
Single-line diagrams - of the switchyard - network chart	First issue of the technical documentation	Revised technical documentation	Revised technical documentation	Revised technical documentation
Network protection chart with settings including back-up protection		First issue of the technical documentation	Network commissioning program	Revised technical documentation
Network operation: - envisaged reactive power use in normal operation - voltage maintenance plan in the event of a fault in the network - network operation restoration strategy	First issue of the technical documentation	Revised technical documentation	Revised technical documentation	Revised technical documentation
3. Technical and administrative procedure				
Information interchange Generator –Transmission System Operator (technical issues and contents)		First issue of the technical documentation	Revised technical documentation	Revised technical documentation

7.2 Interchange of technical data

7.2.1 Minimum scope of technical data interchange in the distribution system connection planning phase between the Distribution System Operator and a customer

Technical data	From the customer toward the Operator	From the Operator toward the customer	Voltage level		
			110 kV	MV	LV
Technical data for an accounting point		x	x	x	x
Layout of the accounting point	x		x	x	
Single line diagram of a system connection	x		x	x	
Chart of protective devices with settings	x		x	x	
Contribution to short circuit currents	x	x	x	x	
Detrimental return effect on the system	x		x	x	x
Filters, reactors and condensers	x	x	x	x	x
Maximum load (*P and Q*) in an accounting point	x		x	x	x
Technical requirements for customer facilities and installation, with telecommunication and metering devices		x	x	x	x
Min. and max. short-circuit three-phase current in an accounting point		x	x	x	

Monitoring a larger number of data is recommended, as required.

Customer shall submit other data relevant for analysis and calculation to the Distribution System Operator.

7.2.2 Minimum scope of interchanged technical data in the distribution system connection planning phase between the Distribution System Operator and a generator

Technical data	From the generator toward the Operator	From the Operator toward the generator	Voltage level		
			110 kV	MV	LV
Technical data for an accounting point	x		x	x	x
Layout of the accounting point	x		x	x	x
Single line diagram of a system connection	x		x	x	x
Active power	x		x	x	x
Apparent power	x		x	x	x
Generation schedule	x		x	x	x
Contribution to short circuit currents	x		x	x	
Filters, reactors and condensers	x	x	x	x	x
Chart of protective devices with settings	x	x	x	x	
Min. and max. short-circuit three-phase current in an accounting point		x	x	x	

Monitoring a larger number of data is recommended, as required.

Generator shall submit other data relevant for analysis and calculation to the Distribution System Operator.

7.2.3 Minimum required technical data exchange in the system connection planning phase between the Distribution System Operator and the Transmission System Operator

Technical data	From the Distr. Syst. Operator toward the Trans. Syst. Operator	From the Trans. Syst. Operator toward the Distr. Syst. Operator	Voltage level	
			110 kV	MV
Technical data for accounting point		x	x	x
Layout of the accounting point		x	x	x
Single line diagram of system connection		x	x	x
Chart of protective devices with settings		x	x	x
Contribution to short-circuit currents	x		x	x
Detrimental return effect on the system	x		x	x
Maximum load (P and Q) in accounting point	x		x	x
Single-line system diagram	x	x	x	x
System protection chart with settings including back-up protection	x	x	x	x
Layout of the feeding facility including the neutral point facility	x	x	x	
Min. and max. short-circuit three-phase currents in an accounting point		x	x	x
Data obtained from transient events recorder	x	x	x	x
Data obtained from devices for monitoring electricity quality	x	x	x	x
Data obtained from devices for relay protection operation selectivity control	x	x	x	x