# GRID CODE

March 2020

Pursuant to Article 116 of the Energy Law (Official Gazette of RS, no. 145/2014, no. 95/2018) and Article 28 of the Statute of Joint Stock Company Elektromreža Srbije Belgrade (Official Gazette of RS, no. 88/2016), the General Assembly at its 55 meeting held on 17.3.2020 has adopted the following:

# GRID CODE

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# CHAPTER 1: GENERAL PROVISIONS

## 1.1. SUBJECT MATTER OF THE GRID CODE

**1.1.1.** Rules set by the Grid Code (hereinafter referred to as the Code) regulate:

1) planning the development of the transmission system (development plan table of contents, planning method) and investment plan table of contents;
2) conditions for secure and reliable operation of transmission system;
3) technical requirements for connection and inter-connection to transmission system;
4) obligations of transmission system user required for secure and reliable operation of transmission system;
5) obligations of system user and transmission system operator in function testing;
6) contents of the Agreement on Use of facilities;
7) use and maintenance of facilities;
8) parameters and method of electricity quality control;
9) planning of the transmission system operation;
10) procedure for registration and confirmation of schedules of the balance responsible parties;
11) types and scope of ancillary and system services;
12) operative procedures and managing the transmission system under normal conditions and in the case of disturbances;
13) access to the transmission system, payment security instrument for system access payment and criteria for determining amount and period requested;
14) metering procedure and defining metering equipment;
15) training of operator personnel and transmission system users in the filed of operative procedures, with the aim of secure and reliable operation of transmission system;
16) other issues necessary for transmission system operation.

## 1.2. TRANSMISSION SYSTEM AND THE SCOPE OF APPLICATION OF THE CODE

**1.2.1.** Transmission system operator, in addition to transmission system, also manages a part of distributive system, which, as a rule, includes: 110 kV bus coupler bays, 110 kV line bays and 110 kV busbars, in accordance with the Categorization of the power system elements referred to in points 1.2.2-1.2.4.

**1.2.2.** 400 kV, 220 kV and 110 kV power system elements are normally classified depending on the voltage level of the facility and the element impact on the reliability of the transmission system and interconnection, according to the following general criteria of categorization into:

- the first group: the power system elements of 400 kV and 220 kV voltage level and 110 kV interconnection lines, with the associated bays;
- the second group: the power system elements of 110 kV that are important for reliable operation of power generation facilities and 110 kV interconnection lines;
- the third group: 110 kV power system elements that do not fall under the criteria

for the first and second group, which are managed by JSC EMS;

- the fourth group: the power system elements that are not managed by JSC EMS.

More detailed criteria of Categorisation are determined by JSC EMS.

**1.2.3.** JSC EMS creates document Categorization of elements 400 kV, 220 kV and 110 kV (hereinafter referred to as: the Categorization), which shall contain a list of all overhead transmission lines, transformer substations and switchyards, with full title, numbering and categorization of elements of the transmission system facilities and the transmission system users' facilities of 400 kV, 220 kV and 110 kV.

**1.2.4.** Apart form the very transmission system, the scope of application of the Code covers also the power system elements of 400 kV, 220 kV and 110 kV, classified under Categorization into the first, second or third group of the power system elements.

## 1.3. FORCE MAJEURE

**1.3.1.** JSC EMS shall be authorised to take measures in the event of force majeure during the application of the Code regardless of the JSC EMS will, i.e. the circumstances the occurrence of which could not be prevented, whereby the effects of these circumstances may result in altered technical requirements for the transmission system use and may cause damage to the transmission system users.

**1.3.2.** Measures referred to in Section 1.3.1. JSC EMS shall take the above measures in agreement with the transmission system users affected by revised technical requirements for use of the system. Immediately upon determining the possible methods to eliminate the consequences of force majeure, JSC EMS shall be obliged to notify the affected transmission system users and to suggest measures that can be taken and deadline in which said measures should be taken.

**1.3.3.** If JSC EMS and the user cannot reach an agreement on measures to be taken within the given time interval, JSC EMS shall decide on implementing the measures for the prevention or elimination of consequences of force majeure. JSC EMS is required to implement such measures that reduce the consequences for the users of the system to a minimum.

**1.3.4.** The transmission system user is required to abide by all the instructions issued by JSC EMS in order to implement appropriate measures in the course of force majeure.

**1.3.5.** JSC EMS is required to prepare a report on the implementation of measures in the event of force majeure, following the procedure for drafting special reports on the transmission system operation, which provides, inter alia, the causes of the occurrence of force majeure, the measures taken and consequences of force majeure. In accordance with the Code, the report shall be submitted, among other competent bodies, to the Commission for monitoring the implementation of the Grid Code.

**1.3.6.** No later than 45 days from the date of occurrence of force majeure, JSC EMS shall prepare and submit for review and compliance an initiative for amending the Code, for the purpose of regulating this issue.

## 1.4. COMMISSION FOR MONITORING THE IMPLEMENTATION OF THE GRID CODE

**1.4.1.** Commission for monitoring the implementation of the Grid Code (hereinafter the Commission) is an advisory body that:

- passes Rules of Procedure of the Commission;

- monitors the implementation of the Code;
- considers initiatives for amending the Code.

**1.4.2.** JSC EMS provides the conditions for the Commission work.

**1.4.3.** Members of the Commission are:

- 6 representatives of JSC EMS, one of whom acts as the Chairman of the Commission;
- 2 representatives of electricity producers whose facilities are connected to the transmission system;
- 1 representative of privileged electricity producers whose facility is connected to the transmission system;
- 2 representatives of the distribution systems operators;
- 1 representative of a closed distribution system operator connected to the transmission system;
- 1 representative of a public supplier;
- 2 representatives of suppliers;
- 2 representatives of end users whose facilities are connected to the transmission system.

**1.4.4.** Representative of the Energy Agency of the Republic of Serbia (hereinafter: Agency) participates the Commission work without voting and decision-making rights.

**1.4.5.** Member of the Commission who represents the group of transmission system users is appointed for a period of two years.

**1.4.6.** Within the group, the transmission system user's right to appoint a member of the Commission shall be determined by order of the list, compiled on the basis of:

- number of the permit issued by the Agency's Register of Issued Permits to the power producers, distribution system operators and suppliers;
- registration number in the Register of privileged electricity producers, kept within the Ministry of the Serbian Government responsible for energy;
- alphabetical order of the end users' facilities connected to the transmission system.

**1.4.7.** The Commission adopts Rules of procedure, regulating the working method of the Commission, specially:

- the procedure for convening regular and extraordinary sessions;
- the procedure for keeping and publishing the list of the transmission system users for each group, and the procedure for publishing the list of the Commission members;
- the procedure for the delivery of materials for the Commission session;
- the procedure for publishing the minutes of the Commission sessions;
- interpretation of the Rules of Procedure.

# CHAPTER 2: GLOSSARY

## 2.1. TERMS

**2.1.1.** The terms used in the Grid Code have the meanings defined by energy sector regulations, with the exception of:

ACTIVE POWER – Real part of conjugated complex product of voltage and current. This is the component of power that performs the desired operation on the consumption side.

GENERATION ADEQUACY – assesment of generating capacity within a certain area to secure the required electricity supply. Transmission system operator calculates the mid-term and short-term generation adequacy for its area according to the interconnection operation rules.

ALLOCATED CAPACITY – The total transmission capacity properly allocated to electricity market participants by the transmission system operator.

AUCTION OFFICE – Legal entity which provides contracted cross border capacity allocation services to transmission system operators.

AREA CONTROL ERROR – Current difference between the actual and planned values of power exchange within the control area, corrected for the value of a frequency member of that control area (control constant of the given control area multiplied by frequency deviation).

AUTOMATIC GENERATION CONTROL – The process of automatic control of power generation (active power) in regulation generating units, so that the frequency and sum of electric power exchange with the neighboring power systems is maintained as close to the planned values as possible.

AVAILABLE TRANSMISSION CAPACITY – The difference in net transmission capacity and transmission capacity allocated to participants in the electricity market.

AVAILABILITY – The state in which the generating unit, transmission element or another element of the power system is able to perform the intended function, regardless of whether actually used or not.

BALANCE ENTITY is the entity for system balancing or re-dispatching, and which is:

a) a group of generating units – within one or more production facilities;
b) a single generating unit;
c) controlled consumption – which represents reversible hydroelectricity plant or pumped-storage facility while operating in the pump mode, or the facility of the end user who can regulate consumption upon the request of the transmission system operator.

BALANCE GROUP – Virtual area that can receive electricity, or from which electricity can be delivered, which is used for the purpose of billing and financial settlement from the aspect of balance responsibility. It includes a set of accounting points in the transmission, or distributive system, as well as receipt and delivery of energy on the basis of blocks of cross-border and internal power exchange of individual market participants.

BALANCE RESPONSIBLE PARTY – Participant in the electricity market who is balance responsible for the deviation of one balance group in the market area of Serbia and who has concluded an agreement on balance responsibility with the transmission system operator.

BALANCING (OF POWER SYSTEM) – The process of activating secondary and tertiary reserves in order to maintain the sum of power exchange with the neighboring power systems and

frequency at the planned value. Deviation from the declared reserve activation merit order list of balancing mechanism is not allowed.

BLACK START (OF A GENERATING UNIT) – Capability of a generating unit when disconnected from the grid to return to the operational regime and to start delivering the power, in the situation when part of the transmission system, it is connected to, is de-energized.

BLACKOUT STATE – The system state in which the operation of part or all of the transmission system is terminated.

BLOCK OF ELECTRICITY EXCHANGE – Reported exchange of energy between two balancing groups (block of internal energy exchange), or between balancing group and cross-border partner (block of cross-border exchange), in a given time interval, of defined quantity and exchange direction.

BREAKDOWN – Outage of larger scale, significant dysfunction or substantial damage to the facility, part of the facility or to the transmission system element. Breakdowns occur as a consequence of failures or damages to the installed high-voltage or other equipment, or natural disasters and other unforeseen and unexpected events. As a rule, breakdowns cause reduced reliability and safety of the equipment or transmission system operation, which could endanger safety and health of people and property, thus requiring urgent removal of causes and consequences of a breakdown.

CAPACITY – Rated continuous load of a generating unit, transmission element or other electrical equipment.

CATEGORISATION OF POWER SYSTEM ELEMENTS – The process according to which JSC EMS classifies all 400 kV, 220 kV and 110 kV power system elements into one of 4 groups (categories), according to the classification criteria issued by JSC EMS and published in the Document on Categorisation of 400 kV, 220 kV and 110 kV power system elements of the Republic of Serbia. The purpose of categorising the power system elements is to determine control areas of the JSC EMS and of the transmission system users' control centres, and to regulate the JSC EMS and the transmission system users' responsibilities related to the use of transmission facilities and of the transmission system users' facilities.

COMPENSATION PROGRAM – The program for power exchange between control areas, parts of control areas or control blocks, used for compensation of unintended deviations. Power can be delivered or received from the interconnection during the compensatory period, according to the constant power program and in the same tariff periods in which the deviation occurred during the reference period.

CONNECTION POINT – Property boundaries between transmission system and facility of the producer or the end user.

CONSUMPTION (NET CONSUMPTION) – Electricity, or power, delivered from the transmission grid to the transmission system used.

CONTROLLED CONSUMPTION – Consumption which can be turned on/off upon operator's request, or can be changed on the basis of the agreement on ancillary services, the Grid Code and Market Code.

CONTROL AREA – An integral part of interconnection managed by one operator of the transmission system. It may include subareas under the authority of another transmission system operator, when the relations between such operators are defined within a contract.

CONTROL PROGRAM – Sum of all exchange plans of the control area, or all programs of the exchange of control areas and compensation program. It is used as input for secondary control.

DAILY OPERATING SCHEDULE OF ORGANIZED ELECTRICITY MARKET – electronic document containing results of day-ahead or intra-day trading on organized electricity market in the form of internal power exchange. JSC EMS is provided this document by operator of organized electricy market or legal entity authorized by the operator to deliver the daily schedule on behalf of its balance group.

DEAD TIME – Time from the beginning of protection and impulse giving for tripping the breaker, to the impulse for turning the breaker on by the device (function) for automatic reclosing (AR). Dead time does not include the time of tripping, or turning the breaker on.

DELIVERY POINT – A point where the electricity is delivered from transmission network, or to the transmission network.

DISTURBANCE – Condition of the power system that does not meet any requirements defined for normal operation of the system.

DISTURBED ACCESS – Operating condition at the connection point, or inter-connection point, at which the effective value of at least one-phase voltage is higher or lower than the required range for normal operating voltages, i.e. when the value of frequency is beyond the range 49.5 - 50.5 Hz (transient phenomena in the transmission system are not taken into account). If the transmission system user has several connection, or inter-connection points in one facility, it is not considered that there is disturbed access if the total transmission capacity of connection points, with normal operating conditions, exceeds the approved capacity of this user.

EIC Z CODE – A unique identification code for each Metering Point. This code consists of 16 alphanumeric characters describing the facility, Metering Point and voltage of measurement. The codes are generated by JSC EMS.

ELECTRICITY METER – A device for measuring and recording electricity and power. Electricity meter is a multifunctional device: it measures active and reactive power per Time of Use tariffs, registers load profile of active and reactive power. Commands the switching between internal tariff registers in the meter.

ELECTRICITY METER CONFIGURATION – The setting up of metering and tariff parameters in the meters. Configuration of electricity meter can be primary, when the transformation ratio of instrument transformer from Metering Point is entered as parameter in the meter, or secondary, when meter is measuring only secondary values of energy and power from the Metering Point.

EMERGENCY WORKS – Works on the power system elements, or in the vicinity of the power system elements, whose performance is not envisaged by the appropriate outage plans (these works are normally carried out due to actual or potential failure of the power system element).

EXCHANGE PLAN AND PROGRAM (SCHEDULE) – Exchange plan defines the agreed transaction in terms of power (MW), start and end times, type of transactions (e.g. guarantee). Exchange program defines total planned power exchange between two control areas, subareas within a control area, or between control blocks.

EXCITATION CONTROL – Decentralised, locally installed device on the generator for regulating the excitation of current.

EXPLOITING (USE) OF FACILITIES – Activities aimed at ensuring the best use of the existing, already constructed power facilities and the overall energy system through application of technical and economic methods. In other words, it is a set of control actions (manual or automatic) undertaken to meet the needs of the transmission system users, provided that

adequate conditions for normal operation of power systems and the lowest operating costs are met.

FAILURE – An event that occurs on the equipment and leads to termination of the normal performance and functioning of equipment, and to equipment outage.

FAULT TRIPPING TIME – Time covering pre-set time for activating principal (primary) protections and tripping time.

FLICKER – Distortion of voltage wave causing discomfort to the sense of sight exposed to the effect of lightening devices that are powered by fluctuating voltage.

FUNCTIONAL TESTS – Tests carried out by the transmission system operator within the system maintenance and development, including also the connection of facilities to the transmission system, applicaton of new operational procedures, tranings, collection of information on the behaviour of transmission system and the transmission system users during the disturbance and similar. Transmission system users may also carry out functional tests for similar purposes.

GENERATING UNIT – an indivisible set of devices (turbines, generators and necessary accompanying devices) which can generate electricity so that the frequency of the produced voltage, generator speed and frequency of the network voltage are in constant relation and are thus synchronised.

GENERATOR STATISM (DROP OF A GENERATOR) – One of the settings parameters on the turbine governor. It is equal to the quotient of relative quasi-stationary frequency deviance on the transmission grid and relative change of output active power from the generator, caused by the action of primary regulator.

HIGHER HARMONICS – Sinusoidal component of a voltage or current wave with frequency equal to n x 50 Hz, where n is an integer greater than 1.

HYDRO GENERATOR UNIT – Generator unit in the hydroelectric power plant.

INTERCONNECTION (SYNCHRONOUS AREA) – A system of two or more individual transmission systems connected by interconnection lines and in synchronized operation. Within the synchronous area, the system frequency is them same in stationary state.

INTERCONNECTION OPERATION RULES – The rules which the transmission system operators as members of ENTSO-E shall be obliged to implement according to European legislation and internal acts of the organisation.

INTER-CONNECTION POINT – Property boundaries between the transmission grid and distribution facility.

INTERNAL EXCHANGE OF ELECTRICITY – Power exchange between the participants in the electricity market within the transmission system operator's control area.

ISLAND OPERATION – Operation of a facility in a part of the transmission system separated from the rest of transmission system which is in synchronous operation with the interconnection.

LOCAL DATA ACQUISITION – Acquisition of metering values from the meters at the Metering Point. Local data acquisition can be performed visually (by observing the status of meter and registers), or by local communication via optical or serial port of meter and register.

LOCAL EQUIPMENT FOR SECONDARY CONTROL – Equipment located at the power plant which passes the control impulse or set point of active power to the turbine regulator of the generating unit.

MAINTENANCE OF FACILITIES – The activities that ensure proper technical condition of facilities (examination, inspection, overhaul and performance testing). The facilities are maintained according to appropriate standards and regulations on technical standards, according to the manufacturer's instructions and according to internal technical documents and users' annual plans based on operating experience and monitoring of the development of maintenance technology.

METERING DATA – Metering values stored in the registers of the meter. These values are active and reactive energy, active and reactive power load profiles, and maximum demand. Each metering data is associated with time flag of occurrence.

METERING POINT – A point (in electrical means) of connection to voltage and current instrument transformers which supply the meters and are used for measuring the power flows between the facility of the transmission system user and the transmission grid.

NET TRANSFER CAPACITY – Maximum total exchange program between the two adjacent control areas, i.e. between the subareas within a control area. It is calculated according to the interconnection operation rules.

NORMAL OPERATION OF TRANSMISSION SYSTEM – Operation of the transmission system in which all requirements for secure operation of the system are met, including stability requirements, and in which there is no interruption of electricity supply from the transmission system due to causes within the transmission system.

OBIS CODE – A unique identification code for all quantities registered in the meter as per *IEC 62056-61/2002.*

WORK PERMIT – Type of the document issued prior to the commencement of works on the power system elements, or in the vicinity of the power system elements.

OPERATOR – A person in the facility responsible for supervising the operation of the facility and execution of orders placed by the responsible dispatch centre related to the facility.

OUTAGE – Unexpected disconnection of one or more of power systems elements due to failure or other causes.

POTENTIAL FAILURE – Accidental event of internal or external origin, which occurs on the equipment and causes a decrease in reliability of equipment (there is a significant probability of the equipment outage and associated equipment outage).

POWER SYSTEM ELEMENT – Transmission line, transmission line bay, transformer, transformer bay, busbar system, bus coupler bay, busbar measurement bay, disconnector... Such element is categorised into a specific group of Categorisation of 400kV, 220 kV and 110 kV elements.

POWER FACILITY (FACILITY) – Construction-electric installation used for generation, transmission, distribution or consumption of electricity.

POWER FACTOR – Cosine of the phase difference between voltage and current.

POWER SYSTEM – A set of all interconnected electrical facilities that make a single technical and technological unitity.

PRIMARY CONTROL – Primary control is an automatic decentralised function of turbine regulator that adjusts the output power of a generating unit as a consequence of frequency deviation in synchronous area. Primary control should be spread, as uniformly as possible, on the units in operation in synchronous area.

PRIMARY CONTROL BAND – Scope of power settings on the primary control in which the primary regulators can provide automatic control in both directions in response to frequency deviation.

PRIMARY CONTROL RESERVE (PRIMARY RESERVE) – Part of the primary control band measured from the operation point of a generating unit before the disturbance, to the maximum value of active power of primary control. It can be positive (increase in the production of active power) or negative (decreased in the production of active power). Primary reserve corresponds to the frequency containment reserve (FCR) from the interconnection operation rules which is automatically activated though primary control.

PRIMARY REGULATOR – Subsystem of turbine regulator for the correction of generator's specified power based on the speed of generator rotation.

PROTECTION DEVICE – A device used to protects the element of a power system from abnormal operating conditions. Protection service is carried out by switching off protected element and sending of alarm signal to the command board.

REACTIVE POWER – Imaginary unit of conjugated complex obtained product of voltage and power. Reactive power creates and maintains electromagnetic fields of AC equipment. Reactive power must be delivered to devices whose operation requires electromagnetic field, such as motors and transformers. Reactive power is generated by generating units, synchronous compensators, or electrostatic equipment such as capacitors and it directly affects voltage in the power system. Reactive power is also generated by overhead transmission lines when loaded below the natural power

RELIABILITY – Capability of the transmission system elements to deliver electricity to the corresponding transmission system users over a certain period of time within the accepted standards and in the desired amount. Reliability at the transmission level can be measured according to frequency, duration and size (or probability) of negative effects on consumption, transportation, or generation of electricity.

REMOTE DATA ACQUISITION – Remote collection of metering data from the authorised metering data accounting center.

RE-DISPATCHING – Activating tertiary (in exceptional cases secondary as well) reserves in order to maintain or restore normal or safe operation of the transmission system, primarily with the aim to maintain safety criteria "N-1". In case of re-dispatching, a deviation from the declared sequence of tertiary reserves activation is possible. As a rule, re-dispatching involves active power increase in a balancing entity and an equal decrease in another balancing entity.

REGIONAL SECURITY COORDINATOR – the entity with which transmission system operators contracted the services as envisaged by the interconnection operation rules regarding the coordinaton of security of operation of transmission systems, i.e. interconnection.

RESERVE FOR TERTIARY CONTROL (TERTIARY RESERVE) – According to the manner of activation it is divided into direct and program tertiary reserve. Direct tertiary reserve is the one activated at any time by the dispatcher's order in less than 15 minutes. Direct tertiary reserve corresponds to the *frequency restoration* reserve from the interconnection operation rules, which is manually (upon verbal order) activated through tertiary control, i.e. fast tertiary reserve from the Market Code (mFRR). Program tertiary reserve is a reserve activated in a period longer than 15 minutes. Program tertiary reserve corresponds to the *replacement* reserve from the interconnection operation rules which is activated as part of a plan (as a rule, through Transmission System Daily Schedule) by tertiary control, i.e. slow tertiary reserve from the Market Code (RR). According to the direction, tertiary reserve is divided into positive and negative reserve. Positive reserve is considered to be: production increase, cross-border receipt of electricity and reduction of consumption. Negative reserve is considered to be: production decrease, cross-border delivery of electricity and consumption increase.

SCADA SYSTEM – The system for collecting and processing data submitted in real time from transmission facilities and from the transmission system users' facilities. This system is used for operation monitoring, the remote command and other aspects of the transmission system control.

SECURITY CRITERION "N–1" – Safety criterion which implies that a single failure of any power system element (mandatorily, generator, transmission line, transformer and optionally, other elements in the grid in accordance with risk assessment) does not lead to overloading of other elements or impairment of voltage constraints in the power system nodes.

SECONDARY CONTROL (FREQUENCY AND EXCHANGE POWER) – Centralised automatic function that regulates the generation in the control area within the reserve for secondary control, for the purpose of:

- maintaining the cross-border active power flows in accordance with the exchange program with other control areas and simultaneously;
- resetting the pre-set value of frequency in case of frequency deviation caused by the control area (especially in the case of larger frequency deviation caused by the control area, after the outage of big generation unit) in order to release the active power capacity engaged by the primary control (to restore the reserve for primary control).

Secondary control is realised by engaging selected generating units in power plants equipped and included in this type of control.

SECONDARY CONTROL BAND – Scope of power settings on the secondary regulator in which the secondary control can operate automatically at certain times, in both directions from operating point of secondary control of frequency and exchange power.

SECONDARY CONTROL RESERVE (SECONDARY RESERVE) – Part of the secondary control band between the operation point of a generating unit and maximum/minimum value (positive or negative reserve) of active power of secondary control. Secondary control complies with the *frequency restoration* reserve from the interconnection operation rules which is automatically activated by secondary control (aFRR).

SECONDARY REGULATOR – A unique centralised equipment of the transmission system operator in each control area that supports the operation of secondary control.

SECURE OPERATION OF THE POWER SYSTEM – Power system operation in which the following conditions are met:

1. voltages in all nodes are within normal operating values;
2. frequency is within the range defined for the quasi-stationary state;
3. load currents of all elements of the 400 kV, 220 kV and 110 kV transmission grid do not exceed the permanently allowed values for these elements;
4. short circuit currents at all nodes do not exceed the maximum allowed values for equipment installed in the given node;
5. an appropriate band is provided for primary, secondary and tertiary control;
6. criterion "N-1" is met, and in case of its disturbance there is a possibility for restoring it in the shortest possible time;
7. all synchronous generators operate in regimes according to their operating diagrams.

SELF-CONSUMPTION – Energy consumed by the facility for its regular operation. Usually, this consumption is separated from the rest of consumption and is supplied from the separated busbars within the facility. It is also common to provide special connection with the

transmission grid or distribution grid for this consumption, as well as independent sources of power.

SINGLE-PHASE AR – Operating cycle of protection and device (function) for automatic reclosing (AR), which trips single-phase earth faults (only the phase affected by earth fault) and turns it on after expiry of dead time.

STABILITY – The transmission system stability is the ability of the system to restore the state of operating balance for the given initial operating state after being exposed to physical disturbance, whereby the most of the system variables are limited, thus the entire system practically remains complete.

SYNCHRONOUS TIME – A fictitious time based on the system frequency in synchronous area that is set with regard to the astronomic time. If synchronised time is ahead of astronomic time, this means that the system frequency is higher than 50 Hz on average, and vice versa.

SYSTEM PROTECTION – Underfrequency protection, overload protection, protection against permanent asymmetry of currents, protection against power oscillations and voltage protection. These types of protection are primarily used to preserve secure operation of the power system.

SWITCHYARD – Part of the power substation of the same voltage level.

TECHNICAL CONTROL SYSTEM – System for the exchange and processing of data transferred between facilities and control centres, as well as among control centres, in order to provide conditions for the transmission system control.

TECHNICAL LOSSES IN THE TRANSMISSION GRID – Losses of power occurred under regular technical conditions of the system, generated by the heating of elements of the transmission grid, due to the active resistance in these elements (Joule's losses), losses due to hysteresis, losses due to eddy currents, losses due to discharge current in isolation, losses due to corona or dielectric losses.

TERTIARY CONTROL – Activation of tertiary reserve in order to restore the reserve for secondary control or for the purposes of re-dispatching.

THREE-PHASE AR – Operating cycle of protection and devices (functions) for automatic reclosing (AR) which trips multiphase faults (short circuits and ground faults) at three-phase and activates all three phases after the expiry of dead time.

TIE-LINE (INTERCONNECTION LINE) – Transmission line connecting two control areas or two transmission systems.

TOTAL CAPACITY – Cross-border transmission capacity calculated according to the interconnection operation rules, and represents a sum of net transmission capacity and transmission reliability margin.

TRANSFORMATION RATIO – Obtained after multiplication of the transmission ratios of voltage and current transformers at the measuring point, used for the translation of the secondary values of energy and power measured by electricity meter, into physical values of energy and power.

TRANSMITION RELIABILITY MARGIN – Part of the cross-border transmission capacity required to ensure reliable transmission system operation due to uncertainty regarding the conditions of the planned transmission system operation. These uncertainties arise primarily from the operation of secondary control, need for electricity exchange due to a breakdown and deviation of the plant from the planned operation in real time.

TRANSMISSION SYSTEM CONTROL – A set of actions ensuring the transmission system functioning under normal operating conditions, and bringing the system back to normal and

safe operation after disturbances. Transmission system control is carried out from the transmission system operator's dispatch centres. Transmission system control includes the regulation of frequency and power exchange, voltage control, supervision of the transmission system operation, rehabilitation of disorders, data collection and more.

TRANSMISSION SYSTEM USER – Energy entity or consumer, who is the owner or holder of the right to facility use connected to the transmission system, i.e. supplier or public supplier with the right to the transmission system access.

TRANSMISSION SYSTEM USER'S DISPATCHING CENTRE – Dispatching centre, substation control room or some other facility with local staff authorised to control the facility or part of the power system under the authority of the transmission system user. The authority of this centre is governed by the law, bylaws and relevant agreements.

TURBINE GOVERNOR – Decentralised, locally installed control device for regulating the turbine valves of generating units.

TURBO GENERATOR UNIT – Generator unit in a thermal power plant.

TYPES OF POWER PLANTS – The Code distinguishes between the following types of power plants: Run-of-the-river, storage and reversible hydroelectric power plants, coal and gas-fired power plants, wind power plants and other power plants.

TYPICAL DAY – Calendar day determined by JSC EMS in compliance with the interconnection operation rules.

UNINTENDED DEVIATION – Difference between realisation of cross-border electricity exchanges consisting the programs of control area exchanges, from the plan programs of these exchanges.

VALIDATION – Validity check of measurement data acquired from remote or local communication, carried out according to predefined algorithms and analysis of logbooks from the meters.

VOLTAGE COLLAPSE – Occurrence of rapid lowering of voltage in the transmission system due to lack of reactive power.

VOLTAGE CONTROL – At the level of transmission system: coordinated controlling action that includes managing of reactive power generation in generating units, synchronous compensators, static devices for compensation, as well as controlling of the reactive power flow in 400 kV, 220 kV and 110 kV grids by changing the transformation ratio and by turning on/switching off the elements of the 400 kV, 220 kV and 110 kV grids. At generating unit level: automatic or manual adjustment of the excitation current in order to achieve adequate voltage on the generator or on the high-voltage side of the step-up transformer.

VOLTAGE (CURRENT) IMBALANCE – The state of multiphase system in which effective values of interphase voltages or currents (basic component), or phase angles between adjacent interphase voltages or currents are not all equal. The level of inequality is usually expressed by the ratio of inverse and zero components to direct component of voltage or current.

VOLTAGE REDUCTIONS – Reduction of operating voltage in distribution grids to which the energy is supplied from the transmission grid, to the value of 95% of the distribution grid rated voltage.

WORK COMPLETION NOTICE – Type of document issued following the completion of work on the power system elements, or in the vicinity of the power system elements.

WORKS SUPERVISOR – A person with whom the authorised person of the responsible dispatch centre opens the work permit, after which this person checks the basic measures implemented

to secure the work place and applies further measures for safe operation; the person also informs the authorized dispatch centre about the completion of works.

400 KV, 220 KV and 110 KV GRID – Power system elements classified into the first, second and third Categorisation group. It includes the transmission grid and parts of the transmission system user's facilities through which electricity is physically transmitted.

## 2.2. ABBREVIATIONS

**2.2.1.** Cyrillic abbreviations used in the Grid Code have the following meaning:
AR – Automatic Re-closure;
EPS – Electric Power System;
JSC EMS – Joint Stock Company Elektromreža Srbije
SRPS **–** denotation for standard and related documents issued by the Standardization Institute of Serbia.

**2.2.2.** Latin abbreviations used in the Grid Code have the following meaning:
*CIGRE – Conseil International des Grands Reseaux Electriques* (International Association for Large Electricity Systems);
*ENTSO-E – European Network of Transmission System Operators for Electricity;*
*GIS – Gas Insulated Switchgear;*
*GPS – Global Positioning System;*
*IEC – International Electrotechnical Commission;*
*MMS – Market Management System;*
*OBIS – Object Identification System;*
*SCADA – Supervisory Control and Data Acquisition.*
*SRAAMD – System for Remote Acquisition and Accounting of Metering Data.*

# CHAPTER 3: PLANNING THE DEVELOPMENT OF THE TRANSMISSION SYSTEM

## 3.1. INTRODUCTION

**3.1.1.** By planning the development of the transmission system, the necessary development of the transmission system and certain conditions in which this system will operate in the following period are considered, in order to determine measures for providing normal operation of the transmission system.

**3.1.2.** The planned construction, reconstruction and upgrade of transmission facilities ensure preconditions for development of generation and distribution capacities, electricity market and reliable delivery of electricity for projected level of consumption.

**3.1.3.** Apart from the criteria for ensuring normal operation of the transmission system, during the planning of the transmission system development JSC EMS takes into account all relevant economic indicators in order to minimise the costs of the optimal development of the transmission system.

**3.1.4.** This chapter contains precise technical criteria, maps and data used during the planning of the transmission system development, periods for which Transmission System Development Plan is drafted, the content of these plans, and also the Investment Development Plan.

## 3.2. CONDITIONS FOR SECURITY AND RELIABILITY OF TRANSMISSION SYSTEM

### 3.2.1. INTRODUCTION

**3.2.1.1.** Technical criteria for secure and reliable operation of transmission system that govern JSC EMS during planning of the transmission system development are general criteria that are relevant for all technical functions that JSC EMS performs based on the law and other general acts.

**3.2.1.2.** The same technical requirments apply when connecting and/or inter-connecting the facilities to the transmission system, planning the transmission system operation and managing the transmission system operation.

### 3.2.2. TRANSFER CAPACITY

**3.2.2.1.** Transfer capacity, i.e. allowed continuous electrical or thermal load of all overhead transmission lines and transformers in grid 400 kV, 220 kV, 110 kV shall be calculated based on:

- technical specifications;
- expected conditions of operation;
- techno-economic conditions of exploitation;
- current state of overhead transmission lines, i.e. transformers.

**3.2.2.2.** JSC EMS does the calculation of the transmission capacity of elements of the grid 400 kV, 220 kV and 110 kV according to:

- permanently allowed values of phase conductors currents for overhead lines and cables;
- values of rated power, i.e. current for transformers.

**3.2.2.3.** It is necessary to dimensionate the entire additional equipment in line and transformer bays in the grid 400 kV, 220 kV and 110 kV (like current instrument transformers, disconnectors, circuit breakers and other equipment) so that it does not pose limitation to transmission capacity in the planned switching state, determined in accordance with the provision 3.2.2.2.

### 3.2.3. VOLTAGE

**3.2.3.1.** Nominal values of voltage in the transmission grid of the Republic of Serbia are:

400 kV, 220 kV and 110 kV.

**3.2.3.2.** The value of voltage in normal operating conditions in any point of the grid 400 kV, 220 kV and 110 kV is within the following range:

- 400 kV grid: between 380 kV and 242 kV;
- 220 kV grid: between 198 kV and 242 kV;
- 110 kV grid: between 99 kV and 121 kV.

### 3.2.4. FREQUENCY

**3.2.4.1.** Nominal value of frequency is 50 Hz. When transmission system of the Republic of Serbia operates within the interconnection, values from the interconnection operation rules are applied to allowed deviations from the nominal value of frequency in the transmission grid.

**3.2.4.2.** In cases when the transmission system of the Republic of Serbia operates in isolation from the neighbouring transmission systems, the allowed frequency in the transmission grid in quasi-stationary state is 50 Hz ± 0.5 Hz.

### 3.2.5. SECURITY CRITERION "N-1"

**3.2.5.1.** Security criterion "N-1" can foresee outage in consumption, providing it is foreseeable and limited to local area.

**3.2.5.2.** Security criterion "N-1" is not applied to "radially fed" consumption.

**3.2.5.3.** Busbar and bus coupler bay outages are not taken into consideration when analysing if security criterion "N-1" is met.

**3.2.5.4.** Security criterion "N-1" is tested on models, which apart from the JSC EMS transmission system, include models of other transmission system, in accordance with the interconnection operation rules.

### 3.2.6. SHORT-CIRCUIT CURRENTS

**3.2.6.1.** Equipment in transmission facilities and facilities of the transmission system users is dimensioned to meet calculated values of short circuit currents.

**3.2.6.2.** In case of a short circuit, the stabile operation of transmission system must not be compromised.

### 3.2.7. STABILITY

**3.2.7.1.** In order to ensure that the transmission system operates in conditions of satisfied stability, EMS JSC analyses the following types of stability:

- stability of the rotor angle when the system is exposed to small and great disturbances in short time interval;
- frequency stability in short and long time intervals;
- voltage stability when the system is exposed to small and large disturbances in short and long time intervals;

in accordance with definitions and classification *IEEE/CIGRE*. Short time interval is considered to be the first 3-5 seconds after disturbance has occurred, i.e. 10-20 seconds for very large systems with dominant oscillations between the areas. Long time interval is considered to be the first 30 seconds for oscillations of synchronisation power between machines, i.e. 15 minutes after disturbance has occurred for transient processes of secondary control.

## 3.3. TRANSMISSION SYSTEM DEVELOPMENT PLAN

### 3.3.1. METHOD OF TRANSMISSION SYSTEM DEVELOPMENT PLANNING

**3.3.1.1.** JSC EMS develops and publishes the Transmission System Development Plan every year. The Transmission System Development Plan is prepared for the upcoming ten-year period.

**3.3.1.2.** Development of transmission system is planned in a way that allows flexible operation of generation capacities in all foreseeable modes of the transmission system operation.

**3.3.1.3.** Transmission system planning takes into consideration the need to meet future demands of all users of the transmission system.

**3.3.1.4.** Transmission system planning meets the needs of electricity exchange on the electricity market.

**3.3.1.5.** Transmission System Development Plan contains data on total consumption and generation trends with special emphasis on the significant changes, the commisioning of new facilities or de-commisioning of the existing facilities of transmission system users.

**3.3.1.6.** The main objective of the Transmission System Development Plan is to provide to all existing and potential users of the transmission system, participants in the electricity market and the competent authorities, the following:

- Comprehensive overview of the transmission system development at a given time interval;
- Overview of major changes in the transmission system (list, locations and basic characteristics of the transmission system facilities which will be reconstructed, expanded, built, or shut down, including the tie-lines).

**3.3.1.7.** EMS JSC cooperates with distribution system operators in preparation of the Transmission System Development Plan. In addition to meeting the technical criteria of the transmission system, the following is also taken into consideration:

- Quality of electricity supply to distribution facilities that are radially inter-connected to the transmission system;
- Provision of reserve direction within the distribution system for feeding distribution facilities that are radially connected;
- Need to find economically optimal solution for both system operators.

**3.3.1.8.** JSC EMS cooperates with transmission system operators when producing Pan-European ten-year transmission grid development plan, regional investment plan, as well as

report on medium-term generation adequacy, and in accordance with rules on interconnection operation.

**3.3.1.9.** JSC EMS, based on recorded historical data, data submitted by users of the transmission system and submitted requests for connection to the transmission system, creates a consumption forecast (active and reactive power) for all connection points and inter-connections. When forecasting consumption, JSC EMS as a rule produces several different scenarios related to future consumption, which cover different economic development routs of the Republic of Serbia, thus providing the test of flexibility, i.e. sensitivity of planned facilities in the transmission system.

**3.3.1.10.** Based on the transmission system parameters, JSC EMS models the transmission system. This model shall take into account the real current limitations of all elements of the transmission system and system protection settings.

**3.3.1.11.** When modelling generation, JSC EMS as a rule produces several different scenarios of possible development of the generation system of the Republic of Serbia, thus providing the test of flexibility, i.e. sensitivity of planned projects in the transmission grid. Furthermore, JSC EMS takes into account recorded limitations in operation of these generating units that deviate from rated parameters, as well as their unavailability. Limitations present in longer time period, as well as limitations that periodically occur, are dully taken into account. The frequency of these occurrences is also treated.

**3.3.1.12.** JSC EMS archives all events that are relevant for the transmission system development planning. Based on these archives, JSC EMS determines the schedules of generation and consumption that will be included in the analyses that are used for planning the transmission system development.

**3.3.1.13.** When analysing the operating modes of the transmission system, the information on the planned unavailability of generating units and transmission grid elements are taken into consideration.

**3.3.1.14.** JSC EMS notifies, by January 31 of the year preceding the first year the Transmission System Development Plan refers to all users of the transmission system (including future transmission system users whose request for the connection facility to the transmission system is approved) on the data to be delivered for preparing the Transmission System Development Plan (data necessary for planning future development are included in the Annex A: Standard data). Data are submitted in the form as specified by JSC EMS. Transmission System Development Plan requires a harmonised set of input data. Any considerable deviations between different data sources for the adopted data set shall be supplied with relevant explanation.

**3.3.1.15.** Users of the transmission system submit to JSC EMS all requested information specified under item 3.3.1.14. by 30 April of the year preceding the first year the Transmission System Development Plan refers to.

**3.3.1.16.** JSC EMS may request from the transmission system user to submit other information needed for the purposes of modeling facilities of transmission system users, i.e. parts of distribution grid.

**3.3.1.17.** The data necessary for the transmission system development planning must be changed if it is proved in practice that originally reported values do not match reality. In such cases, the JSC EMS will request from the transmission system users to correct the data, and if the user does not provide satisfactory correction, JSC EMS shall make changes of disputed data according to recorded operational events.

**3.3.1.18.** In case the data relevant for the transmission system planning change, the transmission system user informs JSC EMS about these changes within one month after the change of data. The user indicates the time when the change occurred or will occur, or if the change is temporary, start/end time of change.

**3.3.1.19**. JSC EMS submits the draft Transmission System Development Plan to the distributon system operatior by 30 September of the year preceding the first year the Transmission System Development Plan refers to in order to harmonise the Distribution System Development plan with the Transmission System Development Plan.

**3.3.1.20.** JSC EMS submits its Transmission System Development Plan to EARS for approval by 30 November in the year preceding the first year to which the concrete ten-year plan applies to and publishes it upon obtaining such an approval.

### 3.3.2. CONTENT OF THE TRANSMISSION SYSTEM DEVELOPMENT PLAN

#### 3.3.2.1. Introduction

**3.3.2.1.1.** Transmission System Development Plan contains:

- Planning assumptions (foreseen electricity consumption by year and peak power by years, distribution of consumption according to consumption nodes, planned structure of generation capacities);
- Results of analysis of the condition of facilities, equipment and operation of the transmission system;
- Optimal variant of the transmission system development in the planning period which is determined on the basis of technical and economic analyses;
- Inventory of transmission system facilities by year and the priorities that need to be constructed, reconstructed or upgraded;
- Development plan of supporting infrastructure for the transmission system (telecommunications system, data management system, power metering system, etc.);
- Examining adequacy of generation;
- Examining the possibility of frequency and power interchange control;
- Analysing the possibility of voltage control;
- Stability analysis;
- Analysis of short circuit currents.

#### 3.3.2.2. Transmission system development

**3.3.2.2.1.** The first step in developing Transmission System Development Plan is the analysis of the current state of the transmission grid (age of facilities, unavailability of certain elements of the transmission grid, observed congestion and recorded transmission events) as well as security analyses for the present state of the transmission grid. The second step is the analysis of transmission grid including all facilities whose construction is in process based on the previous development plans, taking into account the years when they are to be put in operation. Based on these analyses, different variants of alternative solutions are made for the construction of new transmission system facilities, reconstruction and expansion of the existing transmission grid elements. The process is repeated until the end of the planning period, taking into account proposed solutions for each variant. For each variant, costs of depreciation, maintenance and losses are assessed, and then, all variants are compared for economic effectiveness and optimal variant is evaluated for the transmission grid development.

**3.3.2.2.2.**. New tie lines are planned on the basis of system studies and feasibility studies, which examine broader impact of the planned lines, considering that the decision to construct these elements of the transmission grid is based on the consent of the neighbouring transmission system operators.

**3.3.2.2.3.** Definition of the final Transmission System Development Plan by years includes a plan for construction of new transmission facilities, reconstruction of existing transmission facilities and construction of new tie-lines, and the descriptions of the required transmission system investment activities.

**3.3.2.2.4.** The Transmission System Development Plan includes, as information of special importance, data on places of possible congestions in the transmission grid (the list of transmission elements deemed to be exposed to frequent overloads).

**3.3.2.2.5.** If it is determined that the associated equipment related to transmission lines or transformers in the transmission grid can become a constraint in the base case or after a single outage of the transmission grid elements, JSC EMS shall enter in the Transmission System Development Plan the data about equipment in the transmission and distribution system facilities, which constrain the flow of power through the transmission grid and which has to be timely replaced due to the reasons mentioned herein.

**3.3.2.3. Medium-term generation adequacy**

**3.3.2.3.1.** If during the analysis of adequacy of medium-term generation adequacy it is established that it is impossible to ensure transmission balance (lack or significant surplus of generated power versus consumption), this information must be especially emphasized in the Transmission System Development Plan.

**3.3.2.4. Load-frequency control**

**3.3.2.4.1.** For each time profile for which planning is done, it is examined whether the reserve for primary, secondary and tertiary control at the transmission level is higher than the minimum quantity of the reserve prescribed by the Grid Code.

**3.3.2.5. Voltage Control**

**3.3.2.5.1.** If potential problems related to voltage control are identified, JSC EMS shall include in the Transmission System Development Plan, measures within its competence and warnings if problems are caused by inappropriate operation of the facilities of the transmission system users (for example, power consumption factor over permitted limit), and deviations from nominal technical characteristics (permanent constraints of generator units versus designed parameters, that is, the parameters prescribed by the Grid Code, including voltage control, and similar).

**3.3.2.6. Stability**

**3.3.2.6.1.** JSC EMS shall, if necessary, and at least once every five years, include in its Transmission System Development Plan, the stability study of the transmission system.

**3.3.2.6.2.** If the results of stability analysis indicate the possible shortcomings of automatic voltage control, primary control, and local equipment for secondary control and protection settings, JSC EMS shall take necessary measures within the transmission grid (installation, pre-protection settings, etc.), or agree upon the necessary measures with the users of the transmission grid (installation of stabilization devices on generating units, pre-setting and installation of primary control and voltage control, secondary control setting, etc.).

**3.3.2.7. Short-circuit currents**

**3.3.2.7.1.** Short-circuit currents in the facilities of the transmission system users are calculated during the preparation of the Transmission System Development Plan if the potential major changes (new generating unit connected to the 400 kV system, new 400 kV transmission line and similar) are expected due to anticipated changes in generation and transmission system, i.e. at the request of the transmission system users. Otherwise, JSC EMS is obligated to check short circuit currents in each facility of the transmission system at least once every five years.

**3.3.2.7.2.** If JSC EMS assesses that the calculated values of prospective short circuit currents (due to the development of the transmission system) may jeopardise the existing installed equipment in the transmission system facilities and facilities of the transmission system users, JSC EMS shall take measures in the transmission facilities and agree with the transmission system users about measures to be taken in their facilities. These measures primarily include preparation of plans for replacement of affected equipment, determination of the new connection status in the transmission grid and facilities of transmission system users, and monitoring short circuit currents in real time.

## 3.4. CONTENT OF TRANSMISSION SYSTEM INVESTMENT PLAN

**3.4.1.** Every year, JSC EMS develops Transmission System Investment Plan, for three year period, harmonized with Distribution Systems Investment Plan.

**3.4.2.** EMS JSC submits the Transmission System Investment Plan to EARS for approval by 30 November in the year preceding the first year such three-year plan refers to.

**3.4.3.** Transmission System Investment Plan particularly includes as follows:

- Title and investment code;
- Total estimated budget value for each investment;
- Dynamics of the financial performance of the investment plan in the next three years;
- Sources of financing;
- Implementation of the plan of investments currently in progress.

**3.4.4.** In order for EMS JSC to decide on the transmission system investments related to the connection to the distribution system, the following conditions are previously to be met:

- Government of the Republic of Serbia has approved the Annual Business Plan of EMS JSC;
- EMS JSC and the distribution system operator have concluded an agreement on connecting the distribution system operator facility with the transmission system operator facility.

**3.4.5.** In case EMS JSC is the party building the connection facility to the transmission system, the following requirements are to be met prior to the JSC EMS decision on the investment in building such a facility:

- Government of the Republic of Serbia has approved the Annual Business Plan of EMS JSC;
- EMS JSC and consumer, or producer, have concluded an agreement defining the rights and obligations of EMS JSC and consumer in the process of connecting a facility to the transmission system.

# CHAPTER 4: TECHNICAL REQUIREMENTS FOR CONNECTION AND INTER-CONNECTION TO TRANSMISSION SYSTEM

## 4.1. INTRODUCTION

**4.1.1.** The purpose of technical requirements for connecting and inter-connecting the facilities to the transmission system, is the development of necessary preconditions for normal operation of transmission system and precise definition of the obligations of JSC EMS and transmission system users.

**4.1.2.** Technical requirements for connection and inter-connection relating to electricity measurement are discussed in Chapter 8 Electricity Metering.

**4.1.3.** For technical requirements that are not explicitly defined by the Code, JSC EMS may refer to Serbian standards. In case of their absence, international standards may apply.

## 4.2. TECHNICAL REQUIREMENTS FOR CONNECTION AND INTER-CONNECTION OF ALL TYPES OF FACILITIES

### 4.2.1. TECHNICAL CRITERIA

**4.2.1.1.** The technical criteria from the section 3.2 of the Code must be met after connecting/inter-connecting a facility of a transmission system user.

### 4.2.2. CONNECTION/INTER-CONNECTION SCHEME

**4.2.2.1.** JSC EMS act laying down connection and inter-connection determines the scheme of connection and inter-connection.

**4.2.2.2.** A facility can be connected or interconnected in several directions. For each of these directions, adequate switchgear, protection, measurement and control equipment shall be provided for the part which belongs to the transmission grid and the part which belongs to the facility of the transmission system user.

**4.2.2.3.** The scheme for connection/inter-connection of the switchyard is determined on the basis of all available data and proposals, in order to set standard switchyard. In this respect the following is taken into account:

- Single-pole scheme of the facility and connector (in case of connection);
- Operating characteristics of the facility and technological process;
- Standard operating procedures and for this type of facility;
- Possibility for delivery of power to the facility of the transmission system user from the distribution or other grids;
- Consumption of the facility during normal operation or during any foreseeable changes;
- Planned development of the facility and transmission system;
- Telecommunication equipment which may affect the transmission capacity of 400 kV, 220 kV and 110 kV grid elements.

**4.2.2.4.** Connection/inter-connection scheme includes:

- Circuit breakers of appropriate technical characteristics that enable selective disconnection of transmission lines, transformers and busbar system in the facility of the transmission system user and neighbouring facilities;
- Disconnectors (output and busbar for transmission lines, busbar for transformers and bus coupler bays);
- Earthing elements (for the transmission line bays, 400 kV transformer bays, as well as for 400 kV busbars);
- Measuring equipment.

**4.2.2.5.** Circuit breakers referred to in the position 4.2.2.4. are dimensioned to be able to break the maximum planned short circuit currents at the connection/inter-connection point.

**4.2.2.6.** Coordination of insulation at all breakers, disconnectors, earthing elements, power transformers, voltage transformers, current transformers, surge arresters, insulators, equipment for grounding the neutral point, capacitors, silencers and coupling equipment, shall be performed in accordance with the SRPS EN standards.

### 4.2.3. VOLTAGE

**4.2.3.1.** Facility of a customer or distribution system operator remains in operaton within the transmission grid without outage depending on the voltage in the connection/inter-connection point U, as follows:

а) with connection/inter-connection points to 400 kV:
- for the interval $90\%U_{nom} \leq U \leq 105\%U_{nom}$ permanently;
- for the interval $105\%U_{nom} < U \leq U_{nom}$ at least 60 minutes;

б) with connection/inter-connection points to 110 kV and 220 kV:
- for the interval $90\%U_{nom} \leq U \leq 111{,}8\%U_{nom}$ permanently;
- for the interval $111{,}8\%U_{nom} < U \leq 115\%U_{nom}$ at least 60 minutes.

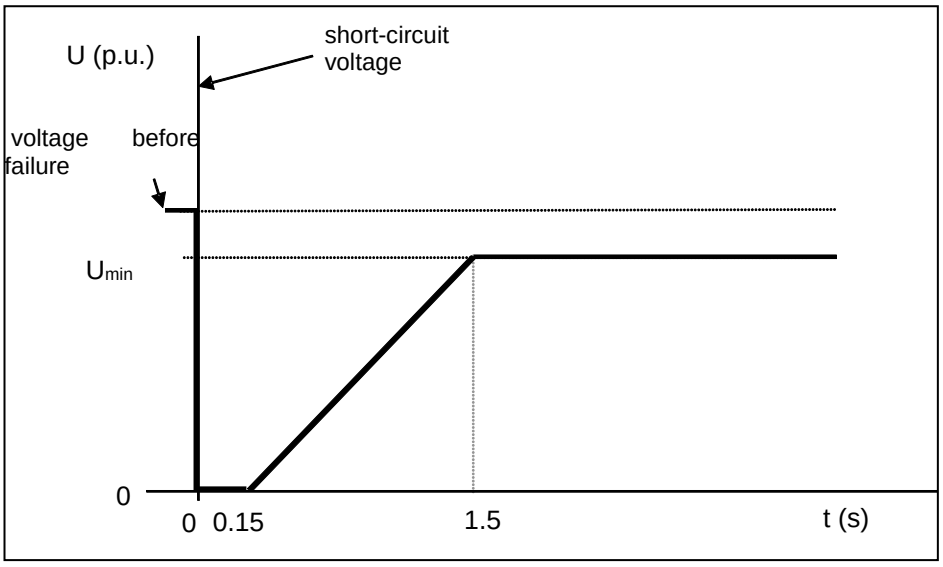



Figure 4.1.

**4.2.3.2.** In case of voltage drop in the transmission grid caused by short circuit, transmission system user facility, except turbo-generator unit and hydro-generator unit which cases as specifically regulated in position 4.3.8.2.3, remains in operation within the transmission grid without outage for the area above the line as presented in Figure 4.1, i.e. according to the following conditions:

- if the voltage at the connecting/inter-connecting point is 0 V, the facility remains in operation for at least 0.15 s;
- if the voltage at the connecting/inter-connecting point is $U_{min}$, the facility remains in operation for at least 1.5 s;
- if the voltage at the connecting/inter-connecting point is higher than $U_{min}$, the facility remains in operation until the failure is cleared;
- for voltage values between 0V and $U_{min}$ of the nominal values, times are determined by linear interpolation in accordance with the Figure 4.1.

$U_{min}$ is the minimal operational voltage at which the transmission system user facility remains permanently in operation without transmission grid outage in accordance with the position 4.2.3.1.

**4.2.3.3.** In case of voltage increase in the transmission grid, transmission system user facility remains connected to the transmission grid according to the following conditions:

- for the time period up to 50 ms, the facility remains in operation if the voltage at the connection/inter-connection point is lower than or equals 120% of the nominal value;
- for the time period between 50 ms and 1000 ms, the facility remains in operation for voltage lower than or equal to the value which is determined based on linear interpolation, in accordance with the Figure 4.2, where $U_{max}$ is the maximum value of voltage in normal working condition, laid down in section 3.2.3 of the Grid Code.

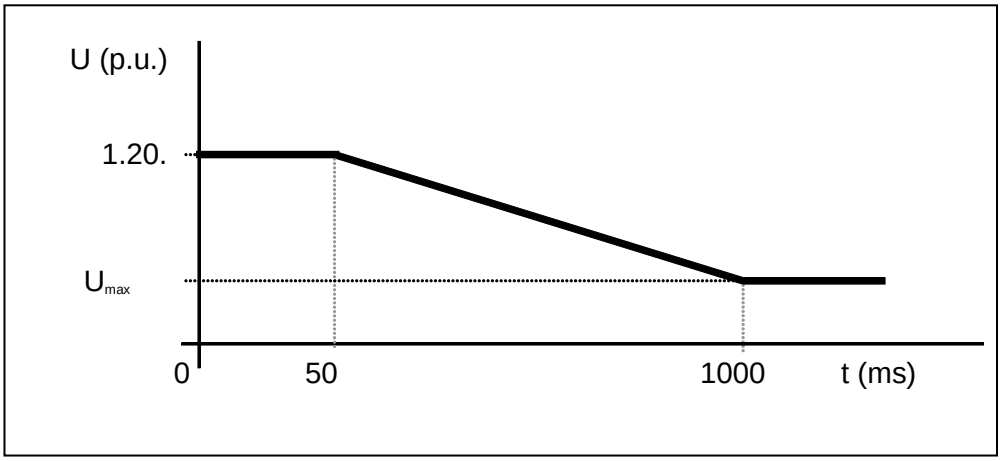



Figure 4.2

### 4.2.4. FREQUENCY

**4.2.4.1.** Transmission system user facility remains in operaton within the transmission grid without outage for the time period depending on the value of frequency f, and according to the following conditions:

- for the interval 47.5 Hz ≤ f < 48.5 Hz, at least 30 minutes;
- for the interval 48.5 Hz ≤ f < 49.0 Hz, at least 90 minutes;
- for the interval 49.0 Hz ≤ f ≤ 51 Hz, permanently;
- for the interval 51 Hz < f ≤ 51.5 Hz, at least 30 minutes.

**4.2.4.2.** Requirement from 4.2.4.1. does not refer to disconnection of facilities due to under-frequency protection.

### 4.2.5. REACTIVE POWER ABSORPTION FROM TRANSMISSION GRID

**4.2.5.1.** Transmission system users secure conditions during regular operation of their facilities in such a way that the reactive and active power ration absorbed from the transmission grid in the connection/inter-connection point is below 0.33 at each 15 min interval, with the measuring system registering interchange of reactive and active energy except for:

- generation units connection points in accordance with the Grid Code and section 4.3.7.
- distribution system facility inter-connection points supplying the distribution network where local production is connected, which is regulated by the exploitation agreement.

### 4.2.6. QUALITY OF THE VOLTAGE WAVE

#### 4.2.6.1. Voltage asymmetry

**4.2.6.1.1.** Voltage asymmetry caused by the transmission system user facility at the point of connection/inter-connection shall not exceed:

- 1% if the facility is connected/inter-connected to the 110 kV and 220 kV grid;
- 0.6% if the facility is connected to the 400 kV grid.

**4.2.6.1.2.** Exceptionally, for facilities connected to the 110 kV grid supplying the railways (so called electro-traction substation) JSC EMS may, in its act for connecting to the grid, require voltage asymmetry higher than 1% provided that this does not hinder access of other users to the transmission system, i.e. that it does not violate the preconditions for normal operation of the power system.

#### 4.2.6.2. Higher harmonics

**4.2.6.2.1.** The higher harmonic voltages generated by the transmission system user facility at its connecting/inter-connection point shall not exceed values provided in the Table 4.1:

| Odd harmonics, indivisible by 3 | | Odd harmonics, divisible by 3 | | Even harmonics | |
|---|---|---|---|---|---|
| Higher harmonics order h | Higher harmonics voltage [%] | Higher harmonics order h | Higher harmonics voltage [%] | Higher harmonics order h | Higher harmonics voltage [%] |
| 5 | 1.6 | 3 | 1.6 | 2 | 1.12 |
| 7 | 1.6 | 9 | 0.8 | 4 | 0.64 |
| 11 | 1.2 | 15 | 0.24 | 6 | 0.32 |
| 13 | 1.2 | 21 | 0.16 | 8 | 0.32 |
| $17 \leq h \leq 49$ | $1.2 \cdot 17/h$ | $21 < h \leq 45$ | 0.16 | $10 \leq h \leq 50$ | $0.19 \cdot 10/h + 0.16$ |

**4.2.6.2.2.** Total harmonic voltage distortion, calculated according to the *IEC* 61000-3-6 standard, caused by the transmission system user facility at the connection/inter-connection point shall not exceed the value of 2%.

#### 4.2.6.3. Flickers

**4.2.6.3.1.** Flickers caused by the transmission system user facility at the connection/inter-connection point shall not exceed:

- $E_{Pst} = 0.8$;
- $E_{Plt} = 0.6$;

where $EP_{st}$ and $EP_{lt}$ parameters are defined according to IEC standards 61000-3-7 which relate to electromagnetic compatibility.

### 4.2.7. PARTICIPATION IN THE TRANSMISSION SYSTEM DEFENCE PLANS

**4.2.7.1.** JSC EMS act laying down the connection/inter-connection includes the obligation and the manner of inclusion of the facility in the Transmission System Defence Plans.

**4.2.7.2.** Details regarding the inclusion of the facility in the plans shall be subsequently specified by the JSC EMS after consulting the transmission system user.

**4.2.7.3**. Most important tools and infrastructure required for the defence plans implementation shall be available to all transmission system facilities, distribution system facilities connected to the transmission system, and also generating units providing ancillary services of black start and island operation, in case of loss of voltage from the transmission system, and at least for 24 hours.

### 4.2.8. COMMUNICATION AND REAL-TIME DATA INTERCHANGE

**4.2.8.1.** JSC EMS act laying down the connection/interconnection determines the way of exchanging data in real-time and communicating with transmission system user, as well as the manner of connecting technical control systems in accordance with the Annex B.

**4.2.8.2.** JSC EMS shall set requirements and method of real-time data interchange between the facilities of the transmission system users and relevant JSC EMS infrastructure, i.e.:

- Main characteristics of the terminal equipment in the facility;
- Method of terminal equipment connection/inter-connection to the communication infrastructure of JSC EMS;
- Maintenance requirements of the communication system availability used by JSC EMS;
- Protocol on real-time data interchange;
- Parameters ensuring real-time data transfer;
- Class of metering converter accuracy.

**4.2.8.3.** Metering converters in the transmission system user facility shall be of 0.5 accuracy class. Such metering converters shall be provided for frequency measurement of frequency, voltage, electricity, active and reactive power.

**4.2.8.4.** In case of the communication between an individual facility and JSC EMS control centre, protocol IEC 60870-5-101 or *IEC* 60870-5-104 shall be applied. In case of the communication between a control centre of the transmission system user that manages several facilities and JSC EMS control centre, protocol *IEC 60870-6 (TASE.2)* shall be applied.

**4.2.8.5.** Connection/inter-connection to telecommunication system of JSC EMS is established through the optical system of the transmission type *SDH*.

**4.2.8.6.** The transmission system user shall provide JSC EMS with reliable access to output data in real-time as stated in the Appendix B for all the elements in the transmission system user facility categorised in the first, second or third group of Categorisation, as well as those in direct galvanic connection with the stated elements.

**4.2.8.7.** In addition to the data as stated in 4.2.8.6, distribution system operator shall supply JSC EMS with the following real-time data:

- total distribution system production and consumption;

- voltages, currents, active and reactive power flows, information on the status of switchgear equipment, for low voltage switchyards of their transformer stations connected to 110 kV transmission system.

**4.2.8.8.** EMS JSC delivers real time data to the distribution system operator as stated in 4.2.8.6. from the transmission 110 kV facilities specified in the exploitation contract, and to the producers and customers the data from the connection substation for the facility of the producer or the consumer, regarding the protection applied to a particular facility in accordance with section 4.2.10.

**4.2.8.9.** EMS JSC and the transmission system user may agree to exchange additional signals in relation to the list in Appendix C.

### 4.2.9. CONTROL CENTRE OF THE TRANSMISSION SYSTEM USER

**4.2.9.1.** Transmission system user declares its control centre for the facility subject to application for approval of connection to the transmission system. In terms of management, subject centre shall be subordinated to the control centre of JSC EMS.

**4.2.9.2.** Control centre of the transmission system user shall be in constant operation.

**4.2.9.3.** Transmission system user shall provide remote control directly from its control centre for:

- Breakers 400 kV, 220 kV and 110 kV;
- Disconnectors 400 kV, 220 kV and 110 kV;
- Positions of transformer tap changer 400/x kV/kV, 220/x kV/kV and 110/x kV/ kV (voltage control on the low voltage side of the facility as the prerequisite of voltage reduction);
- Breakers in low voltage switchyard (as the prerequisite for load shedding).

**4.2.9.4.** Control centre of the transmission system user shall also possess:

- At least two independent audio links with JSC EMS control centres (principal and backup), whereby it is recommended that one connection is made via the JSC EMS telecommunication system;
- Fax or e-mail;
- Relevant supervision of the facility operations (according to the requirements from Item 4.2.8.6.).

### 4.2.10. PROTECTION

#### 4.2.10.1. Introduction

**4.2.10.1.1.** Connection Approval shall define the protection system of the facility being connected/ interconnected to the transmission system, as well as the obligations of JSC EMS and the transmission system user to obtain coordination of the protection system for the transmission purposes, both in the process of development planning and in the process of operational planning and transmission system usage.

**4.2.10.1.2.** While choosing protection during the reconstruction of some bays in the facility, it is necessary to take into account the specificities of the installed equipment and in particular the conditions that the existing technical control system may require.

**4.2.10.1.3.** Protection is designed to enable prompt and selective elimination of faults towards protecting the equipment, transmission system facilities and facilities of the transmission system users from permanent damage, i.e. to minimize the consequences of faults or irregular events in the transmission supply system and to maintain stable operation of the power transmission system.

**4.2.10.1.4.** In order to ensure a reliable relay protection operation, it is necessary that the range of protection of each main protective device has an adequate reserve either remote or localized in other devices.

**4.2.10.1.5.** Protection devices are, as a rule, modern microprocessor-based protection devices which in addition to protection function, have the capacity to perform:

- chronological recording of events at millisecond resolution;
- recordings of grid disturbances (fault recorder) and faults showing the operating parameters (current, voltage, frequency, etc. ) in millisecond resolution;
- self-supervision.

In addition to microprocessor devices, usually in old facilities, protective devices of electromechanical or electrostatic structures shall be used.

**4.2.10.1.6.** At the voltage level of 110 kV in the facilities of the transmission system user and at the voltage levels of 110 kV, 220 kV and 400 kV relay protection and control devices are installed as separate devices. At the voltage level of 110 kV it shall be allowed to combine the functions of maintenance and backup protection into a protective-control device. At lower voltage levels, the use of combined protective and control devices is allowed. Main protection device may have a unified function of checking the fulfillment of the synchronized requirements when turning on a switch. At the voltage level of 110 kV, 220 kV and 400 kV, the control functions shall be as follows:

- Measurement of electrical quantities (current, voltage, power, frequency);
- Command, control and realization of blocking conditions of the elements in the field;
- Checking the fulfillment of the synchronising requirements when turning the switch on.

**4.2.10.1.7.** If the concept of protection requires communication of protection units from various facilities, the transmission system user meets its obligations regulated by the act on connection/ interconnection relating to the said communication no later than 15 days before the commissioning of the facility (or part of the facility).

**4.2.10.2. Selection of the type of protection devices for 110 kV transmission system**

**4.2.10.2.1.** In the process of protection selection, it will be required to take into consideration the specific features of the previously installed equipment, particularly the requirements of the existing technical control system.

**4.2.10.2.2.** For 110/x kV transformer protection, gas relay (Buholtz protection of transformer tank and OLTC breaker), contact thermometer, overpressure relay and electric protection against internal and external faults, as well as overload protection should be installed. Required protective functions by electric protection devices should be:

a) for main protection devices on 110 kV side:

- transformer differential protection;
- restricted earth-fault protection;
- "tank" protection, only as necessary alternative solution for restricted earth fault protection of 110 kV windings;
- overload protection - thermal image;
- overload / overcurrent protection;
- multi stage three phase overcurrent protection;
- multi stage earth fault overcurrent protection;
- protection against continuous current misbalance;
- breaker failure protection;

- pole discordance protection breaker protection (if not realized by an internal breaker's scheme );
- Trip circuit supervision of the breaker (as an external device for each tripping coil);

b) for backup protection device on 110 kV side:

- multi stage three-phase overcurrent protection (autonomous or conventional design depending on whether one or two accu-batteries are applied in power station 110/x kV);
- multi stage earth fault overcurrent protection;

c) protection device for the x side kV (x = 35, 20, 10, 6):

- multi stage three phase overcurrent protection;
- multi stage earth fault overcurrent protection.
- simplified bus bar protection for x kV;
- multi stage single-phase overcurrent protection for protection of the earthing equipment in neutral of the x kV side
- trip circuit supervision for the breaker (as external device or internal function in the protection device).

**4.2.10.2.3.** For protection of 110 kV overhead lines main and backup protection against faults is required. Required protective functions by protection devices should be

a) for main protection devices:

- distant protection with at least four time-under impedance stages;
- line differential protection (mandatory for 110 kV cables, and for overhead lines in the cases where the calculations show that the selectivity of protection devices cannot be achieved by distance protection);
- automatic reclosure for breaker;
- broken conductors protection;
- breaker failure protection;
- switch on to fault protection;
- multi stage three phase overcurrent protection;
- multi stage earth fault overcurrent protection;
- directional earth fault overcurrent protection;
- overload protection;
- detection of current reversal of failures;
- weak end infeed supply protection;
- power swing blocking;
- secondary circuits supervision (secondary current and secondary voltage circuits);
- fault locator;
- communication logic between the protection devices at the ends of the transmission line (supports communication logic among distance protection devices, directional earth fault devices, communication for line differential protection);
- pole discordance protection;
- trip circuit supervision for breaker (as external device for each tripping coil );

b) for backup protection devices:

- multi stage three phase overcurrent protection;
- multi stage earth fault overcurrent protection;
- direction earth fault overcurrent protection; supervision of secondary current and secondary voltage circuits;

In plants with auxiliary buss bar system 110 kV, switching of protection trips on bus coupler bay breaker shall be provided.

**4.2.10.2.4.** Main and backup fault protection should be installed to protect 110 kV also two-phase transmission lines (e.g. railway substations). Required protective functions by protection devices should be

a) for main protection devices:
- multi stage overcurrent protection;
- multi stage earth fault overcurrent protection;
- automatic reclosure for breaker;
- overload protection;
- breaker failure protection;
- pole discordance protection (if not completed by an internal breaker's scheme);
- trip circuit supervision of the breaker (as external device for each tripping coil);

a) for backup protection devices:
- multi stage overcurrent protection;
- multi stage earth fault overcurrent protection.

**4.2.10.2.5.** If the facility of the transmission system user has 110 kV switchyard with embedded grid tone command, standard field with three current transformers and at least one voltage transformer (for controlling the level of signal) shall be used. Such plant shall be fitted with the three-phase multi stage overcurrent and earth fault overcurrent protection.

**4.2.10.2.6.** Capacitor batteries in the connecting filter shall be protected by the protection against the instantaneous current imbalance that is connected on the current transformer between the neutral points of two groups of the capacitor banks in star shape connection. If there are coupling inductive elements with oil insulation, protection with gas relays needs to be applied.

**4.2.10.2.7.** Bus bar protection is applied in the 110 kV switchyard with single and multiple bus bar systems with at least six bays.

**4.2.10.2.8.** Local differential bus bars protection will be used in 110 kV GIS switchyard of the transmission system user when required by the manufacturer.

**4.2.10.2.9.** 110 kV switchyard with installed differential protection of bus bars shall also have the function of the protection against the breaker failure.

**4.2.10.2.10.** In 110 kV switchyard with several bus bars, protection devices should be installed in bus coupler bay, with multi stage three-phase overcurrent and multistage earth fault overcurrent protection including breaker failure functions.

**4.2.10.2.11.** Backup protection functions shall be applied locally in the physically independent protection device.

**4.2.10.2.12.** Transmission system user shall be responsible for installation of additional protection equipment in its facility aimed at facility protection in case of technological process in the case of transmission grid disturbance. Equipment should not be activated by the transient processes.

### 4.2.10.3. Selection of the type of protection for connection to 220 kV and 400 kV levels of transmission grid

**4.2.10.3.1.** In a case of connection/ interconnection of user's facilities to 220 kV and 400 kV transmission systems JSC EMS shall define technical requirements related to protection in accordance with the specifics of each individual request for connection.

**4.2.10.4. Protection settings**

**4.2.11.4.1.** Transmission system users require from JSC EMS protection settings plan for EPS elements in their facilities that meet the criteria of the first, second and third group of categorization of at least 20 days before the facility (or part of the facility) commissioning. JSC EMS submits this plan to the transmission system user within 10 days from receiving a request from the user.

**4.2.10.4.2.** Transmission system users submit for approval a protection settings plan for EPS elements to the JSC EMS in their facility that meet the criteria of the fourth group of categorization, which are directly galvanically connected to the elements that meet the criteria of the first, second or third group categorization at least 15 days before the facility (or part of the facility) commissioning. JSC EMS within 7 days from receiving the plan of protection setting issues consent to the transmission system user, or defines to the user the changes in the settings plan in order to achieve selectivity and time required trips for all types faults.

**4.2.10.4.3.** Setting plan of protection devices is made keeping in mind the fault of one element of the transmission system only (N - 1 criterion).

**4.2.10.4.4.** Transmission system user implements the parameters from the protection settings plan in their protection devices and immediately informs JSC EMS.

**4.2.10.4.5.** JSC EMS coordinates protection systems with neighbouring transmission system operators with special reference to the determination of the type and protection settings of the interconnection (cross border) lines.

**4.2.10.5. Selectivity of protection zones**

**4.2.10.5.1.** Protection system shall be operating selectively by zones in order to trip a limited part of the transmission system under the faulty situation. Mandatory principle applied here is overlapping of protection zones for reliable protection operation and for every part of the transmission system to have its backup protection.

**4.2.10.5.2.** Selectivity of protection zones takes into account:

- Topology and conditions of the facility of the transmission system user;
- Technical requirements at the connection/ interconnection point;
- Connection status for the fault of one element of the transmission system.

**4.2.10.6. Clearing times**

**4.2.10.6.1.** Clearing times in the transmission grid 400 kV, 220 kV and 110 kV shall be set by JSC EMS. In order to trip selectively only the transmission system element that is under fault situation, timing of the protection activation shall be set in the so-called “stages” of activation.

**4.2.10.6.2.** Clearing times of electrically close faults (excluding those with high impact of transitional resistance of the fault) on the transmission lines, which shall be tripped within the first stage of protection activation, shall be at the maximum of:

- 100 ms in 400 kV transmission grid;
- 100 ms in 220 kV transmission grid;
- 150 ms in 110 kV transmission grid.

**4.2.10.6.3.** Electrically distant faults on the transmission lines, as well as on the neighbouring bus bars, shall be tripped in the second stage of distant protection and the trip time shall be at the maximum of:

- 350 ms in 400 kV transmission grid, if the system for simultaneous tripping has not been used, i.e. 100 ms if that system is used;

- 500 ms in 220 kV transmission grid, if the system for simultaneous tripping has not been used, i.e. 100 ms if that system is used;
- 500 ms in 110 kV transmission grid, if the system for simultaneous tripping has not been used, i.e. 100 ms if that system is used.

**4.2.10.6.4.** Faults on power transformers should be tripped at the maximum of 100 ms by activation of the electric protection from internal faults (differential protection, restricted earth fault protection, or alternative "tank" protection).

**4.2.10.6.5.** Busbar faults should be tripped at the maximum of:

- 100 ms if differential protection of bus bars has been installed (local protection);
- Time equal to trip of the second stage of distant protection of transmission lines, because the faults on them are eliminated by trips of supply lines in neighbouring facilities (distant protection), i.e. time equal to trip time of the multi stage bi-directional distant protection of the transformer which low-voltage side is connected to these bus bars.

**4.2.10.7. Automatic reclosure (AR)**

**4.2.10.7.1.** Overhead lines in the transmission grid should have the function for automatic reclosure (AR) with the following operational logics:

- Single-phase AR in 400 kV, 220 kV and 110 kV transmission grid with interruption time that is 1s;
- Three-phase AR in 220 kV and 110 kV transmission grids, and only in extreme cases in 400 kV transmission grids, with interruption time that is 1 s.

**4.2.10.7.2.** Three-phase AR and manual turn-on of circuit-breakers in a 400 kV, 220 kV and 110 kV transmission network shall be applied during the synchronization requirements checks. Synchronization requirements checks in the case of a three-phase AR, as well as manual turn-on of circuit-breakers in a 220 kV and 110 kV transmission grid, shall be carried out if after analyzing the operation of the system or conducted studies it is established that, in case of three-phase AR or manual turn-on circuit-breakers, problems may occur with the transmission system stability or excessive power currents at individual transmission lines during the turn-on (which can cause an immediate breakdown). JSC EMS shall issue an order to activate the function of synchronization requirements checks for these transmission lines.

**4.2.10.8. Under-frequency protection**

**4.2.10.8.1.** In order to meet the requirements of Under-frequency Protection Plan, distrubution system operator installs under-frequency protection in its system with the following characteristics:

- Frequency setting range: 47-50 Hz, in increments of 0.005 Hz;
- Setting the response time: 0-150 ms;
- Possibility of voltage blocking for voltage in the range of 30-90% of the nominal voltage;
- Possibility of detecting the direction of the active power flow, except for derivatives, where the active energy is injected or taken throughout the year.

## 4.3. ADDITIONAL TECHNICAL REQUIREMENTS FOR GENERATION UNITS

### 4.3.1. INTRODUCTION

**4.3.1.1.** Additional technical requirements for connection of generation units shall be prescribed due to their specific performance and their roles with regard to other facilities in the transmission system, particularly with a view of provision of ancillary and system services and restoration of the transmission system after the blackout.

### 4.3.2. TRANSMISSION GRID CONNECTION

**4.3.2.1.** If the line exclusively intended for the supply of general consumption of the power plant from the transmission grid has been provided, it can be used as the alternative connection for delivery of generated electricity if previously approved by JSC EMS.

**4.3.2.2.** JSC EMS may require a producer to provide the power supply line for auxiliry supply of the connection substation from the generation facility, in case it is technically and economically unreasonable to provide this line from the distribution system.

### 4.3.3. SYNCHRONIZATION TO THE TRANSMISSION GRID

**4.3.3.1.** Synchronization devices provide for the synchronisation of generator unit to transmission grid for the following operational conditions:

- Start of the generation unit in normal operation;
- Synchronization after the generator tripping of the transmission grid to the self-consumption taking into consideration the concept of self-consumption;
- Connection to the system of busbars without supply aimed at activation of those busbars (only for hydropower plants).

**4.3.3.2.** Synchronization of generation units must be provided for all frequencies for 47.5 – 51.5 Hz range and for all voltage levels in the transmission grid within the normal operational range.

**4.3.3.3.** Generating unit shall be synchronised to the transmission grid if the above requirements are met:

- Frequency difference $\Delta f$ is less than 0.1 Hz;
- Voltage difference $\Delta U$ is less than 10% of nominal voltage;
- Angle difference $\Delta\upsilon$ is less than 10°.

### 4.3.4. REAL-TIME DATA EXCHANGE

**4.3.4.1.** Generating unit is equipped in a manner that JSC EMS technical control system is supplied with real-time data as listed in Appendix C.

**4.3.4.2.** If a generating unit can operate in the primary control, it must be equipped so as to send the signal to the JSC EMS technical system as regards the status of operational participation of the primary control (on, off) and to receive a command signal from JSC EMS to turn the primary control on/off.

**4.3.4.3.** If the generation unit has the secondary control capability, it is equipped in a way that JSC EMS technical system is provided with the following additional data:

- Maximum and minimum power of the control band when a generating unit is operating in the secondary control;
- Level of power alternation by the impulse of secondary control;
- Base power of generating unit;

- Status of the secondary control device on the generator (on, off);
- Data required for calculation of the generating unit share in secondary control.

**4.3.4.4.** Generating unit with the secondary control capability shall be equipped so as to receive the following real-time data from JSC EMS:

- Reference values for regulation (on and off of the secondary control), current required power of the secondary control (in the form of set value or regulation impulse);
- Connection status of the switchgear in the transmission system facility connected to the generation unit;
- Current values of the voltage, frequency, active and reactive power flows in the transmission system facility connected to the generating unit.

**4.3.4.5.** Wind generating units shall be equipped so that they can receive from the JSC EMS technical system the set value for the production of active power in case the transmission system security is endangered.

### 4.3.5. DELIVERY OF ACTIVE POWER TO THE TRANSMISSION GRID

**4.3.5.1.** At frequency values in transmission grid less than 49 Hz, a generating unit may reduce generating active power in the amount which is not higher than:

$$\Delta P = 0.05 P_{nom} \cdot \Delta f / Hz$$

where the values are as follows:

$\Delta P$ – reduction of active power generation;

$\Delta f$ – absolute frequency deviation from the nominal value;

$P_{nom}$ – rated active power of generator.

The stated decrease in the delivered active power does not refer to the effect of primary or secondary regulation.

**4.3.5.2.** Step-up transformer must not be a limiting factor for delivery of the active power from the generation unit to the transmission grid.

**4.3.5.3.** Wind generation unit shall be equipped so as to reduce nominal active power of at least 25% of the total installed power per minute.

### 4.3.6. PRIMARY, SECONDARY AND TERTIARY CONTROL

#### 4.3.6.1. Primary control

**4.3.6.1.1.** Each generation unit whose rated active power is above or equal to 50 MW, except for those that are able to combine generation of thermal and electricity, must have primary control capability.

**4.3.6.1.2.** Each generation unit whose nominal active power is less than 50 MW can have primary control capability in accordance with the agreement with the JSC EMS.

**4.3.6.1.3.** Following requirements shall be applied to all generation units participating in the primary control:

- Primary control band must be at least ± 2%$P_{nom}$;
- Active power characteristic – frequency of the primary control device must be adjustable within 4-6% range;
- The following values have been adopted for other values:
  a. Primary control activation time: up to 2 seconds after the disturbance for activation of primary control, maximum 15 seconds after the disturbance for activation of primary control reserve, requiring engagement of 50% power of

the primary control full control band or less, and for disturbances requiring engagement of primary control within 50% to 100% of a full control band, time limit for primary control response shall be determined linearly from 15 s to 30 s;
b. Operational utility: primary reserve must be activated in full for the level of deviation of frequency of the quasi-stationary status ± 200 MHz;
c. Duration of the primary reserve delivery is minimum 15 minutes;
d. Regulator insensitivity should not exceed ± 10 MHz;
e. Metering accuracy must be better or equal to 10 MHz;
f. Blind spot of primary control has to be adjustable within the range of 0 to ± 20 MHz;
g. Metering cycle of generator rotation speed for primary control must not be longer than 0.1 s;
h. Metering cycle for tracking should be 1 second (recommended), and the maximum is 10 seconds.

**4.3.6.2. Secondary control**

**4.3.6.2.1.** Each hydro-generation unit with $P_{nom} \geq 50$ MW must have secondary control capability and the minimum 0.3 $P_{nom}$ control band must be provided.

**4.3.6.2.2.** Each turbo-generation unit with $P_{nom} \geq 150$ MW, except for those that are able to combine generation of thermal and electric power, must have secondary control capability, and the minimum control band to be provided is as follows:

- for turbo-generators using coal as fuel: control band above 0.15 $P_{nom}$;
- for turbo-generators using gas or oil as fuel: control band above 0.25 $P_{nom}$.

**4.3.6.2.3.** While operating in secondary control, generation units may change the active power by the amount of at least:

- 1%$P_{nom}$ per minute for turbo-generation units;
- 20%$P_{nom}$ per minute for hydro-generation units;

through the whole range between the technical minimum and rated power, as well as stable output value of active power during these changes.

**4.3.6.3. Tertiary control**

**4.3.6.3.1.** All hydro-generators must have synchronization time to transmission grid less than 15 minutes.

**4.3.6.3.2.** All engines in pumping plants, i.e. hydro-generators with reversible operation capability, must have synchronization time to transmission grid less than 15 minutes (for both operational regimes).

**4.3.6.3.3.** Each generator must have capability of operating under reduced generation of active power. Minimum level of that generation, where the stable operation of the generator is guaranteed, so-called technical minimum, must meet the following values:

- For hydro-generators: $P_{min} \leq 0{,}45\ P_{nom}$;
- For turbo-generators using coal as fuel: $P_{min} \leq 0{,}7\ P_{nom}$;
- for turbo-generators using gas or oil as fuel: $P_{min} \leq 0.4\ P_{nom}$;
- fFor turbo-generators with a combined cycle: for a gas turbine $P_{min} \leq 0.4\ P_{nom}$, and for a steam turbine $P_{min} \leq 0.8\ P_{nom}$;
- For other types of generators $P_{min} \leq 0.8\ P_{nom}$.

### 4.3.7. VOLTAGE CONTROL

**4.3.7.1.** Generation unit, except for wind generators, shall be equipped is such a way to excise voltage control within the range as presented in the figures:

- 4.3, if connected to voltage level 400 kV;
- 4.4, if connected to voltage level 220 kV or 110 kV;

and also permanently for the normal voltage range of the transmission grid, or temporarily, when the voltage is outside normal range in accordance with point 4.3.8.2.1, where $U_M$ is voltage of the transmission grid at the connection point and $Q/P_{max}$ relation between the reactive and maximum active generator power at the connection point (which is a maximum active power a generation unit may permanently generate, reduced by the active power which is not delivered to the transmission system, or as agreed between the transmission system operator and a producer).

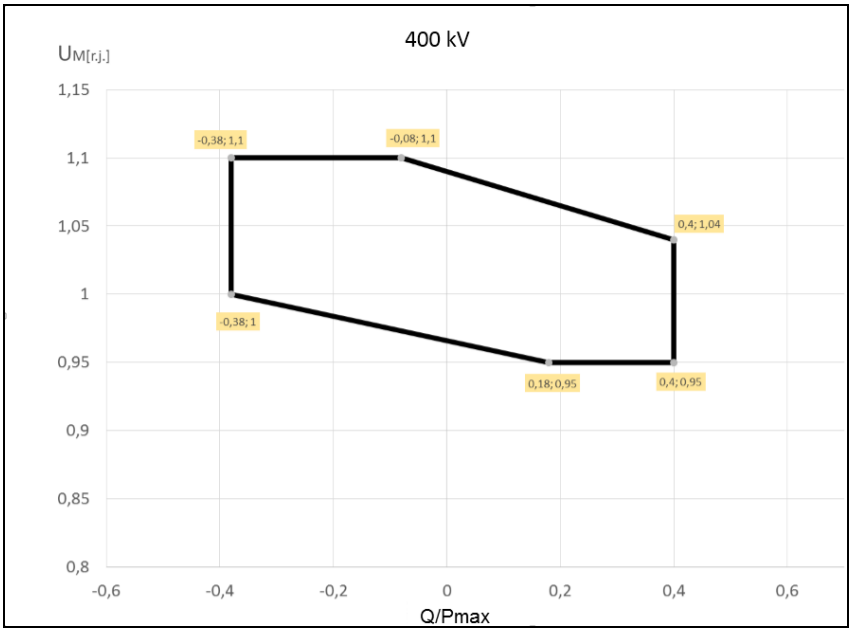



Figure 4.3.

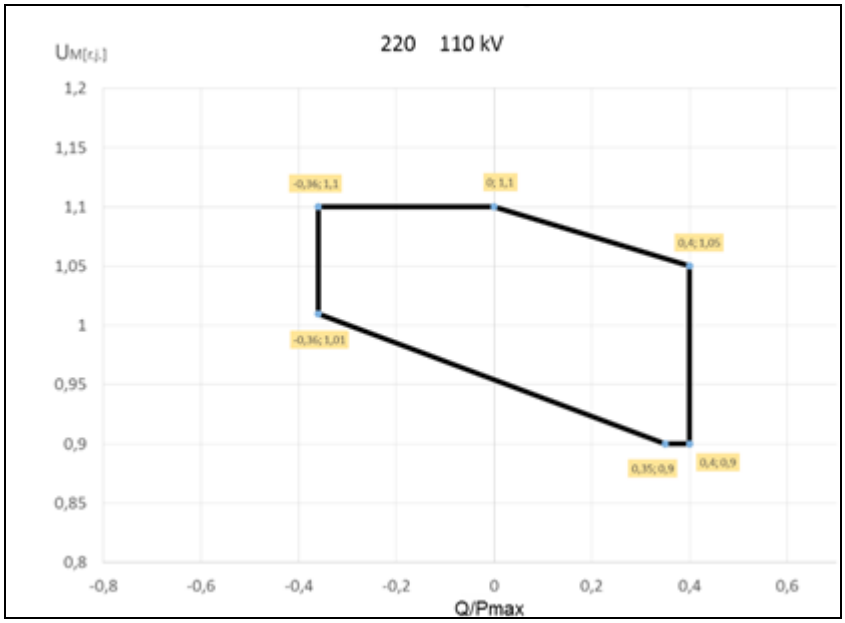



Figure 4.4.

**4.3.7.2.** Wind-generation unit shall be equipped in such a way to be able to perform voltage control within the marked area in Figure 4.5 and 4.6. ($U_M$ and $Q/P_{max}$ mean the same as 4.3.7.1.).

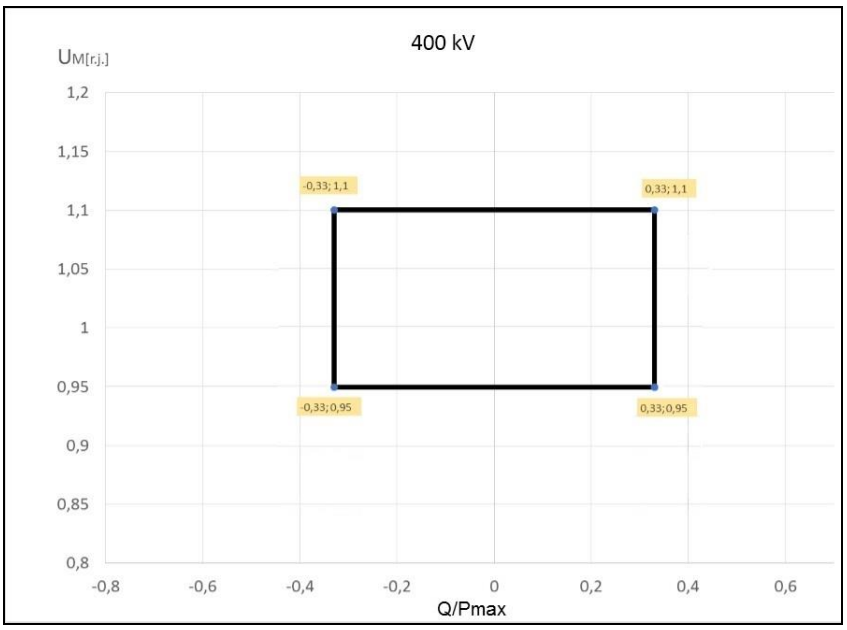



Figure 4.5.

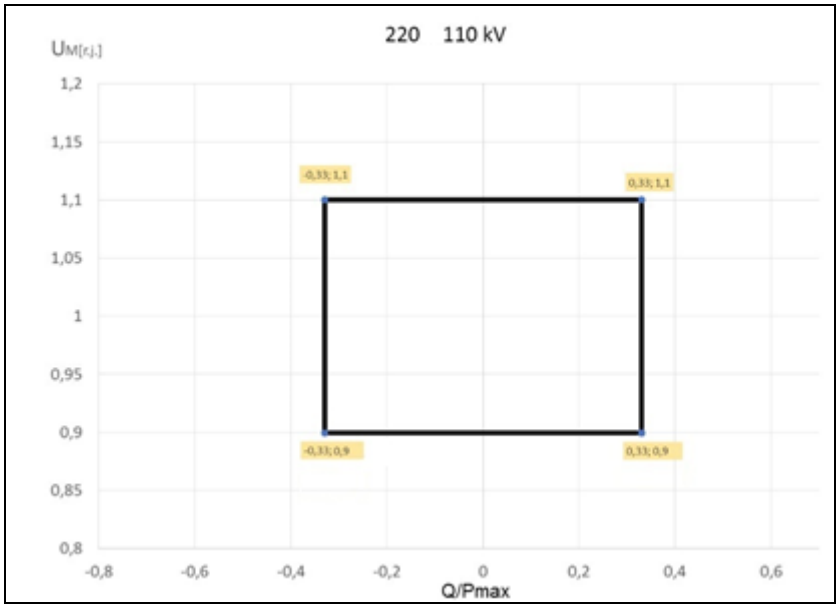



Figure 4.6.

**4.3.7.3.** Statism coefficient of voltage control in the connection point of a generator unit to the transmission grid, calculated as $(\Delta U_m/U_{nom})/(\Delta Q_m/Q_{gn})$, must be adjustable within the range of -1,5% to -6%, with the following values:

$\Delta U_m$ – change of the transmission grid voltage in the connection point of the generating unit to the transmission grid;

$\Delta Q_m$ – change of the reactive power which the generating unit delivers to the transmission grid;

$Q_{gn}$ – value of the rated reactive generator power;

$U_{nom}$ – nominal voltage of transmission grid to which a generating unit is connected.

**4.3.7.4.** In case of significant disturbances in the network (failures), generating unit is equipped in such a way to have the ability to increase the excitation voltage to the highest value of excitation voltage, as defined in the SRPS EN 60034-16-1:2012. The period of voltage increase should not be longer than 100ms (in accordance with IEEE Std. 421.2 – 1990) and lasts at least 500 ms after the voltage returns to the normal operating range, but no longer than 10 seconds from the start of voltage drop.

### 4.3.8. DISCONNECTING GENERATION UNIT FROM THE TRANSMISSION GRID

#### 4.3.8.1. Disconnecting generator due to frequency deviation

**4.3.8.1.1.** Reversible hydro-generation unit. i.e. pumping unit whose rated power is above 100 MW, is equipped for prompt turn off from the transmission grid in the pumping regime for frequency range 49 Hz – 49.8 Hz.

**4.3.8.1.2.** Generation unit remains interconnected to the transmission grid without outage for the frequency change in the amount of up to ± 2 Hz/s. To change the frequency greater than ± 2 Hz/s is allowed outage generating units from the grid after 1.25 s.

#### 4.3.8.2. Disconnecting generator due to voltage deviation

**4.3.8.2.1.** Depending on the level of voltage at the connection point to the transmission grid U, generation unit remains interconnected to the transmission grid without outage for different periods, as follows:

a) for connection points at 400 kV:

- for interval $85\%U_{nom} < U \leq 90\%U_{nom}$, at least 60 minutes;
- for interval $90\%U_{nom} < U \leq 105\%U_{nom}$, permanently;
- for interval $105\%U_{nom} < U \leq 110\%U_{nom}$, at least 60 minutes;

b) for connection points at 110 kV and 220kV:

- for interval $85\%U_{nom} < U \leq 90\%U_{nom}$, at least 60 minutes;
- for interval $90\%U_{nom} < U \leq 111.8\%U_{nom}$,
- for interval $111.8\%U_{nom} < U \leq 115\%U_{nom}$, at least 60 minutes.

**4.3.8.2.2.** In the quasi-stationary state, when the voltage at the connection point is outside the values specified in paragraph 4.3.8.2.1. generating units may be excluded from the grid by application of automatic device.

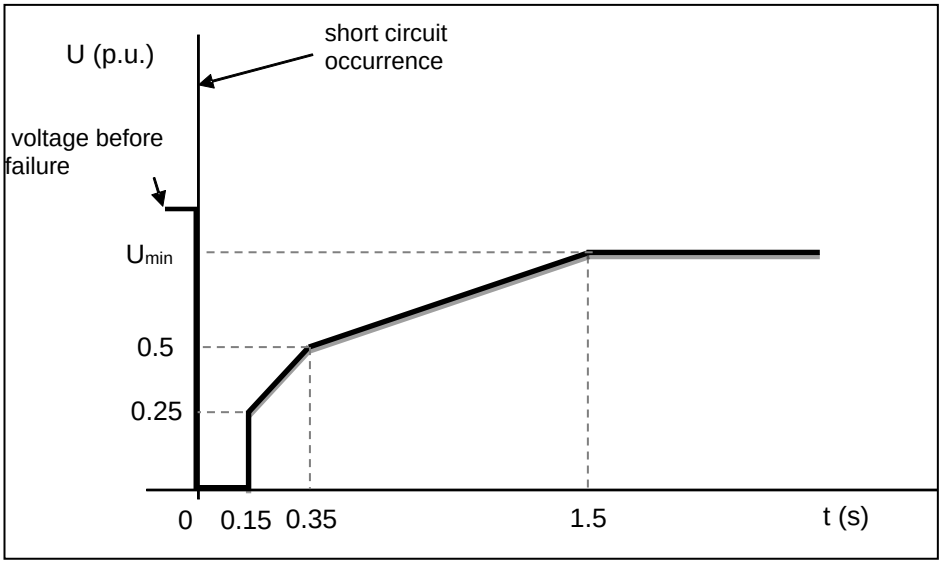



Figure 4.7.

**4.3.8.2.3.** In case of voltage drop in transmission grid, due to short circuit occurrence, turbo generating, i.e. hydrogenerating unit, remains in operation withour outage from the transmission grid, for the area above the line at the Figure 4.7. $U_{min}$ is a minimum operational voltage at which this generating unit remains in operation permanently without outage from the transmission grid in accordance with the item 4.3.8.2.1.

### 4.3.9. BEHAVIOUR OF THE GENERATION UNIT IN CASE OF DISTURBANCE

#### 4.3.9.1. Transient stability in case of short circuits in the transmission grid

**4.3.9.1.1.** Protection in the transmission grid ensures that electrically close faults are turned off in not longer than 150 ms, to avoid generation unit tripping due to instability (it is assumed that before the short circuit the generating unit is within the limits of permitted power supply diagram) if the short circuit power on the high-voltage side of step-up transformer exceeds the level of at least 6 times rated power of the generating unit.

#### 4.3.9.2. Transient stability due to small disturbances

**4.3.9.2.1.** Oscillations of active power flows in the transmission grid must not result in generating unit tripping of the grid by application of protection devices nor to reduction of active power generation.

**4.3.9.2.2.** Turbine-generation device for secondary control must not react to power oscillation in the grid.

#### 4.3.9.3. Generating unit tripping to self-consumption

**4.3.9.3.1.** Turbo-generation unit with rated power above 250 MW is equipped to be capable to exercise the following in case of frequency or voltage deviation and under the requirements defined in paragraph 4.3.8. of the Code:

- To switch to self-consumption operation mode, or
- To reconnect to the grid within 15 minutes after the tripping caused by the mentioned voltage or frequency deviation.

**4.3.9.3.2.** Capability of the generation unit from item 4.4.9.3.1. to switch to self-consumption operation shall be guaranteed also in the case of transmission grid disturbance in line with the protection activation scheme.

**4.3.9.3.3.** After the power unit has switched to self-consumption operation, turbo-generation unit shall be capable of operating under the given regime for at least 60 minutes.

**4.3.9.3.4.** Hydro-generation unit, regardless of the installed power, shall meet all requirements set in items 4.3.9.3.1.- 4.3.9.3.3. for the turbo-generation unit.

#### 4.3.9.4. Capability for black start of hydro-generation unit

**4.3.9.4.1.** Capability of black start of hydro-generation unit in hydro-power plants shall be provided upon the request of JSC EMS for the needs of restoration of the electric transmission grid in after partial or full blackout.

**4.3.9.4.2.** Operation of the hydro-generation unit in the black start mode until the connection of consumption is guaranteed in the period minimum 15 minutes.

#### 4.3.9.5. Capability of the island mode of operation of hydro-generation unit

**4.3.9.5.1.** Capability of the island mode of operation of the hydro-generation unit shall be provided upon the request of JSC EMS for the needs of restoration of the transmission system in after partial or full black out.

**4.3.9.5.2.** Hydro-power plant declared for island mode of operation shall be capable of synchronizing on to the part of the transmission system in island operation, whose power is

above the power of its auxiliary supply and below the rated power of this generation unit. Island mode of operation shall be guaranteed for the period of at least 6 hours.

**4.3.9.5.3.** If the hydropower plant is in island mode of operation, it is equipped to have the ability of sudden change of generation up to the level of 10% of the rated power of the generating units operating at that moment.

### 4.3.10. STABILITY

**4.3.10.1.** Turbo-generation unit of rated power exceeding 200 MW, i.e. hydro-generation unit of rated power exceeding 100 MW shall be equipped with a device for EPS stabilizer.

**4.3.10.2.** JSC EMS establishes the settings of the device for EPS stabilizer, taking into account the following:

- The device does not respond to non-oscillating changes;
- The output signal from the a device for EPS stabilizer does not exceed the range of ± 10% input of voltage regulator signal;
- Not to cause torsional oscillations on other generating units.

# CHAPTER 5: ACCESS TO TRANSMISSION SYSTEM

## 5.1. INTRODUCTION

**5.1.1.** Access, i.e. use of the transmission system includes:

- Access to cross-border transmission capacities;
- Access through the facilities connected, i.e. intra-connected to the transmission system.

**5.1.2.** Access to the cross-border transmission capacities is realized through the following procedures:

- Determining cross-border transmission capacity in cooperation with neighbouring transmission system operators, or regional security coordination centre;
- Allocating the rights to use cross-border transmission capacity to the electricity market participants, in a way stipulated by the Rules on Cross-border Transmission Capacity Allocation;
- Enabling the electricity market participants to exercise allocated right to use cross-border transmission capacity in the manner regulating the rules for allocation of rights to cross-border capacities.

**5.1.3.** Terms and conditions related to refusal of access to cross-border transmission capacities are stipulated by energy legislation, the Rules on Cross-border Transmission Capacity Allocation and the Code, in the part related to the transmission system operation.

**5.1.4.** Through the facilities connected, i.e. intra-connected to the transmission system, the transmission system users are entitled to continuous access to the transmission system under the conditions regulated by the connection approval, the contract on intra-connection and by regulations governing the energy sector.

**5.1.5.** Refusal of transmission system access to the transmission system users, through the facilities connected, i.e. intra-connected to the transmission system, is implemented in a way stipulated by the regulations governing the energy sector.

## 5.2. ACCESS TO CROSS-BORDER TRANSMISSION CAPACITIES

### 5.2.1. CROSS-BORDER TRANSMISSION CAPACITY DETERMINATION

**5.2.1.1.** In compliance with the neighbouring operators of the transmission system, JSC EMS defines:

- Total transmission capacity
- Net transmission capacity;
- Transmission reliability margin;

for every border in both directions on yearly, monthly, weekly and daily basis.

**5.2.1.2.** In determining net transmission capacity and transmission reliability margin, the anticipated operating conditions are taken into account in transmission systems in the region for the relevant period, the technical criteria referred to in Section 3.2. of the Code and the appropriate procedures governed by the interconnection operation rules.

**5.2.1.3.** JSC EMS notifies the balance responsible parties of the necessary data and the format of data which need to be supplied, in accordance with the interconnection operations rules, needed for calculating cross-border transmission capacities for the month M, by the first day in the month M-2. Balance responsible parties submit the said data to JSC EMS by 15$^{th}$ day in the month M-2. For calculations of daily cross-border transmission capacities, for day D, balance responsible parties supply the data on day D by 10.00, in the form as proscribed by EMS JSC.

### 5.2.2. EXERCISING THE ALLOCATED RIGHT TO CROSS-BORDER TRANSMISSION CAPACITY

**5.2.2.1.** After JSC EMS performs the allocation of the right to use cross-border transmission capacities to electricity market participants, these participants acquire the right to nominate cross-border exchange of electrical energy within the development of the Daily Plan of the transmission system operation, i.e. within the intra-day plan changes.

**5.2.2.2.** All the procedures relating to the cross-border exchange of electrical energy are regulated by the Code in the part referring to the transmission system operations.

## 5.3. ACCESS THROUGH THE FACILITIES

### 5.3.1. INTRODUCTION

**5.3.1.1.** In order to regulate the requirements of the transmission system users' access through the facilities connected, i.e. intra-connected to the transmission system, it is necessary to determine:

- Measures related to the quality of delivery and of delivered electricity;
- The manner of establishing the facts about disrupted access.

**5.3.1.2.** JSC EMS is obliged to monitor the conditions of access to the transmission system though the facilities. In the case when it is determined that values referred to in points 5.3.2.2.1., 5.3.2.3.1. and 5.3.2.4.1 are exceeded, JSC EMS shall consider the causes of disrupted access and shall decide on the measures needed to be taken in order to harmonize the quality of delivery and of the delivered electricity with proscribed values. These measures comprise regulating of the conditions for the transmission facilities operation and the transmission system users' facilities, and the transmission system development.

### 5.3.2. PARAMETERS AND METHOD OF ELECTRICITY QUALITY CONTROL

#### 5.3.2.1. Introduction

**5.3.2.1.1.** Quality of electricity supply shall be estimated on the basis of electricity supply interruption.

**5.3.2.1.2.** Quality of delivered electricity shall be estimated based on:

- voltage quality;
- frequency quality.

#### 5.3.2.2. Voltage quality

**5.3.2.2.1.** Voltage quality in the connection, i.e. intra-connection point shall be compliant with the standard SRPS EN 50160 (for the highest voltage level defined by this standard) in the following aspects:

- effective value;
- current value;

- asymmetry;
- higher harmonics;
- flickers.

**5.3.2.3. Frequency Quality**

**5.3.2.3.1.** Frequency quality in the connection, i.e. intra-connection point shall be compliant with the standard SRPS EN 50160.

**5.3.2.4. Quality of electricity delivery**

**5.3.2.4.1.** Power supply may be interrupted in the connection, i.e. intra-connection point due to causes from within the transmission system, for a total duration in one calendar year as follows:

- 2 hours for the connection points of generating units;
- 4 hours for other connection, i.e. intra-connection points at the voltage levels of 400 kV, 220 kV and 110 kV;
- 6 hours for other connection, i.e. intra-connection points at the voltage levels below 110 kV.

The above time intervals do not cover the periods of planned outages in the transmission system.

**5.3.2.5. Measuring the quality of delivered electricity**

**5.3.2.5.1.** Measuring the quality of delivered electricity at the connection and intra-connection points shall be carried out in accordance with the standard SRPS EN 61000-4-30, by measuring phase voltages and line currents.

**5.3.3. DETERMINATION OF FACTS ON DISRUPTED ACCESS**

**5.3.3.1.** The beginning of the disrupted access in cases of effective voltage value deviation when a facility is not integrated into a technical system of transmission system control shall be the moment when the transmission system user control centre notifies (by phone or in writing) the relevant control centre of JSC EMS.

**5.3.3.2.** Data to be considered when establishing the facts on the transmission system user's disrupted access through the facilities are as follows:

- data from the facilities (data on protection activities, chronological registry of events, log file, audio recordings of conversation with the control centres and other data);
- data from the control centres (SCADA system data, log files, audio recordings of conversation with the control centres and facilities and other data).

**5.3.3.3.** The data listed in the position 5.3.3.2. below shall be ranked, in terms of credibility, in the following order:

1. data exchanged in real-time between JSC EMS and the transmission system user whose facility has experienced a disrupted access, i.e. other data equally accessed by JSC EMS and the transmission system user;
2. data from *SCADA* system, facilities and control centres of JSC EMS;
3. data from the facilities and control centres of the transmission system user whose facility has experienced a disrupted access;
4. data from the facilities and control centres of other transmission system users.

**5.3.3.4.** JSC EMS and the transmission system user may require, by an official letter within 15 working days after disrupted access, the other party to deliver the data referred to in position 5.3.3.1. Term for submission of said data shall be 15 days.

## 5. 4. COLLATERAL INSTRUMENT FOR TRANSMISSION SYSTEM ACCESS

**5.4.1.** Transmission system user – transmission system access fee payer (hereinafter: the payer) shall secure its obligations undertaken by the Agreement on Transmission System Access by collateral instruments.

**5.4.2**. Provision of the agreed financial collateral shall constitute an important element in the Agreement on Transmission System Access and a deferring condition for legal enforcement of the respective Agreement.

**5.4.3.** Financial collateral amount shall be fixed depending on the type of collateral instrument and the calculated risk value.

**5.4.4.** EMS JSC shall calculate the risk value for failures to carry out obligations regarding the access the transmission system service and it shall equal

- the maximum amount of monthly invoice for transmission system access within the previous 12 months for all connection points of the final customer or energy entity which perfors energy-related activities in accordance with market principles;
- 10% of the maximum amount of monthly invoice for transmission system access within the previous 12 months for all connection points of the energy entity which performs only regulated energy-related activities.

**5.4.5.** EMS JSC shall calculate the new risk value for the next calendar year for each payer by October 5th of the current year at the latest.

**5.4.6.** Risk value for new connection i.e. intra-connection point shall be calculated according to the planned average monthly quantities of energy and the approved power and the effective fees for transmission system access, submitted by the payer when concluding the Agreement on Transmission System Access.

**5.4.7.** At the end of each quarter, EMS JSC shall calculate new risk value for the payer, on the basis of maximum amount of the realised monthly invoices for the service of transmission system access within the stated three-months period. Should the new risk value change more than 10%, EMS JSC shall require change of the amount of collateral instrument.

**5.4.8.** The value of the relevant collateral shall be defined according to the established risk value.

**5.4.9.** In case of payers default, collection of receivables shall be provided by the following collateral instruments:

- Bank guarantee of a bank headquartered in the Republic of Serbia and with licence issued by the NBS;
- Bank guarantee with a revolving clause of a bank headquartered in the Republic of Serbia with licence issued by the NBS;
- Special purpose (guarantee) deposit with a revolving clause of the bank headquartered in the Republic of Serbia with licence issued by the NBS.

**5.4.10.** The payer shall select one of the three stated collateral instruments, as regulated by the Agreement on Transmission System Access concluded between EMS JSC and the payer.

**5.4.11.** The payer shall submit new or extend the effective collateral instrument 65 days before the date of expiry.

**5.4.12.** The payer shall provide proper collateral instrument in the case of risk value change as mentioned in the item 5.4.7. Exceptionally, in cases of risk value decrease, the user may reserve the right to retain the instrument with the actual risk value.

**5.4.13.** Bank guarantee shall be irrevocable, unconditional, payable on first demand, waiving all objection rights and without protest, effective until the end of the calendar year (31 December of the current year).

**5.4.14.** Bank guarantee shall be issued for the double amount of the calculated risk value for the respective payer.

**5.4.15.** In the case of payer`s default, EMS JSC will protest the bank guarantee, in order to collect the total unpaid amount of receivables increased by the official default interest rate, informing the payer about such a deed in writing at least 2 business days before enforcing the guarantee.

**5.4.16.** Bank guarantee with a revolving clause shall be issued for the amount of the calculated value of the payer's risk and the amount of bank guarantee shall not be reduced during the period of validity regardless of the payment made by the bank as guarantor upon the EMS JSC request. Such guarantee may be enforced partially, and up to the value of the bank guarantee.

**5.4.17.** Validity period of the bank guarantee and a bank guarantee with a revolving clause must be extended 60 days from the date of termination of the access agreeement.

**5.4.18.** Special-purpose (guarantee) deposit with a revolving clause is a collateral instrument in which payer deposited funds in a special-purpose account with the bank headquartered in the Republic of Serbia with the licence issued by the NBS: The funds in the special-purpose account payer deposited in favour of EMS JSC for the period of minimum one year and on the double amount of the calculated risk value.

**5.4.19**. The payer, the bank and EMS JSC shall conclude the agreement on opening and administration of a special-purpose (guarantee) deposit.

**5.4.20.** In the case of payer`s default, EMS JSC is entitled, after the first written demand to the Bank, to collect the receivables from the special-purpose (guarantee) revolving principle deposit. The payer shall refill the special-purpose revolving principle (guarantee) deposit according to the the deadline defined by the agreement on opening and administraton of the special-purpose deposit.

**5.4.21.** Validity of special-purpose revolving principle (guarantee) deposit shall be 60 days after the date of termination of the Agreement on Transmission System Access.

# CHAPTER 6: TRANSMISSION SYSTEM OPERATION

## 6.1. INTRODUCTION

**6.1.1.** In order to ensure preconditions for normal operations of transmission system in real time, it shall be necessary to plan the development of the transmission system and to connect, i.e. inter-connect the facilities of the transmission system user in the manner prescribed by the Code.

**6.1.2.** This chapter of the Code regulates the rules that ensure conditions for normal operation, i.e. secure operation of the transmission system in real time, which are related to:

- provision of ancillary, i.e. system services;
- preparation of the Transmission System Defence Plans;
- planning of the transmission system operation;
- managing the transmission system in real time;
- protection system operations;
- communication system operation;
- reporting on transmission system operation.

**6.1.3.** Through procurement of ancillary, i.e. system services within the stipulated amount, JSC EMS provides the mechanisms for transmission system planning and managing.

**6.1.4.** The Transmission System Defence Plans are the basis for acting under the most severe disturbances and during the restoration of the transmission system after the partial or full blackout.

**6.1.5.** Planning of transmission system operations implies harmonization of the needs for generation, consumption and exchange of electricity, as well as operation performance on the transmission system elements while observing the criteria of normal operation.

**6.1.6.** Transmission system has to be managed in real time in such a way to make the operations of the system run within the planned mode as much as possible. However, the electricity market participants have to be provided with possibility to change the initial plans of generation, consumption and exchange of electricity.

**6.1.7.** Transmission system control also implies special attention to make the operations of the transmission system run in normal conditions, and in the case of disturbances all available measures shall be undertaken to lead to the fastest elimination of disturbances and restoration of the system into normal operating conditions.

**6.1.8.** Reporting on the transmission system operations based on conducted analyses on operations, shall provide necessary feedback, which, inter alia, may impact the following:

- transmission system development planning;
- technical requirements for connection and inter-connection of the facilities;
- method planning of the transmission system operation;
- control of the 400 kV, 220 kV and 110 kV transmission grid.
- concept and contents of the technical standards and procedures.

## 6.2. TYPES AND SCOPE OF ANCILLARY AND SYSTEM SERVICES

### 6.2.1. INTRODUCTION

**6.2.1.1.** System services shall include:

- primary control;
- secondary control;
- tertiary control;
- voltage control;
- sale of electricity to compensate for adverse deviations in the control area;
- participation in the restoration of the transmission system following the blackout.

**6.2.1.2.** With the aim to secure provision of system services, JSC EMS concludes a contract on provision of ancillary services with transmission system end users, which includes:

- primary regulation;
- secondary reserve;
- tertiary reserve;
- capacities for voltage control;
- black start and island operation.

**6.2.1.3.** Transmission system user with the concluded agreement on ancillary services provision with EMS JSC shall maintain in proper condition all its equipment necessary for providing ancillary services and immediately inform EMS JSC on the change of its capacities affecting the possibility or quality of providing such services.

**6.2.1.4.** Transmission system user may, during the given period, agree the primary, i.e. secondary and tertiary reserve per a generating unit, i.e. a group of generating units, only with one transmission system operator.

**6.2.1.5.** EMS JSC may agree with other transmission system operators mechanisms for the exchange of primary, secondary and tertiary control energy and joint use of primary, secondary and tertiary reserve in accordance with the regulations and rules on inter-connection operations.

### 6.2.2. PRIMARY RESERVE

**6.2.2.1.** Based on the rules on interconnection operations, competent authority of *ENTSO-E* shall prescribe the amount of mandatory primary reserve on annual bases for the control area of JSC EMS, which is provided from generation units in the control area of JSC EMS.

### 6.2.3. SECONDARY RESERVE

**6.2.3.1.** The minimum secondary reserve shall amount to 160 MW and shall be provided from generation units in the control area of JSC EMS.

### 6.2.4. TERTIARY RESERVE

**6.2.4.1.** The following values shall be adopted as minimum levels of the direct tertiary reserve:

- 300 MW for positive reserve from the generation units in the control area of JSC EMS;
- 150 MW for negative reserve from the generation units in the control area of JSC EMS.

**6.2.4.2**. Direct positive tertiary reserve of a generating unit is calculated as lower than the following two values:

1) 15min·ΔP/Δt, where ΔP/Δt is an absolute value of the speed of increase of active power generation for a generation unit expressed in MW/min (speed), previously verified by functional testing;
2) $P_{nom}$ – P, where $P_{nom}$ is a nominal active power of a generating unit, and P is a generated active power of a generating unit.

**6.2.4.3**. Direct negative tertiary reserve of a generating unit is calculated as lower than the following two values:

1) 15min·ΔP/Δt, where ΔP/Δt is an absolute value of the speed of decrease of generated active power of a generator expressed in MW/min, previously verified by functional testing;
2) P – $P_{tm}$, where P is a generating active power of a generating unit, and $P_{tm}$ is the power of a technical minimum of a generating unit declared in the agreement on providing ancillary services.

**6.2.4.4**. Direct positive tertiary reserve of controllable consumption is calculated as lower than the following two values:

1) 15min·ΔP/Δt, where ΔP/Δt is an absolute value of the speed of the decrease of active power of controllable consumption in MW/min, previously verified by functional testing;
2) P – $P_{tm}$, where P is an active power of controllable consumptons, and $P_{tm}$ the power of the technical minimum of controllable consumption declared in the agreement on providing ancillary services.

**6.2.4.5**. Negative tertiary reserve of controllable consumption is calculated as lower than the following two values:

1) 15min·ΔP/Δt, where ΔP/Δt is an absolute value of the speed of increase of active power of controllable consumption in MW/min, previously verified by functional testing;
2) $P_{od}$ – P, where $P_{od}$ is an approved active power of a generator unit defined by an act on connection to the transmission system, and P is an active power of controllable consumption.

**6.2.4.6**. Total available positive, i.e. negative direct tertiary reserve shall be calculated as sum of all the stated reserves at all available hydro generating units, controllable consumption and all turbo generator units in operation.

### 6.2.5. VOLTAGE CONTROL

**6.2.5.1.** Ancillary service of voltage control shall be provided by all generation units connected to the transmission system in accordance with their technical characteristics.

### 6.2.6. COMPENSATIONS FOR UNINTENTIONAL DEVIATIONS IN THE CONTROL AREA

**6.2.6.1.** JSC EMS shall be responsible for realization of the programme of compensations for unintentional deviations of its control area, which shall be calculated in accordance with the rules on interconnection operations.

### 6.2.7. PARTICIPATION IN RESTORATION OF TRANSMISSION SYSTEM

**6.2.7.1.** Ancillary services provided by the transmission system users in terms of the transmission system restoring after the blackout shall be as follows:

- black start of generating units;

- island operation mode of generating units.

## 6.3. TRANSMISSION SYSTEM DEFENCE PLANS

### 6.3.1. INTRODUCTION

**6.3.1.1.** The purpose of the Transmission System Defence Plans is be to create technical and organizational preconditions to preserve operational safety of the system, i.e. to enable normalization of the situation, in case of serious disturbances.

**6.3.1.2.** In the worst scenario, i.e. in the case of partial or full blackout of the transmission system, defence plans shall define the procedures that will lead to the fastest possible transmission system restoration.

**6.3.1.3.** Transmission System Defence Plans include:

- Underfrequency protection plan;
- Load Shedding Plans;
- Transmission system restoration plan.

**6.3.1.4.** When approving the connection, i.e. contracting the inter-connection of facilities, JSC EMS shall regulate participation of the facilities in the Transmission System Defence Plans.

**6.3.1.5.** JSC EMS shall prepare the Transmission System Defence Plans in cooperation with the transmission system users.

**6.3.1.6.** Transmission system users shall provide all required data for the development of the plans within the deadlines and in forms prescribed by JSC EMS.

**6.3.1.7.** All participants in implementation of the Transmission System Defence Plans shall acquaint themselves with the contents of the plans and train their staff for efficient use.

### 6.3.2. UNDERFREQUENCY PROTECTION PLAN

**6.3.2.1.** Underfrequency protection plan shall be used as the transmission system protection against major blackouts and outage of a major portion of generating units. It shall be implemented in several phases, when the frequency reaches the following values:

1. 49.8 Hz – alarming of the operational staff in the control centres, in major transmission facilities and in the transmission system users' facilities;
2. 49.0 Hz – activation of the first degree of underfrequency protection (5% of consumption turned off);
3. 48.8 Hz – activation of the second degree of underfrequency protection (additional 15% of consumption turned off);
4. 48.6 Hz – activation of the third degree of underfrequency protection (additional 10% of consumption turned off);
5. 48.4 Hz – activation of the fourth degree of underfrequency protection (additional 10% of consumption turned off);
6. 48.4 Hz – activation of the fifth degree of underfrequency protection (additional 10% of consumption turned off)
7. 48.0 Hz – activation of the sixth degree of underfrequency protection (additional 10% of consumption turned off);
8. 47.5 Hz – outage of the generators is allowed for the purpose of protection thereof against permanent damage.

**6.3.2.2.** Upon drop in frequency range 49.2 – 49.8 Hz, additional level of underfrequency protection shall be provided by disconnecting generators in the reversible hydropower plants from the grid when in pumping mode of operation, i.e. pumps in pumping facilities, In that sense, JSC EMS shall regulate settings of underfrequency protection in this type of facilities.

**6.3.2.3.** Distribution system operator shall be responsible for taking part in underfrequency protection plan including prescribed levels of consumption within their distribution systems.

**6.3.2.4.** JSC EMS shall include in underfrequency protection plan the end users whose facilities are connected to the transmission system, in accordance with the possibility to separate directions of the consumption supply that can be included in this plan without any unacceptable technological consequences related to the end user's interests.

**6.3.2.5.** Underfrequency protection plan shall be subject to regular annual revision. In order to achieve that, the following procedure must be implemented:

- By May 31st, JSC EMS shall submit the request to the transmission system users to deliver the data (the request for drafting the list of distribution supply routes for inclusion into underfrequency protection plan shall be delivered to distribution system operator);
- By June 30th, transmission system users shall deliver requested data to JSC EMS;
- By July 31st , JSC EMS shall check whether the data supplied by the transmission system user meet the criteria referred to in item 6.3.2.1.
- if users fails to meet the criteria for plan preparation, JSC EMS shall contact these users in order to jointly eliminate the deficiencies – this harmonization shall be completed by August 31;
- By October 5, JSC EMS shall deliver the underfrequency protection plan to the transmission system users, in part related to these users.

**6.3.2.6.** Revised underfrequency protection plan shall enter into force by October 15.

**6.3.2.7.** The accuracy of frequency measurement for unloading and maximum response time of underfrequency protection shall be regulated by the rules of operation of interconnection.

**6.3.2.8.** The owner, i.e. holder of the right to use frequency protection devices shall be responsible for maintaining the devices in operational order.

**6.3.2.9.** JSC EMS and transmission system users, in accordance with their authorities, shall ensure that underfrequency protection is implemented in accordance with underfrequency protection plan.

### 6.3.3. LOAD-SHEDDING PLANS

**6.3.3.1.** Load-shedding Plans shall define:

- measures to be undertaken before load-shedding implementation;
- implementation of load-sheddings.

**6.3.3.2.** Load-shedding Plans shall include:

- Immediate Load-shedding Plan;
- Urgent Load-shedding Plan;
- Long-term Load-shedding Plan.

**6.3.3.3.** JSC EMS shall develop Load-shedding Plans in consultation with the transmission system users.

**6.3.3.4.** As a preceding measure, i.e. an accompanying factor of load-sheddings, Load-shedding Plans shall also contain voltage reductions implemented in the facilities of

220/x kV/kV and 110/x kV/kV (x <110). All distribution facilities interconnected to the system shall be capacitated for application of voltage reductions.

**6.3.3.5.** Immediate Load-shedding Plan refers to disturbances of great intensity when it is not possible to delay load-shedding. This plan does not take into account any selectivity (every facility connected, i.e. inter-connected to the transmission system, or the part thereof, may be disconnected).

**6.3.3.6.** Urgent Load-shedding Plan is intended for the disturbances of minor intensity when load-sheddings can be postponed for a while. This plan is selective to some extent and includes the list and schedule of disconnection of transformers 110/x kV/kV (x <110) or terminals x kV.

**6.3.3.7.** Distribution system operator shall include at least 35% of consumption within their distribution system into the plan for urgent load-sheddings.

**6.3.3.8.** The Long-term Load-shedding Plan shall be drafted for disturbances lasting longer than two hours. Therefore, this plan does take into account selectivity of disconnection of end users at the medium voltage (35 kV, 20 kV, 10 kV). This plan also serves as a basis for limiting the supply of electricity in case of general shortage of electricity.

**6.3.3.9.** Distribution system operators shall be obliged to include at least 60% of consumption within their distribution system into the Long-term Load-shedding Plan.

**6.3.3.10.** Duration of the load-shedding has time limitations as stipulated by regulations governing energy sector.

**6.3.3.11.** Load-shedding Plans shall be subject to regular annual revision. In order to achieve that, the following procedure must be implemented:

- By May 31st, JSC EMS shall submit the request to the transmission system users to deliver the data (the list of distribution supply routes for inclusion in the Plan);
- By June 30th, transmission system users shall deliver requested data to JSC EMS;
- By July 31st, JSC EMS shall check whether the data supplied by the transmission system user meet the criteria referred to in items 6.3.3.7. and 6.3.3.9;
- if user fails to meet the criteria for the plan development, JSC EMS shall contact the user in order to jointly eliminate the deficiencies – this harmonization shall be completed by August 31;
- By October 5th, JSC EMS shall deliver the transmission system users the Load-Shedding Plans, in part related to these users.

**6.3.3.12.** Revised Load-Shedding Plans shall enter into force by October 15.

**6.3.3.13.** Load-Shedding Plans shall include the end users whose facilities are connected to the transmission system while one should take into account level of prioritization of end users, causes of general danger and of the large-scale material damage.

#### 6.3.4. TRANSMISSION SYSTEM RESTORATION PLAN

**6.3.4.1.** Transmission system restoration plan shall include several basic scenarios, in order to make it usable in any blackout.

**6.3.4.2.** In drafting said Plan, JSC EMS shall envisage sufficient number of generation units within its control area which shall provide system service of black start and island mode of operation, in order to ensure swift restoration of the transmission system in all foreseeable situations.

**6.3.4.3.** The plan for the transmission system restoration shall encompass all transmission system users in accordance with technical characteristics of the facility.

**6.3.4.4.** Parts of the Plan for the transmission system restoration shall be harmonized with the neighbouring transmission system operators in order to achieve compatibility thereof.

**6.3.4.5.** EMS JSC shall test the The plan for restoration of the transmission system by the simulation of blackout.

**6.3.4.6.** JSC EMS shall perform regular revision of the Plan for restoration of the transmission system, at least once in two years' period.

**6.3.4.7.** In case of changes in the Plan for restoration of the transmission system, JSC EMS shall deliver this plan to all transmission system users, in part referring to their facilities, at least 15 days prior to entering into force of the said plan.

## 6.4. PLANNING OF THE TRANSMISSION SYSTEM OPERATION

### 6.4.1. INTRODUCTION

**6.4.1.1.** Planning of the electric transmission operations shall encompass activities on planning the time horizon of one year ahead, to the intra-day.

**6.4.1.2.** The most significant activities to be implemented in the scope of planning of the electric transmission operations shall imply the following:

- development of the annual plan related to the transmission system operations;
- development of the daily plan related to the transmission system operations;
- development of disconnection plans within the 400 kV, 220 kV and 110 kV grid;
- determining of cross-border transmission capacitates (in accordance with paragraph 5.2.1. of the Code).

### 6.4.2. ANNUAL PLAN OF THE TRANSMISSION SYSTEM OPERATIONS

**6.4.2.1.** Annual plan of the transmission system operations aims to examine whether all basic preconditions for transmission system normal operations have been met, including the evaluation related to potential problems in the provision of system services, i.e. problems in achieving power system balance in the Republic of Serbia, in the part related to electricity.

**6.4.2.2.** JSC EMS shall draw up the Annual plan related to the transmission system operations until November 30 in the year preceding the year for which the plan is developed.

**6.4.2.3.** The annual plan of transmission system operations comprises at a monthly level:

- the plan for consumption, production and exchange of electricity;
- the plan for providing primary, secondary and tertiary reserve;
- the planned quantity of electricity for compensation of technical losses in transmission network;
- the planned value of net transmission capacity;

i.e:

- consumption, production and exchange of electricity in the hour of monthly peak demand;
- planned unavailability of generating units on a daily basis;
- the plans for transmission system operations for specific days.

**6.4.2.4.** JSC EMS shall plan transmission system losses based on mathematical models, using historical data in calculated technical losses in the previous period and taking into account the

planeed consumption, generation and cross-border exchange, as well as the expected changes in the transmission system topology in the coming periods.

**6.4.2.5.** The plan of operations for the specific day referred to in point 6.4.2.3. shall comprise the data in accordance with the rules on interconnection operations. JSC EMS shall inform balance responsible parties about the dates to be considered as specific, at least 30 days prior to the deadline for submission of the data related to those specific dates.

**6.4.2.6.** Not later than October 1 of the year preceding the year for which the annual plan of transmission system operations is developed, balance responsible parties shall deliver to JSC EMS the annual plan of their balance groups' operations, which shall comprise at a monthly level:

- planned summarized load of active power ;
- planned consumption of active power by certain facilities, at the JSC EMS special request (e.g. distribution area consumption in the other control area);
- planned consumption of active power required for pumping;
- planned generation of active power(at connection point) in the facilities connected to the transmission system;
- planned summarized generation in the facilities connected to the distribution system according to the type of primary energy source;
- planned active power exchange both in the control area of JSC EMS and on its borders (import and export are disclosed separately);
- the plans of available capacities for the provision of contracted ancillary services;

and if required:

- planned unavailability of generating units connected to the transmission system on a daily basis, with reasons for unavailability;
- all plans referred to in indents 1-7 herein related to the hour of maximum load on a specific date.

JSC EMS shall define the form in which listed plans are to be delivered to it, and shall be obliged to publish the form on its official web site at least thirty days prior to the deadline for data submission;

**6.4.2.7.** If, based on the security analyses for specific days, JSC EMS estimates that the requirements for normal operations have not been met, i.e. the requirements for realization of primary, secondary and tertiary reserve and for voltage control, JSC EMS shall contact balance responsible parties demanding certain changes to be made in the submitted schedules.

**6.4.2.8.** JSC EMS shall conduct regular verification, i.e. correction of the annual plan of transmission system operations by 25th in the month M-1, whereby the verification, i.e. correction of the said plan shall refer to all months starting with the month M until the end of the year;

**6.4.2.9.** In case of unforeseen changes in operations of the balance responsible group, which could not have been anticipated prior to the deadline, referred to in point 6.4.2.8. the balance responsible party shall promptly notify JSC EMS of these changes. This correction shall not refer to the previous period.

### 6.4.3. DAILY SCHEDULES

### 6.4.3.1 INTRODUCTION

**6.4.3.1.1.** Daily schedules shall include:

- daily schedules of balance groups;
- Daily plan of transmission system.

**6.4.3.1.2.** For submission, validation and confirmation of daily schedules of balance groups, a MMS shall be used. JSC EMS shall provide redundancy in this system.

**6.4.3.1.3.** JSC EMS shall publish on its website the User's manual for MMS system.

**6.4.3.1.4.** JSC EMS and balance responsible parties shall provide redundant communication channels for the purpose of submitting daily schedules of balance groups.

**6.4.3.1.5.** JSC EMS is obliged to establish data formats and the procedure for submission, validation and confirmation of balance groups' daily schedules under normal circumstances, as well as in situations where the JSC EMS information system is not available, and to publish them on its official website.

**6.4.3.1.6.** JSC EMS is obliged to inform as soon as possible the balance responsible parties in case of sudden unavailability of information system and/or when the normal functioning of information system is restored.

**6.4.3.1.7.** Each balance responsible party shall nominate at least one person to be permanently available for contacts with JSC EMS in matters relating to creating daily schedules.

**6.4.3.1.8.** Submission of balance group daily schedule shall be done only by its balance responsible party.

**6.4.3.1.9.** The basic time interval within the daily schedules shall be one hour.

**6.4.3.1.10.** By introducing common rules on cross-border transmission capacities allocation with the neighbouring transmission system operator, different rules for certain borders may apply concerning submission of cross-border power exchange, which shall be determined in the contract concluded with the neighbouring transmission system operator.

**6.4.3.2. Procedure for nomination and confirmation of the daily schedule of balance group**

**6.4.3.2.1.** Balance responsible party shall nominate to JSC EMS the daily schedule of its balance group for day D in accordance with the User's manual for MMS system not later than 14:30 for day D in day D-1. MMS system is not available between 23:50 and 00:10.

**6.4.3.2.2.** Balance responsible party can modify the nominated daily schedule for day D of its balance group that does not include balance entities for paragraphs 1-3 from Article 6.4.3.2.4, i.e. of its balance group that includes balance entities for paragraphs 1-7 and 9-10 from Article 6.4.3.2.5, not later than 15:30 for day D in day D-1.

**6.4.3.2.3.** Balance responsible party can modify nominated blocks of cross-border exchange from Articles 6.4.3.2.4 and 6.4.3.2.5 in daily schedule of its balance group for day D until 14:30 in day D-1, and from 14:30 until 15:30 in day D-1 only if there is a mismatch with nomination of its cross-border partner which is available to JSC EMS by the neighbouring transmission system operator.

**6.4.3.2.4.** Daily schedule of balance group that does not include balance entities, depending on the role assigned to the balance responsible party as regards the nomination of daily schedules, defined in the agreement on balance responsibility, contains:

- production responsible schedule in each time interval that cannot exceed the sum of the subscribed powers of individual generating units belonging to the balance group;
- consumption responsible schedule in each time interval that cannot exceed the sum of the subscribed powers of the controlled load and of the load of this

balance group facilities i.e. load schedule for certain facilities upon special request by JSC EMS (e.g. load of distribution area in other control area);
- blocks of internal schedule in each time interval;
- blocks of cross-border schedule in each time interval.

**6.4.3.2.5** Daily schedule of balance group that includes balance entities, depending on the role assigned to the balance responsible party as regards the nomination of daily schedules, defined in the agreement on balance responsibility, contains:

- daily schedule for generation separately for each balance entity that cannot exceed the value of subscribed powers for such entity in each time interval;
- maximum and minimum power value for each balance entity;
- maximum power value for each generation and pumped storage unit in each time interval that cannot exceed the value of subscribed powers;
- availability of generation and pumped storage units in each time interval;
- daily schedule of controlled load separately for each balance entity in each time interval that cannot exceed the subscribed powers of such entity;
- daily schedule of balance group facilities i.e. load schedule for certain facilities upon special request by JSC EMS (e.g. load of distribution area in other control area) in each time interval;
- blocks of internal schedule in each time interval;
- blocks of cross-border schedule in each time interval;
- list of generating units engaged for the purpose of tertiary regulation and merit order list of generating units engaged for the purpose of tertiary control in accordance with market rules;
- balance entities which will provide the contracted secondary reserve which work is planned with the capacity corresponding to the middle of their control band, as well as the list of their engagement;
- balance entities which will provide the contracted secondary reserve which work is planned with the capacity corresponding to the middle of their control band, as well as the list of their engagement, number of generation units per balance entity and the amount of provided secondary reserve, i.e. for balance entities in which all generating units that are in operation do not participate in the provision of the reserve, a further amount of reserve for that balance entity is delivered ;

**6.4.3.2.6** The format of schedules from Articles 6.4.3.2.4-5 shall be defined by JSC EMS.

**6.4.3.2.7.** Daily schedule of balance group that does not include balance entities must be balanced in each time interval resolution, i.e. algebraic sum of the power referred to in the all indents of 6.4.3.2.4 must be equal to zero in each time interval resolution.

**6.4.3.2.8.** Daily schedule of the balance group which contains balancing entities, must be balanced in each time interval, i.e. algebraic sum of the power referred to first, fifth, sixth, seventh and eighth indents of point 6.4.3.2.5. must be equal to zero in each time interval.

**6.4.3.2.9.** If daily schedule of balance group, except for organized electricity market, becomes unbalanced as a result of activities set out in point 6.4.3.2.13-16. and 6.4.3.2.19. the JSC EMS leaves the possibility for this balance group to balance its daily schedule by modifying it in intraday process in accordance with point 6.4.3.3. Balance responsible party which daily schedule remained unbalanced even after the intraday process shall be held liable as defined in the contract of balance responsibility.

**6.4.3.2.10.** For each time interval and for each direction, submission of only one block of internal exchange between two balance groups shall be permitted.

**6.4.3.2.11.** Power exchange between electricity market participants belonging to the same balance group shall not be submitted to JSC EMS.
**6.4.3.2.12.** Block of internal exchange shall be submitted by both balance responsible parties which are counterparties in this block of exchange. Otherwise, JSC EMS shall inform about irregularity balance responsible party which daily schedule includes that exchange.
**6.4.3.2.13.** If a balance responsible party which is not a balance responsible party of the organized electricity market does not eliminate the irregularity referred to in point 6.4.3.2.12. within the deadline envisaged for modification the daily schedule (in accordance with point 6.4.3.2.2.), JSC EMS determines that the value of the submitted block of internal exchange of electricity is zero at each time interval.
**6.4.3.2.14.** If balance responsible party, referred to in point 6.4.3.2.12., is a balance responsible party of the organized electricity market, then after the expiration of the deadline envisaged for modification the daily schedule (in accordance with point 6.4.3.2.2), JSC EMS determines that the values of the submitted block of internal exchange are accepted at each time interval and imposes the same block of internal exchange to the another balance responsible party.
**6.4.3.2.15.** The block of internal exchange between two balance groups, none of which is an organized electricity market, must be identical in daily schedules of both balance groups. If that is not the case, i.e. different power exchange in a time interval, which may be registered only after submission of both daily schedules, JSC EMS shall immediately notify both balance responsible parties in accordance with the User's manual for MMS system. If the balance responsible party does not correct the irregularity within the deadline envisaged for modification the daily schedule (in accordance with point 6.4.3.2.2.), JSC EMS determines that the lower value of internal exchange from mentioned daily schedules in the disputable time intervals, is binding.
**6.4.3.2.16.** The blocks of internal exchange between two balance groups, none of which is an organized electricity market, must be identical in daily schedules of both balance groups. If that is not the case, i.e. different power exchange in a time interval, JSC EMS shall immediately notify the both balance responsible parties in accordance with the User's manual for MMS system. If the balance responsible party which is not a balance responsible party of the organized electricity market does not correct the irregularity within the deadline envisaged for modification the daily schedule (in accordance with point 6.4.3.2.2.), JSC EMS determines to accept as binding value from daily schedule of organized electricity market in these time intervals.
**6.4.3.2.17.** In daily schedule of balance group nominated quantity of block of cross-border exchange, in each time interval, should be lower or equal to the allocated cross-border transmission capacity and must be an integer value. If this value is higher than allocated cross-border transmission capacity, JSC EMS shall give information about irregularities and reject the submitted block of cross-border exchange, immediately upon submission of such plan. If the information about the allocated cross-border transmission capacity is not available in the MMS system, JSC EMS informs the balance responsible party about that and waits for the deadline envisaged for modification the daily schedule to expire (in accordance with point 6.4.3.2.3.). If within the deadline envisaged for the modification the daily schedule (in accordance with point 6.4.3.2.3.), JSC EMS concludes that the value of the submitted power exchange is greater than the allocated cross-border transmission capacity, or that cross-border transmission capacity was not allocated, determines that the value of block of cross-border electricity exchange is zero in every time interval.
**6.4.3.2.18.** Information concerning allocated cross-border capacity, as well as their capacity agreement identification shall be made available to each balance responsible party through

the MMS system, in accordance with time intervals defined in the rules for allocation of available cross-border transmission capacities.

**6.4.3.2.19.** The nominated block of cross-border exchange by the balance responsible party, using the allocated cross-border transmission capacity available in the MMS system, in its daily schedule shall be identical to the nomination of block of cross-border exchange of its cross-border partner which is available to JSC EMS by the neighbouring transmission system operator. In case of mismatch in one of time intervals, JSC EMS shall report the irregularity to the balance responsible party and allows it to correct the irregularity. If the balance responsible party does not correct irregularity within the deadline envisaged for the modification the daily schedule (in accordance with point 6.4.3.2.3.) or if JSC EMS does not receive information from the neighbouring transmission system operator about modification of submission of cross-border partner, JSC EMS in co-operation with the neighbouring transmission system operator, based on interconnection rules and mutual agreements, shall consider lower value for these block of cross-border exchange as binding.

**6.4.3.2.20.** The nominated block of cross-border exchange by the balance responsible party in daily schedule until 14:30 in day D-1 for day D, using the allocated cross-border transmission capacity available in the MMS system and which is matched with the neighbouring transmission system operator cannot be changed in a period of time from 14:30 until 15:30 in day D-1 for day D.

**6.4.3.2.21.** Each balance responsible party which do not contain balance entities and has the role for production responsible party is obliged to submit the balance responsible party generation schedule, which contains the first indent from point 6.4.3.2.4.

**6.4.3.2.22.** Each balance responsible party which contains balance entities and has the role for production responsible party is obliged to submit the balance responsible party generation schedule, which contains the first indent from point 6.4.3.2.5.

**6.4.3.2.23.** Each balance responsible party which do not contain balance entities and has the role for consumption responsible party is obliged to submit the balance responsible party generation schedule, which contains the second indent from point 6.4.3.2.4.

**6.4.3.2.24.** Each balance responsible party which contains balance entities and has the role for consumption responsible party is obliged to submit the balance responsible party generation schedule, which contains the fifth and sixth indents from point 6.4.3.2.5.

**6.4.3.2.25.** If balance responsible party with role of production responsible party i.e. consumption responsible party does not nominate daily schedule as referred in points 6.4.3.2.21-24. until gate closure time and corrections gate time of daily schedules of balance group for day D (set out in 6.4.3.2.2.), JSC EMS considers this values set out in points 6.4.3.2.21-24. are zeros in all time intervals.

**6.4.3.2.26.** In case of irregularities in submitted daily schedules set out in 6.4.3.2.4-5, particularly in relation to typical situations as referred to in 6.4.3.2.13-16 and 6.4.3.2.19, the balance responsible party may modify its daily schedule in deadlines set out in 6.4.3.2-3.

**6.4.3.2.27.** Balance responsible party may not cancel in part or in whole the block of cross-border exchange in already confirmed daily schedule.

**6.4.3.2.28.** JSC EMS shall send to the balance responsible party which not consist of balance entity confirmed daily schedule for the blocks of internal and cross-border schedules, confirmed production responsible schedule and confirmed consumption responsible schedules for day D, on the day of submission D-1 until 15:45 CET. Exceptionally, JSC EMS may extend that period in case of unavailability of information systems or delay in receiving the required data from neighbouring transmission system operators, which JSC EMS shall timely report to the balance responsible party.

**6.4.3.2.29.** JSC EMS shall send to the balance responsible party which consists of balance entity confirmed daily schedule for the blocks of internal and cross-border schedules, confirmed production responsible schedule nominated referred to the first indent from point 6.4.3.2.5 and confirmed consumption responsible schedules nominated referred to the fifth and sixth indent from point 6.4.3.2.5. for day D, on the day of submission D-1 until 15:45 CET. Exceptionally, JSC EMS may extend that period in case of unavailability of information systems or delay in receiving the required data from neighbouring transmission system operators, which JSC EMS shall timely report to the balance responsible party.

### 6.4.3.3. Intraday changes to balance group daily schedule

**6.4.3.3.1.** Balance responsible party may modify balance group daily schedule for day D on the day of submission D-1 from 18:00, and on day D to which the daily schedule relates, but not later than 60 minutes prior to the beginning of the time interval covered by the change.

**6.4.3.3.2.** If case of unavailability of information systems or delayed of information from neighbouring transmission system operator JSC EMS shall cancel nomination deadlines stated in point 6.4.3.3.1. until problem is solved.

**6.4.3.3.3.** The balance responsible party intraday change of daily schedule will be accepted if:

- submitted blocks of cross-border exchange are identical to exchanges submitted by the neighbouring transmission system operator;
- submitted blocks of internal exchange are identical to submissions of related balance responsible parties;
- scheduled value for generation separately for each balance entity for available units is between minimum and maximum power value for each balance entity;
- production responsible schedule of balance group cannot exceed the value of subscribed powers for such balance entity;
- scheduled value for controlled load separately for each balance entity for available units is between minimum and maximum power value for each balance entity;
- scheduled value for balance group facilities i.e. load schedule for certain facilities upon special request by JSC EMS (e.g. load of distribution area in other control area) cannot exceed the value of subscribed powers for such balance entity.

**6.4.3.3.4.** In case of intraday submission of block of cross-border exchange, the submitted value shall be identical to intraday allocated capacity. At the end of each month JSC EMS shall check whether the submitted value of cross-border exchange is identical to the intraday allocated capacity. In case of detected irregularity action should be taken in accordance with the Balance Responsibility Contract.

**6.4.3.3.5.** JSC EMS confirm intraday changes to balance group daily schedule for block of cross-border exchange not later than 15 minutes before delivery hour, while for the block of internal exchange, production responsible schedule and consumption responsible schedule shall be confirmed at 23:00 in day D for day D-1.

### 6.4.3.4. Daily plan of transmission system

**6.4.3.4.1.** JSC EMS shall produce daily plan of transmission system.

**6.4.3.4.2.** Daily plan of transmission system shall be prepared based on:

- available cross-border transmission capacities per each border and direction;
- confirmed daily schedules of balance groups;
- load forecast;
- transmission system technical losses forecast;

- planned amount of primary, secondary and tertiary reserve;
- availability of generating units, i.e. of balance entities.

**6.4.3.4.3.** Daily plan of transmission system shall include the following hourly data:

- load schedules of balance groups;
- load schedules of transmission system prepared by JSC EMS based on internal methodologies;
- schedule of controlled load (pump storages);
- scheduled blocks of cross-border exchange of balance groups and cross-border exchange of JSC EMS;
- scheduled blocks of internal exchange between balance groups and internal exchange between balance groups and JSC EMS;
- scheduled generation of balance entities;
- calculated values of primary reserve of balance entities planned for operation i.e. which are available on the merit order list of balance reserve engagement in secondary and tertiary control;
- calculated values of the secondary control range of balance entities which are planned for the operation i.e. which are available on the list of balance reserve engagement in secondary control;
- calculated values of tertiary reserve of balance entities which are planned for the operation i.e. which are available on the merit order list of balance reserve engagement in tertiary control;
- plan of availability of balance entities and the list of balance reserve engagement in tertiary control;
- plan of recoupment of transmission system losses;
- compensation plan for unintended deviations of the control area of JSC EMS according to rules which regulate operating in interconnection;
- set-point frequency delivered by the responsible coordination centre in interconnection;
- data about net and available transmission capacity, as well as the transmission reliability margin for each border.

**6.4.3.4.4.** Daily plan of transmission system shall provide conditions for normal operation and, if it is not possible, conditions for secure operation.

**6.4.3.3.5.** JSC EMS shall conduct security analyses based on the daily plan of transmission system.

**6.4.3.4.6.** If the security analyses show that the submitted daily schedules of balance groups do not provide conditions for normal operation, JSC EMS shall take appropriate measures listed below:

- evaluates which schedules are exerting major impact on disturbance of normal operations;
- communicates and consults with the responsible for schedules in order to modify them;
- plans the configuration and parameters of 400 kV, 220 kV and 110 kV grids;
- cancels planned disconnections in the 400 kV, 220 kV and 110 kV grids;
- plans re-dispatching;
- analyses the impact of cross-border exchanges of electricity;
- managing appropriate blocks of cross-border exchanges in accordance with the contract concluded with other transmission system operators.

6.4.3.4.7. If the normal operations cannot be provided by the measures referred to in 6.4.3.4.6, JSC EMS shall decide to reduce i.e. to reject cross-border exchanges in accordance with rules which regulate operating in interconnection and agreements with adjacent transmission system operators.

### 6.4.4. 400 KV, 220 KV AND 110 KV GRIDS OUTAGE PLANS

#### 6.4.4.1. General Rules for Outage Plans

**6.4.4.1.1.** JSC EMS shall prepare Outage Plans for electricity transmission grid (ETG) elements in coordination with the transmission system users and neighbouring grid operators and regional security centers in accordance with the rules on interconnection operation.

**6.4.4.1.2.** JSC EMS shall prepare annual, quarterly and weekly ETG elements Outage Plans for the first, second and third group. If necessary, ETG users shall prepare ETG Outage Plans for the fourth group according to Classification.

**6.4.4.1.3.** Outage Plans shall include de-energized work conducted in the third zone, in terms of regulations governing general work safety measures, on electrical power facilities with 400 kV, 220 kV and 110 kV voltage, as well as on the elements of lower voltage that form integral part of such elements (transformer tertiary, transformer neutral point etc.) and other works requiring ETG shut off.

**6.4.4.1.4.** When preparing Outage Plans, JSC EMS is required to harmonize outages in the 400 kV, 220 kV and 110 kV transmission grid with generating units schedules, for the purposes of maintaining conditions for normal operation, and, if it is not possible, for safe operation during turn-off procedure.

**6.4.4.1.5.** In order to provide normal conditions for transmission grid operation during planned outage of transmission grid elements JSC EMS may establish (impose) schedule for generating units maximum:

- 100 hours for turbo generator units fuelled with coal;
- 250 hours for hydroelectric power plants;

during one calendar year per unit and in accordance with technical specifications of these units.

JSC EMS shall submit so defined schedules for D day to producer within the periods of time when it planned availability of generator unit:

- until 12:00 on D-3 day for turbo generator units
- until 08:30 on D-1 day for hydroelectric plants.

**6.4.4.1.6.** Outage proposals, for the purposes works due to JSC EMS investments and transmission system users shall be included in Outage Plans.

**6.4.4.1.7.** Outage of ETG elements which are property of transmission system users (OHL bays, bus coupler bays, busbars, transformer bays etc.) and which require switching off transmission line, transmission system user shall plan in time intervals when JSC EMS has planned outage of transmission lines.

**6.4.4.1.8.** Transmission system operators, based on the methodology arising out of the rules on the interconnection operation, shall prepare a list of power system elements which are the the subject of coordinated regional planning and outages between transmission system operators. EMS JSC shall timely inform the transmission system users on the power system elements of the user which are the subject of the coordinated regional outages planning.

**6.4.4.1.9.** EMS JSC and the transmission system users shall be informed on the persons responsible for planning outages.

**6.4.4.1.10.** Power system elements in the process of planning outages may have the status: available, unavailable and in functional testing, in accordance with the rules of interconnetion operation.

**6.4.4.1.11.** For the purpose of mid-term planning, EMS JSC may ask for indicative data on the planned outages of generating units and outages of power system elements from the position 6.4.4.1.8. up to two years in advance.

**6.4.4.1.12.** Detailed procedures for preparing Outage Plans, informing on the responsible persons for outages planning, issuing approvals for switching off ETG elements and implementation of basic safety measures at the location where work is done on ETG facility elements, as well as form and contents of the documents (requests, approvals etc.) based on which outage is approved, shall be defined by JSC EMS in cooperation with transmission system users, which is insterted in the agreements on exploitation.

### 6.4.4.2. Regular Outage Duration

**6.4.4.2.1.** Values, specified in the Table 6.1 for transmission lines and Table 6.2 for other ETG elements but not less than 2 days, shall be adopted for the outage duration due to regular annual maintenance:

Table 6.1.

| Transmission Line Description | maximum turn-off duration |
|---|---|
| Single-system transmission lines of 110 kV, for each 10 km | 1 day |
| Single-system transmission lines of 220 kV, for each 10 km | 1.1 day |
| Single-system transmission lines of 400 kV, for each 10 km | 1.25 day |
| Two-system transmission lines* | Time for single-wire × 1.2 |
| For each river cross-over of transmission line | One additional day |

*duration refers to the whole transmission line (both systems synchoniously), when turned-off

Table 6.2.

| Description of ETG elements | maximum turn-off duration |
|---|---|
| Busbar system | 1 day |
| Transformer of 110/x kV/kV | 3 days |
| Transformer of 220/x kV/kV | 5 days |
| Transformer of 400/x kV/kV | 6 days |
| All bay types | 3 days |

**6.4.4.2.2.** Work on regular maintenance of step-up transformers and other elements, which need to be switched off during the overhaul of the appropriate generator unit, shall be realized during the overhaul period of such generator unit.

### 6.4.4.3. Annual Outage Plan and Annual Regional Inteconnection Outage Plan

**6.4.4.3.1.** Annual Outage Plan shall be prepared as an outage plan on daily bases, and if this is not possible, than according to quarters and months. Annual outage plan includes power system elements of the first, second and third group of Categorisation.

**6.4.4.3.2.** Annual Outage Plan shall be harmonisaed with the regional interconnection outage plan, developed in accordance with the rules on interconnection operation, and it includes the elements of power system determined in the manner as stated in the position 6.4.4.1.8.

**6.4.4.3.3.** Draft plans for outages of power system elements in the facilities of the transmission system users shall be used as basis for the development of the Annual Outage Plans and Annual Regional Interconnection Outage Plans, which such users shall supply to EMS JSC:

- By the deadline stated in the rules on interconnection operation for the power system elements included in the Annual Regional Outage Interconnection Plan, i.e.
- By September 20th of the current year for the next year for the power system elements included only in the Annual Outages Plan.

**6.4.4.3.4.** EMS JSC and transmission system users shall harmonise the outages plan for power system elements in the facilities of the transmission system users for the purpose of development of the regional plan of interconnection outages. EMS JSC, by December 1st of the current year, shall supply transmission system user with the part of the stated plan referring to the power system elements of such user.

**6.4.4.3.5.** EMS JSC supplies the proposal of the Annual Outages Plan to the transmission system users by December 5$^{th}$ of the current year for the following year, after which EMS JSC and the transmission system users harmonise this plan by December 20th of the current year for the following year, when it is finalised. EMS JSC shall supply the Annual Outages Plan to transmission system users latest within 5 days from the date it is completed.

**6.4.4.3.6.** Changes in the Plan of outages of the power system elements which are not included in the Annual Regional Interconnection Outages Plan shall be performed in accordance with the rules on interconnection operation.

**6.4.4.3.7.** Annual outage plans may be changed by JSC EMS on its own initiative or as requested by transmission system user, if there are justified reasons and with consent of the affected transmission system users. Changes shall pertain to the period starting from occurrence of circumstances for change until the end of the year for which Outage Plan was adopted. Changes may be done only in the part of annual plan for which no quarterly Outage Plan was adopted, except if JSC EMS and transmission system users, affected by the change, agree with the change. Transmission system users may file a request to JSC EMS for change of plan, not later than 25th day in the month M-2 for the month M. If switching off elements of one Classification group requires additional switching off of elements regarding other group, the elements additionally switched off shall be reported into the other Classification group's outage plans.

### 6.4.4.4. Quarterly Outage Plan

**6.4.4.4.1.** Quarterly Outage plans shall be prepared based on the Annual Outage Plan and submitted requests for changes to the Annual Outage Plan, except for the first quarter of the year which shall be prepared along with the Annual Outage Plan. Quarterly Outage Plans shall be prepared broken-down by days.

**6.4.4.4.2.** Quarterly plan proposals for halting operation in generation facilities, quarterly proposals for outage plans of facilities for distribution of electricity and quarterly Outage Plan proposals for power facility elements of other transmission system users, shall be submitted to JSC EMS not later than 30 days prior to deadline for the preparation of the

quarterly plan, except for the first quarter which shall be submitted in terms for Annual Outage Plan.

**6.4.4.4.3.** Quarterly Outage Plan for the first, second and third group of Classificaton of ETG elements shall be prepared not later than 15 days prior to the commencement of the period which the plan pertains to, except for the first quarter which is developed also when the annual Outage plan. JSC EMS shall submit quarterly outage plans to transmission system users not later than 5 days following the day of their completion.

**6.4.4.4.4.** Quarterly outage plans may be changed by JSC EMS on its own initiative or as requested by transmission system user, if there are justified reasons and with consent of all affected transmission system users. Changes shall pertain to the period starting from occurrence of the circumstances for change until the end of the quarter for which Outage Plan was adopted. Changes may be done only in part of quarterly plan for which no weekly Outage Plan was adopted, unless JSC EMS and transmission system users, affected by the change, agree with the change. Transmission system users may file a request for change of plan to JSC EMS, not later than Wednesday at 10:00 o'clock in the week S-2 for the week S. If the outage of elements of one Classification group requires additional outage of elements regarding the other group, the elements that are to be switched off additionally shall be included into the other Classification group outage plans.

### 6.4.4.5. Weekly Outage Plan

**6.4.4.5.1.** Weekly Outage Plans shall be prepared broken-down by days and hours.

**6.4.4.5.2.** Weekly Outage Plans, previously set by the quarterly Outage Plan for the week for which weekly plan is adopted, shall be revised in compliance with the approved requests for extension of deadline for work that has already begun, requests for work that was postponed based on the orders received from JSC EMS dispatch centres and outage requests due to occurred or determined potential failure or request for emergency work, as well as the determined new time intervals for implementing outage for delayed or extended work.

**6.4.4.5.3.** If, for justified reasons, the planned work on certain ETG element is not done or not completed within the time interval determined in weekly outage plan, the transmission system user shall propose to JSC EMS a new outage time interval. New outage time interval shall be proposed so that it does not violate the adopted quarterly outage plan. If the additional outage time interval cannot be obtained in the existing quarter, such outage needs to be planned in some of the following quarters. JSC EMS shall be responsible for determining new outage time interval for delayed or extended work in coordination with the transmission system user.

### 6.4.4.6. Submitting and Approving Outage Requests

**6.4.4.6.1.** For the purposes of prescribing procedure of submitting and approving outage requests, JSC EMS shall define the form for the elements of the first, second and third Classification group together with transmission system users.

**6.4.4.6.2.** Regular interchange of lists of authorized persons, which may fill in the form referred to in 6.4.4.6.1 between JSC EMS and transmission system user, shall be performed each year not later than March 1st.

**6.4.4.6.3.** Outage request shall be submitted on three bases:

- for work performed on ETG elements;
- for work in the vicinity of ETG elements;
- for work not requiring basic safety measures at work location.

**6.4.4.6.4.** Transmission system users shall submit to JSC EMS the outage request due to planned works not later than Wednesday at 10:00 o'clock current week for the following week. Outage requests submitted due to existing outage may be submitted immediately upon the occurrence of the outage (emergency work).

**6.4.4.6.5.** Outage approval for planned work shall be submitted by JSC EMS to the applicant not later than Thursday 15:00 o'clock current week for outages planned for the next week, and for emergency works up to 60 minutes following the receipt of the outage request.

**6.4.4.6.6.** Outage approval, based on which transmission system user remains without electrical supply, may be issued by JSC EMS upon prior notification to the affected transmission system users, i.e. the public, according to the regulation specifying delivery and supply of electricity conditions, and distribution system operator at least 20 days in advance.

#### 6.4.5. ADDITIONAL DATA FOR PLANNING OF WORK IN INTERCONNECTION

**6.4.5.1.** Balance responsible party shall submit to JSC EMS upon request data for two days ahead and a week ahead according to the rules on interconnection operation.

**6.4.5.2.** JSC EMS shall timely inform balance responsible parties on the form and type of data as per 6.4.5.1. and the deadlines for their submission, along with explanation on the purpose and the basis the data are asked for.

#### 6.4.6. ESTIMATION OF MID-TERM AND SHORT-TERM GENERATION ADEQUACY

**6.4.6.1.** EMS JSC estimates mid-term and short-term adequacy of production of electricity under the rules on interconnection operation according to the data on availability of generating units, the amout of primary, secondary and tertiary reserve, consumption forecast and values of cross-border transmission capacities.

**6.4.6.2.** In case of identifying an inadeqacy in electricity generation, EMS JSC shall estimate the probability, expected duration and the undelivered electricity due to this ocurrence.

### 6.4.7. REGIONAL SECURITY COORDINATOR

6.4.7.1. EMS JSC cooperates with regional security coordinator according to the rules on interconnection operation, as follows:

- verification of individual grid model of transmission system operator and creation of common grid model of interconnection;
- security analysis at common grid model;
- coordinated calculation of cross-border transmission capacities;
- estimated mid-term and short-term generation adequacy;
- coordination of outage planning;
- other activities under the concluded agreements.

## 6.5. MANAGING THE TRANSMISSION SYSTEM

#### 6.5.1. INTRODUCTION

**6.5.1.1.** JSC EMS shall manage the transmission system in the manner that provides:

- preservation of the transmission system operation;
- reliable delivery of electricity to transmission system users;
- optimal usage of available transmission capacities;
- achieving maximum cost-effectiveness in operation of transmission system as a whole in given circumstances.

**6.5.1.2.** Transmission system control shall be implemented by JSC EMS dispatch centres, established on two levels:

- on the level of the National Dispatch Centre that manages 400 kV and 220 kV transmission grid, along with 110 kV tie-lines;
- on the level of the regional dispatch centres that manage 110 kV transmission grid, with exception of 110 kV tie-lines.

**6.5.1.3.** Transmission system facilities shall be used in compliance with technical characteristics of such facilities issued by the equipment vendor, which were verified during the technical inspection and potential test operation, in compliance with operating condition of the facility and agreement regulating facility exploitation.

### 6.5.2. CONTROL AT NORMAL OPERATION

#### 6.5.2.1. Issuance of Orders

**6.5.2.1.1.** Orders are issued via telephone or in another way, in compliance with the agreement on exploitation of the facility, concluded between the JSC EMS and transmission system user.

**6.5.2.1.2.** Orders shall be issued by dispatchers in the JSC EMS dispatch centres. Such orders shall be executed promptly.

**6.5.2.1.3.** All transmission system users shall implement orders issued by authorized JSC EMS dispatch centres pertaining to electricity generation, electricity consumption, connection status in the 400 kV, 220 kV, 110 kV transmission grid, equipment and devices settings which are under the competence of JSC EMS, in compliance with the Code and relevant contracts. Transmission system users shall not, of its own motion, change connection status in the part of their facilities managed by JSC EMS, pursuant 1.2.2, but only at the request or with the prior consent of the authorized JSC EMS dispatch centre.

**6.5.2.1.4.** Balance entities shall execute independently (without an order from EMS JSC) the last approved daily schedule of the balance group in the part referring to such an entity. In this process, reverse hydro electric power plant reports to the competent EMS JSC dispatch centre at least 15 minutes before the synchronization and untying generators i. e. controlled consumption from the grid. In case it fails to implement the daily plan of its balance group, a balance entity shall immediately inform the competent dispatch center of EMS JSC.

**6.5.2.1.5.** JSC EMS dispatch centres shall issue orders for balancing and re-dispatching balance entities. These orders shall be issued in a timely manner in advance (considering the time required for the implementation of the order in accordance with the technical specifications of the generator i.e. controlled consumption), and shall include the beginning and end of order validity period, the amount of change of capacity balancing entity n relation to the last adopted daily plan of that entity and the value of new balance entity daily work plan.

**6.5.2.1.6.** In case JSC EMS issues an order which can endanger safety of people or facility, subordinate personnel in the transmission system control (operators in transmission facilities, and/or staff in transmission system user control centres) shall not be obliged to execute the order but shall provide explanation for such action. On the other hand, the staff is free to propose control actions to the superior JSC EMS dispatch centre based on available information, whereby the staff has full responsibility for accuracy of such information.

**6.5.2.1.7.** In case of oral issuance of order, the order recipient shall repeat the order to the order issuer, and the order issuer shall confirm the accuracy, or the order procedure shall be repeated.

**6.5.2.1.8.** JSC EMS dispatch centres shall keep activity logs. Activity log shall be kept chronologically. Activity logs shall include all relevant data for transmission grid control, and particularly the following:

- Issued and received orders;
- Trippings and failures of 400 kV, 220 kV and 110 kV transmission grid elements;
- Switch-on or switch-off in the 400 kV, 220 kVand 110 kV transmission grid;
- Generation issues;
- 400 kV, 220 kV and 110 kV transmission grid security issues;
- Implementation of load-sheddings;
- Issues with regard to equipment used for control;
- Issues regarding protection in the 400 kV, 220 kV and 110 kV transmission grid;
- Issued i.e. repealed documents on work;
- Received telegrams;
- other information relevant for transmission system operation.

**6.5.2.2. Load-frequency control**

**6.5.2.2.1.** Load-frequency control shall be done through following activities:

- Application of primary control;
- Application of secondary control;
- Application of tertiary control;
- Provision of additional electricity interchange by engaging balance reserves from suppliers, i.e. transmission system operator.

**6.5.2.2.2.** JSC EMS shall provide at any given moment the primary control band, defined by this Code.

**6.5.2.2.3.** In order to provide safe operaton of the transmission system, EMS JSC may connect or disconnect a generating unit from operation in primary control. Such connection, i.e. disconnection, shall be based on technical reasons.

**6.5.2.2.4.** Each transmission system user providing ancillary service of primary control shall activate or deactivate primary regulators as requested by JSC EMS. If a generating unit providing system service of primary control disposes of an energy source which does not reflect its possibility of providing services of primary control, it shall activate its reserve in primary control until the frequency deviation ends.

**6.5.2.2.5.** JSC EMS shall provide uninterrupted implementation of secondary control, as well as the control band at any given moment, as defined by the Code. JSC EMS may exchange secondary control energy with neighboring transmission system operators, in accordance with the rules on operation of interconnection and concluded agremeents.

**6.5.2.2.6.** Each transmission system user providing system service of secondary control shall, as requested by JSC EMS, include its generator units, declared for secondary control operation, in this type of control.

**6.5.2.2.7.** If the area control error is such that it may not be removed through full activation of the secondary control band, JSC EMS shall timely issue an order for activation of available tertiary reserves through balancing mechanism in compliance with the rules governing electricity market.

**6.5.2.2.8.** Orders for engaging balance entities shall be issued by JSC EMS taking into account that the start time of the engagement of balance entities is practicable in accordance

with the technical specifications and the currently available capacity of the entity for engagement in the balancing mechanism, as well as with the timing of issuing orders

**6.5.2.2.9.** All orders for engagement of balance entities shall be recorded by JSC EMS. These orders shall include the following data:

- reason for engaging balance entities (balancing system, endangered system security, other.);
- EIC identification code of engaged balance entity;
- interval of engagement;
- direction of tertiary control (upward or downward);
- ordered change in MW compared to the applicable daily schedule of balance entity.

**6.5.2.2.10.** JSC EMS is required to keep a record of activated balancing reserves. Data to be recorded are as follows:

- amount of activated balancing reserves in MW;
- interval of engagement;
- producer, supplier or transmission system operator by which the balancing reserve has been activated.

**6.5.2.2.11.** In case that the direct or planned or total tertiary reserve is lower than the minimum amount defined by the Code, JSC EMS shall take measures in order to ensure the lacking reserve. These measures shall include:

- issuing orders to activate or shut down generation units;
- agreements on cross-border electricity exchange.

**6.5.2.2.12.** In case that the neighbouring transmission system operator requests a cross-border electricity exchange for balancing its system, JSC EMS may agree with such exchange if the reserve is greater than the minimum set out in the Code, and in exceptional cases and when this condition is not fulfilled if significant regulatory deviation of neighbouring system is registered or planned.

### 6.5.2.3. Voltage Control

**6.5.2.3.1.** Voltage control shall be implemented based on the daily schedule of transmission system operation and real operating conditions of the transmission system, for the purposes of maintaining voltage within prescribed limits.

**6.5.2.3.2.** Voltage shall be primarily controlled, through issuing appropriate orders for generating or absorption of reactive energy in all operational generator units, based on which the references of the given voltage are determined, synchronous compensators and static compensation facilities that have contractual obligation to provide ancillary services in the area of voltage control.

**6.5.2.3.3.** In addition to generating i.e. absorption of reactive energy, voltage control shall be regulated with reactive power flow control in the 400 kV, 220 kV and 110 kV transmission grid, by changing positions on voltage control transformers.

**6.5.2.3.4.** If, due to voltage control, it is necessary to decrease active energy generation on certain generators due to reactive energy production, JSC EMS shall apply re-dispatching.

**6.5.2.3.5.** JSC EMS shall issue orders for change of positions on step-up transformers of all generator units when the permitted voltage ranges in the transmission grid and the generator are not harmonized.

**6.5.2.3.6.** In the facilities where tie-lines are starting from, the voltage shall be maintained within the range defined with the neighbouring transmission grid operator.

**6.5.2.4. Power System Operation Monitoring**

**6.5.2.4.1.** JSC EMS dispatch centres shall monitor the operation of power system in real time. Monitoring shall be done via *SCADA* system and telephone contacts with transmission system facilities, as well as control centres and transmission system user facilities.

**6.5.2.4.2.** JSC EMS shall provide the following real time information in its dispatch centres:

- System frequency;
- Area control error (only for National Dispatch Centre);
- Indication and alarm signals in transmission system facilities;
- Active and reactive power flows, as well as values of electricity in the 400 kV, 220 kV and 110 kV transmission grid and transmission system user facilities (that are of interest for 400 kV, 220 kV and 110 kV grid operation);
- Active and reactive power of generating units;
- Connection status of equipment;
- Control transformer tap positions;
- Voltage values at 400 kV, 220 kV and 110 kV grids facilities and transmission lines;
- Alarms and signals regarding accuracy of measured values, protection devices operation, communication status etc.

**6.5.2.4.3.** JSC EMS shall define the necessary information in cooperation with the neighbouring transmission system operator, that is subject to real time exchange.

**6.5.2.4.4.** JSC EMS dispatch centres shall be equipped with required computer equipment for collection and processing data, necessary for analysis of security of transmission system operation.

**6.5.2.5. Performance of Works in the 400 kV, 220 kV and 110 kV Transmission Grid**

**6.5.2.5.1.** EMS JSC and transmission system operator shall adhere to to the planned state (available, unavailable, in funcitional testing) of power system elements they own, i.e. they are entitled to use.

**6.5.2.5.2.** Switching off ETG elements shall be done based on outage approval issued by JSC EMS, pursuant to submitted outage requests, in compliance with weekly outage plans or emergency outages.

**6.5.2.5.3.** Operating approval and notification on completion of work are consolidated in the form, defined by JSC EMS jointly with transmission systm users, for performance of work on ETG elements of the first, second and third group of Classification, and as such is mandatory for all transmission system users.

**6.5.2.5.4.** Columns in the Form referred to in Item 6.5.2.5.2 may be filled in by authorized persons of the authorized control/dispatch centres and persons managing the work. Regular exchange of lists of authorized personnel, which may fill in the form between JSC EMS and transmission system user, shall be done each year not later than March 1st current year.

**6.5.2.5.5.** For work on ETG elements, whose bearer of usage rights is JSC EMS, person managing the works whose name is in the turn-off request, shall announce the work to the authorized JSC EMS dispatch centre not later than 30 minutes prior to the time indicated in the turn-off request, and shall request switch-on or turn-off.

**6.5.2.5.6.** If the work is performed on ETG elements that are the property of, and/or whose holder of usage rights is the transmission system user, the authorized dispatch centre of transmission system user shall announce the work to the authorized JSC EMS dispatch centre

not later than 30 minutes prior to the time indicated in the outage request, and shall request switch-on or switch-off.

**6.5.2.5.7.** If for any justified reason, the work cannot be performed, the obligation of the persons managing the work is to inform the authorized dispatch centre accordingly not later than 30 minutes prior to the time for commencement of work (indicated in the outage request form) and to state the reasons why the work cannot be performed. In case of work on transmission system user facilities, user dispatch centre of the transmission grid shall forward this information to the authorized JSC EMS dispatch centre.

**6.5.2.5.8.** Authorized dispatch centre and person managing the work shall fill in operating approval for work on ETG elements and work in the vicinity of ETG elements, after implementing basic protection measures at the work location, which marks the start of the operating approval. Filling in operating approval shall mean issuing appropriate statement by the dispatcher of the authorized dispatch centre and receipt of such statement by the person managing the work. Upon completion of the work, the person managing the work and authorized dispatch centre shall fill in notification on completion of work, which marks the completion of the operating approval. Filling in notification on completion of work shall mean issuing appropriate statement by the person managing the work and receipt of such statement by the dispatcher of the authorized dispatch centre.

**6.5.2.5.9.** For ETG elements that are the property of, and/or whose holder of usage rights is the transmission system user, for works on ETG elements and works in the vicinity of ETG elements, authorized person of the authorized user dispatch centre of the transmission grid and person managing the work shall fill in operating approval and notification on completion of work. After filling in the operating approval, and/or notification on completion of work, the authorized user dispatch centre of the transmission grid shall promptly notify the authorized JSC EMS dispatch centre on time interval of unavailability, and/or availability of ETG elements.

**6.5.2.5.10.** For works not requiring basic safety measures at the work location on ETG elements on implementation of necessary switch-on or switch-off, the authorized dispatch centre shall inform the responsible person on toplogy status of ETG elements of interest for the performance of work and shall permit performance of work. Upon completion of work, the responsible person shall inform the authorized dispatch centre on completion of work. In this case, operating approval and notification on completion of work shall not be filled in.

**6.5.2.5.11.** The authorized user dispatch centre of transmission grid shall promptly inform the authorized JSC EMS dispatch centre on time interval of unavailability, and/or availability regarding ETG elements that are the property of, and/or whose bearer of usage rights is the transmission system user, regarding work not requiring basic safety measures at work location, after such centre allows the responsible person to perform work, and/or receives information that the work has been completed.

**6.5.2.5.12.** Work stipulated in the outage request must be completed until the time interval stipulated in the form. If the work however cannot be completed within such time interval, the person managing work, in coordination with the owner, and/or holder of usage rights of power facility, shall timely notify the authorized dispatch centre of that fact, with which he/she filled in the operating approval and notify such centre on work status and request extension of deadline for work. In case it was done with user dispatch centre of the transmission grid, such dispatch centre shall forward that information to the authorized JSC EMS dispatch centre. Authorized JSC EMS dispatch centre shall make a decision on extension of deadline for work.

**6.5.2.5.13.** JSC EMS shall, within 2 hours, inform the transmission system user dispatch centre of the realization of intended and unintended outages in the 400 kV, 220 kV and 110 kV transmission grid, if that impairs the reliability of user access to transmission grid.

**6.5.2.5.14.** Authorized JSC EMS dispatch centre shall have the right to issue an order to terminate or delay planned outages, if normal and/or secure operation of transmission system is impaired.

### 6.5.2.6. Data collection

**6.5.2.6.1.** JSC EMS shall collect all data necessary for planning and analysing operations of electrical power system in the basic time unit used for planning of operation of electrical power system, which is:

- generating active and reactive electricity of all power plants connected to distribution grid;
- generating active and reactive energy of all power plants connected to distribution grid;
- hourly generation of reactive energy of compensation facilities connected to the transmission grid;
- voltage values in relevant 400 kV, 220 kV and 110 kV grids facilities;
- deviation of frequency and synchronous time;
- current active and reactive power flows for certain time periods;
- hourly interchange of electricity on inter-connectible transmission lines;
- 400 kV, 220 kV and 110 kV grid configuration;
- condition of high-voltage equipment in transmission system facilities and transmission grid user facilities;
- volume and time of duration of secured and activated system services;
- recording excesses of permissible limits for transmission lines, transformers, and/or deviations of voltage or frequency from the prescribed limits;
- meteorological data (inflows, levels, accumulation state, speed and direction of the wind, temperature, air pressure);
- other data necessary for planning and analysis of operation of electrical power system.

Transmission system users shall submit to JSC EMS the stated data regarding their facilities, in a way and in form defined by JSC EMS.

## 6.5.3. CONTROL DURING DISTURBANCES

### 6.5.3.1. Introduction

**6.5.3.1.1.** JSC EMS shall take all available measures in order to avoid disturbances.

**6.5.3.1.2.** It is necessary for JSC EMS dispatch centres to be able to record disturbances and their characteristics based on the received information, in order to formulate control actions for removing or limiting disturbances based on this information.

**6.5.3.1.3.** In case of disturbance, JSC EMS shall promptly take all necessary technical measures in order to prevent spreading of disturbances and provide the return of all parameters in the 400 kV, 220 kV and 110 kV grid to the prescribed limits and to restore electricity supply to the transmission system users that lost the electricity supply. These measures shall include:

- attempt to switch on the elements that tripped-out in the 400 kV, 220 kV and 110 kV grid;

- other switch-on or switch-off in the 400 kV, 220 kV and 110 kV grid;
- re-dispatching;
- change of position on regulatory transformers;
- cancelling planned outages in the 400 kV, 220 kV, 110 kV grid and termination of work in progress;
- making appropriate arrangements for electricity exchange;
- cancelling or reducing existing electricity interchange (if changes in generating and making new agreements in electricity interchange are not possible, and/or if the results of these control actions are insufficient to resolve disturbances);
- load-shedding;
- other measures prescribed by the law and by-laws.

When selecting the above-mentioned measures, JSC EMS shall observe the principles of minimum costs and non-disturbance in the electricity market (as far as possible).

**6.5.3.2. Removal of Disturbances**

**6.5.3.2.1.** In case of overload of power line, transformer or any other 400 kV, 220 kV or 110 kV transmission grid element authorized JSC EMS dispatch centre shall undertake measures for removal of overload.

**6.5.3.2.2.** It is permitted to temporary interlock the overload protection during removal of disturbances, but loads on such elements may not exceed values which can cause damages to the 400 kV, 220 kV and 110 kV transmission grid elements or neighbouring facilities.

**6.5.3.2.3.** In case of tripping of elements in the 400 kV, 220 kV and 110 kV transmission grid, the operational staff within the JSC EMS dispatch centres shall collect data on effects of security measures based on which they shall decide on control actions that need to be carried out.

**6.5.3.2.4.** Transmission system users dispatch centres shall deliver to the authorized JSC EMS dispatch centre data on the performance of the protection from all elements in their facility which are categorized in first, second or third group of the Categorization, as well as of those elements which are in galvanic connection to such elements. In case of power line tripping, these data shall include:

- name of the facility;
- name of the power line (voltage level, number and route);
- type of the protection which reacted;
- type of failure (single-phase, two-phase etc.);
- phases struck by failure;
- degree to which the protection was effective;
- information on activation of AR and whether the AR attempt was successful or not;

while in the case of transformer tripping:

- name of the facility;
- designation of the transformer;
- all types of protection which reacted;
- transformer load immediately before the tripping ;
- ambient, oil and windings temperatures immediately prior to the tripping;
- activation of fixed fire protection (in facilities where such protection exists).

Transmission system user dispatch centre shall also inform the authorized JSC EMS dispatch centre about other circumstances that accompanied the tripping, such as:

- manipulations in the facility;
- works carried out in the facility;

- visible traces of failure in the facility (electric arc, smoke, fire, unusual odour etc.);
- atmospheric discharges in the vicinity of the facility and other weather conditions.

**6.5.3.2.5.** In case of permanent tripping of power line circuit breakers due to the action of power line protection on both sides of the power line, JSC EMS dispatch centre may issue one order for the reconnection of the power line at least 3 minutes after the tripping if during tripping an unsuccessful AR was recorded, or if there was no AR. The power line reconnection shall be done from the side of the power line where lower tripping currents are expected, except in case of a power line which connects a power plant facility, in which case the trial for the connection of the power line to the voltage shall be done towards the power plant facility. In case of the repeated tripping of the power line due to the action of the protection which indicates to a permanent outage on the power line, the power line shall not be reconnected until the outage is removed. Exceptionally, JSC EMS dispatch centre may repeat the order to reconnect the power line in the following cases:

- tripping of power lines in star connection;
- tripping of power lines without circuit breaker;
- non selective tripping;
- other trippings when, by sectioning the transmission grid, the element of the grid with outage can be established by repeated energizing,
- Icing of power lines or other situations when there is an influence of weather conditions, vegetation and civil engineering objects on the power line, after the information from the field have been received from the authorized person.

**6.5.3.2.6.** Upon the order of JSC EMS transmission system users shall, in the shortest period of time (for example by using remote control), to switch on tripped elements of the transmission grid in their facilities, with the exception if protection signals indicate that a damage exists in that facility, when the transmission system user is permitted to make a visual inspection of the installation in the shortest possible time.

**6.5.3.2.7.** The authorized JSC EMS dispatch centre may request changes to the protection settings with the aim to form a connection scheme which shall ensure most reliable power supply to the transmission system user's facility during the tripping of an element of 400 kV, 220 kV and 110 kV transmission grids.

**6.5.3.2.8.** If tripping has occurred in the 400 kV, 220 kV, 110 kV transmission grid, wherein a permanent outage has been established using a prescribed method, operational staff of the JSC EMS dispatch centre, if accesses that the tripping jeopardizes normal operation of the transmission system, shall issue an order to persons authorized by JSC EMS, or to the dispatch centre of transmission system users, to dispatch the intervention teams which shall remedy the failure.

**6.5.3.2.9.** Transmission system users shall inform the authorized JSC EMS dispatch centre about the condition of their facility and potential damages that may cause tripping of the facility or its part.

**6.5.3.2.10.** In the case when the operational staff of JSC EMS dispatch centre receives from an authorized person (from JSC EMS or transmission system user) information on potential failure, the staff shall undertake the following activities:

- consider consequences of disconnection, or tripping of that element;
- consider control activities in order to maintain normal, that is secure operation of the transmission system in case of disconnection, that is tripping of that element;

- if deemed necessary, disconnect the element whose potential failure was identified;
- if assesses that the necessary disconnection shall jeopardize normal operation of the transmission system , issues an order to persons authorized by JSC EMS, to urgently dispatch teams which shall remedy the failure.

**6.5.3.2.11.** In case of permanent or potential malfunction of a power system element of atransmission system user, the responsible EMS JSC control center shall contact the respective user and arrange for the removal of failure.

**6.5.3.2.12.** In case of permanent or potential failure of a power system element or a transmission system user, such transmisson system user shall urgently inform the competent management center of EMS JSC about:

- cause of failure;
- expected time for its removal;
- effect of failure to the availability of other power system elements of that transmission system user.

**6.5.3.2.13.** When EMS JSC determines that a permanent or potential failure of a power element of the transmission system user may jeopardize normal operation of the transmission system, it shall promptly inform such user of the period after which the normal operation of the transmission system cannot be ensured without the return of the stated element into operation. The transmission system user shall notify EMS JSC of its ability to fulfill the stated requirement regarding such period for the elimination of failure or provide EMS JSC with appropriate explanation otherwise.

**6.5.3.2.14.** JSC EMS shall cooperate with neighbouring transmission system operators of interconnection in order to coordinate exploitation and avoid incidents on tie-lines, as well as when the assistance of neighbouring operator is necessary to solve the problem in our transmission system and vice versa, including agreement for cross-border exchange of electricity in accordance with concluded agreements and rules for operation of interconnection.

### 6.5.3.3. Load-sheddings

**6.5.3.3.1.** In case of a lack in active power in the transmission system, voltage collapse i.e. the lack of reactive power in the system, an overload of elements of the 400 kV, 220 kV and 110 kV transmission grid or some other type of disturbance, due to which the normal operation of the transmission system could be jeopardized, load-sheddings may be introduced in the entire system or in some of its parts by implementing Load-shedding Plans, after all possible measures have been taken in order to avoid implementation of the mentioned plans. In such situations, the authorized JSC EMS dispatch centre shall decide on which type of plan shall be applied.

**6.5.3.3.2.** If the transmission system user refuses to implement the Load-shedding Plan in the amount ordered by JSC EMS, JSC EMS is authorized to disconnect parts, or entire facilities of such transmission system user, and to do so up to the level of the prescribed amount, if possible.

**6.5.3.3.3.** Upon request of the Government of the Republic of Serbia, JSC EMS shall participate in the implementation of measures of restrictions in power supply in case of general shortage of electricity, after receiving from the Government of the Republic of Serbia notice about the beginning of the circumstances for the implementation of such measures.

**6.5.3.3.4.** JSC EMS shall timely inform the users of the transmission system and competent officials on planned and expected disturbances and disruptions in power supplies, except

when this is impossible due to the quick reaction aimed to prevent the disintegration of the whole transmission system or part thereof.

**6.5.3.4. Power system restoration**

**6.5.3.4.1.** If there is partial or total blackout of the transmission system, the authorized JSC EMS and transmission system user's dispatch centres shall restore the transmission system guided by the Restoration Plan of the transmission system.

## 6.6. OPERATION OF THE PROTECTION SYSTEM

### 6.6.1. Documentation and technical instructions

**6.6.1.1.** JSC EMS shall have the updated documentation related to the types and settings of all protections both in its own facilities and in the facilities of the transmission system user.

**6.6.1.2.** The transmission system user shall submit to JSC EMS the updated documentation on possible functional changes or reconstructions of the protection systems in his facilities, which have an impact upon power transmission, as well as an approved plan regarding settings, referred to in point 4.2.11.4.1.

**6.6.1.3.** JSC EMS stipulates basic technical requirements regarding settings of the protection of the power lines and energy transformers in the 400 kV, 220 kV and 110 kV transmission grids.

### 6.6.2. Pre-setting, replacement and maintenance

**6.6.2.1.** Pre-setting or replacement of the protective system in facilities of the transmission system users which have an impact upon operation of the 400 kV, 220 kV and 110 kV grids shall be carried out exclusively upon prior consent of JSC EMS.

**6.6.2.2.** The user of the transmission system shall, after presetting of the existing protection or replacing the protection, notify JSC EMS not later than three working days following the changes introduced in protection systems in his facility.

**6.6.2.3.** JSC EMS, that is the transmission system user, shall ensure periodic examination and maintenance of the protective system in their facilities, in accordance with the regulations which establish technical norms related to the maintenance of the power facilities.

**6.6.2.4.** Protections on intercontinental power lines shall be pre-set in accordance with the agreements with neighboring transmission system operator.

### 6.6.3. Functioning in real time

**6.6.3.1.** JSC EMS coordinate the operation of the protection for all users of the transmission system in order to ensure the maximum approved periods in which there shall be disconnection due to failure, which are stated in section 4.2.10. Deviation from the maximum approved periods of disconnection are allowed only due to technical obsolescence of installed circuit breakers, or protection devices, in which case these deviations shall not exceed 10%.

**6.6.3.2.** In case that the analysis of disturbances in the 400 kV, 220 kV and 110 kV transmission grid have shown unselective operation of the protection system in facilities of the transmission system user , JSC EMS shall undertake measures within its competences in order to promptly remove the irregularities.

**6.6.3.3.** In case that the main protection device of the power line or one of more basic protections of the energy transformer are not available, a time limited operation for the protected element is possible with only spare protection device, respectively with remaining basic protections, in accordance with measures and procedures related to operation of

protective and automatic devices in the 400 kV, 220 kV and 110 kV transmission grid which are set by JSC EMS.

### 6.6.4. Plan for overload protection setting

**6.6.4.1.** JSC EMS shall make and apply the Plan for overload protection setting of power lines for winter and summer seasons.

**6.6.4.2.** Plan for overload protection setting of the power lines shall take into consideration technical properties of the power line and its belonging high-voltage equipment in transmission fields, in accordance with expected seasonal meteorological conditions, with the aim to provide for effective protection of the power line and its belonging high-voltage equipment against permanent deformation which can be caused by thermal stress due to too high current load.

**6.6.4.3.** The plan for overload protection setting of the power lines encompasses all 400 kV and 220 kV power lines, as well as 110 kV power lines on which overloads can be expected.

## 6.7. COMMUNICATIONS AND OPERATIONAL TECHNOLOGY

### 6.7.1. COMMUNICATIONS SYSTEM

**6.7.1.1.** Communications system of the JSC EMS shall enable continuous communications with the transmission system users, market participants and other transmission system operators in accordance with interconnection operation rules.

**6.7.1.2.** In case of a failure of communications devices and lines, the act on connection or act on inter-connection, or an agreement on a facility exploitation, shall envisage the procedure of commucation with public connections.

**6.7.1.3.** The communications shall provide for conversation, AGC signals, SCADA system, protection devices.

**6.7.1.4.** Transmission system users and JSC EMS, in accordance with their respective competences, ensure continuous data transmission to the relevant JSC EMS dispatch centre.

**6.7.1.5.** All communications systems, lines and devices shall be redundant to provide for the case of a disaster.

**6.7.1.6.** All telephone conversations made from the JSC EMS dispatch centres shall be recorded and kept for a minimum of 30 days.

### 6.7.2. OPERATIONAL TECHNOLOGY

**6.7.2.1.** The operational technology system shall be designed and used to allow JSC EMS to fulfil all obligations related to the 400 kV, 220 kV and 110 kV grid control in the way set forth by the Code.

**6.7.2.2.** JSC EMS dispatch centres shall have clearly and understandably presented measurements real-time values in the 400 kV, 220 kV and 110 kV transmission grids.

**6.7.2.3.** Adequate and reliable auxiliary supply of JSC EMS dispatch centres and other critical points necessary to ensure data for the calculation of the area control error shall be provided and periodically tested at least once a year.

**6.7.2.4.** All interconnected power lines shall be equipped with devices for the telemetering of active power and active energy, while the relevant measured values shall be supplied to the competent JSC EMS dispatch centre.

**6.7.2.5.** JSC EMS shall have the possibility to archive the measurement values for the purpose of the transmission system operation analysis, behaviour of generators analysis and reports about transmission system operation.

**6.7.2.6.** All generators participating in the secondary control shall be integrated in an appropriate measurement and control circuit which shall provide real time measurements to form the area control error.

**6.7.2.7.** As a rule, the redundant configuration of the management system is used in the transmission system facilities.

### 6.7.3. TEMPORARY UNAVAILABILITY OF JSC EMS DISPATCH CENTRES

**6.7.3.1.** In case of a temporary unavailability of a regional dispatch centre, its functions shall be taken over by the National Dispatch Centre. In that sense, the National Dispatch Centre shall have appropriate documentation and SCADA signals at its disposal.

**6.7.3.2.** In case of a temporary unavailability of the National Dispatch Centre its functions shall be taken over by a redundant National Dispatch Centre.

**6.7.3.3.** Conditions of operations reestablishment of a JSC EMS dispatch centre (qualified staff, equipment and procedures) shall be ensured continuously.

### 6.7.4. MAINTENANCE OF COMMUNICATIONS AND CONTROL EQUIPMENT

**6.7.4.1.** JSC EMS and transmission system users shall maintain their 400 kV, 220 kV and 110 kV grid communications and control equipment in proper operating condition.

**6.7.4.2.** Conditions of operations reestablishment of the 400 kV, 220 kV and 110 kV grid communications and control equipment shall be constantly ensured.

**6.7.4.3.** Maintenance works on the 400 kV, 220 kV and 110 kV grid communications and control equipment shall be planned in such a way that the normal operation of transmission system is not jeopardized. When planning these works, JSC EMS shall cooperate with transmission system users and the neighbouring transmission system operators.

### 6.7.5. REQUIREMENTS FOR THE TRANSMISSION SYSTEM USERS

**6.7.5.1.** Communications equipment in facilities of the transmission system users which is subject to provisions of the Grid Code is the equipment which is necessary for communication of JSC EMS control centres with this facility.

**6.7.5.2.** Based on technical requirements set forth in Chapter 4 and Appendix C, transmission system users provide to the JSC EMS operational technology system all real time data necessary for controlling activities.

**6.7.5.3.** The transmission system user shall possess documentation relating to communications equipment and equipment for transmission system control installed in the facility. Upon request of JSC EMS, the transmission system user shall submit for inspection the documentation referred to in this section.

**6.7.5.4.** In case of a failure of the communications equipment or the transmission system control equipment the transmission system user shall immediately notify JSC EMS.

**6.7.5.5.** Transmission system user shall announce and request JSC EMS consent to disconnect the communications equipment or transmission system control equipment in his facility at least three days before switching off.

## 6.8. STABILITY DEVICES OPERATION

**6.8.1.** A device for stabilizing the power system shall be active during normal operation of the facility and under disturbances. For reversible generating unit this device shall be active during both the generator mode and the pumping mode.

**6.8.2.** A device for stabilizing the power system can be temporarily deactivated by a transmission system user only during the start-up process and stopping of generator unit.

**6.8.3.** If stability analyses show the necessity to install the system for damping of oscillations (power system stabilizer), EMS and the owner, or a holder of the right to use the generator unit will start negotiations on the installation of these systems.

**6.8.4.** All modifications made to the device for stability in the transmission system user's facilities, i.e. to the generators which affect the stability of the transmission system, shall be harmonised with JSC EMS.

## 6.9. REPORTING ON THE POWER SYSTEM OPERATION

### 6.9.1. INTRODUCTION

**6.9.1.1.** JSC EMS shall monitor and analyse the operation of the power system pursuant to facts on the operation of individual parts or elements of this system, which are collected by:

- operational technology system;
- devices for remote transmission of metering and of signals;
- orally and in writing by the transmission system user.

**6.9.1.2.** Reports on the operation of the power system include regular and exceptional reports. Transmission system users shall submit to JSC EMS all necessary data for producing reports referred to in this section within the deadline and in format set forth by JSC EMS.

**6.9.1.3.** When producing, submitting and publishing the reports, JSC EMS shall pay particular attention to the confidentiality of information contained in the report.

### 6.9.2. REGULAR REPORTS

**6.9.2.1.** JSC EMS shall make regular reports on the transmission system. Regular reports shall contain data on:

- realized consumption regarding energy and power;
- realized production;
- energy consumed for pumping;
- cross-board power exchange;
- technical losses in the transmission system;
- voltage at distinctive points of the 400 kV, 220 kV and 110 kV grid;
- participation of the transmission system users in system services;
- unavailable power plants and reasons for unavailability;
- production, exchange and consumption chart;
- trippings and damages in the 400 kV, 220 kV and 110 kV grid;
- switching-on and off in the 400 kV, 220 kV and 110 kV grid;
- balancing and re-dispatching;
- reserve provided for in accordance to the system services contracts;
- quality of secondary control;
- more important operational events;
- connections and inter-connections of facilities to the transmission system;

- significant reconstructions and enlargements of transmission facilities and transmission system users facilities;
- other data important for power system operation.

**6.9.2.2.** Regular reports shall be made on a daily, weekly, monthly and annual basis, and shall contain data defined in point 6.8.2.1.

**6.9.2.3.** JSC EMS shall, not later than March 31st of the current year, make a regular annual report on the operation of the transmission system which relates to the preceding year and publicize it on its internet web-site.

### 6.9.3. EXCEPTIONAL REPORTS

**6.9.3.1.** Exceptional reports JSC EMS shall make and submit to the authorized bodies and affected transmission system users an exceptional report on occurrences regarding the operation of the facilities and operation of the transmission system in cases of disturbance in power supply (from the transmission system, respectively to the transmission system), reduction or cancellation of contracted power by JSC EMS, that is when JSC EMS assesses that consequences of the plant event may jeopardize normal operation of the transmission system in the approaching period and the functioning of the power market, not later than 3 working days following the occurrence.

**6.9.3.2.** Upon request of JSC EMS, the transmission system user shall submit to JSC EMS, in the shortest possible time, data on the occurrence during operation in his facility which had impact upon the operation of the transmission system.

**6.9.3.3.** JSC EMS shall make and submit to the authorized bodies an exceptional report also if it assesses that in the forthcoming period difficulties could be expected regarding power supply to the end users and regarding the functioning of the power market.

# CHAPTER 7: USE AND MAINTENANCE OF FACILITIES

## 7.1. INTRODUCTION

### 7.1.1. USE OF FACILITIES

**7.1.1.1.** This Chapter deals with aspects related to the use (exploitation) of transmission system facilities and transmission system users' facilities which are important for normal and reliable operation of said facilities, and consequently of the entire transmission system.

**7.1.1.2.** In order to regulate the use of facilities as good as possible, this part of the Code shall regulate also the contents of the contract stipulating the use of facilities, concluded between EP EMS and transmission system user.

### 7.1.2. MAINTENANCE OF FACILITIES

**7.1.2.1.** Pursuant to regulations governing planning and construction of facilities, the owner, or the holder of rights to use the facility, shall ensure performance of works on the facility maintenance. Regular, emergency and specialized examinations and testing of facilities may be carried out by companies or other legal entities that meet the prescribed requirements in terms of qualified personnel and equipment for performance of works.

### 7.1.3. FACILITY BREAKDOWNS

**7.1.3.1.** In case of breakdown in the transmission facilities, JSC EMS shall undertake the following activities:

- report the breakdown the competent authorities;
- temporarily remedy the consequences by means of the facility rehabilitation;
- provide the necessary goods, services and works to eliminate all the harmful consequences of the breakdown.

## 7.2. GENERAL TERMS AND CONDITIONS FOR THE USE OF FACILITIES

**7.2.1.** General terms and conditions for the use of transmission facilities and transmission system users' facilities shall set forth technical and organizational conditions for the use of said facilities which are significant for normal operations of the transmission system and of the facilities thereof.

**7.2.2.** All technical and organizational conditions stipulated in the Code shall be considered general conditions for the use of transmission system facilities and the transmission system users' facilities. All service provided by JSC EMS to transmission system users within the scope of general conditions for the use of transmission facilities are considered to be standard services of transmission system operator.

**7.2.3.** Where the facilities are used beyond general conditions set forth in the Code, the transmission system user, or JSC EMS, shall undertake measures in accordance with its obligations to harmonize the use of such facility with the provisions of the Code.

**7.2.4.** Where the transmission system user requires special conditions for the use of its facility under approval of JSC EMS, i.e. if it is impossible to implement measures referred to

in Article 7.2.3., all special conditions for the use shall be entered into the relevant agreement on exploiting of facility.

**7.2.5.** Special conditions for the use of the transmission system user's facility shall not disrupt normal operation of the transmission system.

**7.2.6.** Special conditions for the use of facility of one transmission system user shall not create additional costs for other transmission system users.

## 7.3. CONTENTS OF THE CONTRACT ON EXPLOITING OF FACILITIES

**7.3.1.** Contract on exploiting facilities, apart from general agreement elements pursuant to law regulating contractual relation, shall also contain the information on:

- facilities to which the Agreement applies;
- limits of ownership on primary, secondary and other equipment;
- authorised volume of active power which may be delivered to the transmission network, as well as of delivery of active and reactive power at the point of connection to the system in case of local production in the distribution system, which is determined based on the security analysis and calculations of voltage values for the expected operation modes;
- competent control centers of EMS JSC and transmission system users;
- authorised personnel for technical cooperation
- exchange of technical documentation;
- technical parameters referring to electricity metering;
- confidential data based on the criteria referred to in the Code.

Special conditions of use, if any, may also be entered into the Agreement, i.e. non-standard services of transmission system operator.

**7.3.2.** The established accounting parameters, based on which the transmission system access shall be calculated, may be entered, as necessary, into the Contract on exploiting: transmission ratio of the instrument transformers, data on electricity meters configuration, correction coefficient, as well as the rules on substitution of missing data.

**7.3.3.** The Contract on exploiting shall be without legal burden in the part referring to general conditions of use, i.e. standard services of transmission system operator.

## 7.4. AUTHORIZED PERSONNEL

**7.4.1.** For the purpose of efficient use of transmission system facilities and of the transmission system user's facilities, it is necessary that JSC EMS and transmission system users mutually authorize personnel for technical cooperation.

**7.4.2.** Such personnel shall be assigned the following activities:

- planning of the transmission system operation;
- managing the transmission system;
- carrying out works on the transmission grid 400 kV, 220 kV and 110 kV;
- protection systems operation;
- communication system operation;
- operation of the technical control system;
- operation of the local equipment for primary and secondary control;
- submission of technical norms, procedures and documents.

**7.4.3.** It shall be necessary to provide data on the appointed personnel, as follows:

- name and surname;
- business name;
- organizational unit of the enterprise;
- address of the organizational unit of the enterprise;
- telephone number;
- fax number;
- cell phone number;
- e-mail address.

Format and deadlines for the exchange of said data shall be specified by JSC EMS.

**7.4.4.** In case of changes regarding the data referred to in section 7.4, JSC EMS and the transmission system user shall in a timely manner notify the other party of changes in their respective lists of authorized personnel, with accompanying data.

## 7.5. ACCESS OF JSC EMS PERSONNEL TO THE FACILITY

**7.5.1.** Upon receiving the timely announcement of JSC EMS, the transmission system user shall guarantee, in the shortest time possible and under any circustances, access to its facility to JSC EMS personnel who have been assigned the following activities:

- checking the validity and settings of the protection devices on elements of the first, second and third Categorization groups as well as elements galvanically connected to said elements;
- checking the validity of electricity meter and of the accompanying metering equipment;
- collecting the recordings of disorders and defects, as well as chronological event registration form the protection and control devices;
- collecting information from the SCADA system of the transmission system user's facility;
- checking the validity of the communication devices relevant for the transmission system communication;
- checking the validity of the devices for collecting and exchange of data in real time with the JSC EMS technical control system;
- checking the validity and settings of the primary regulators and of the local equipment for secondary control;
- checking the validity and settings of voltage regulators;
- electricity supply termination;
- permanent disconnection of the facility from the transmission system.

The transmission system user shall have the right to attend said activities.

**7.5.2.** The right of access to sealed components of the metering equipment shall be granted exclusively to representatives of JSC EMS, except in cases where safety of persons and equipment is jeopardized. The owner or the holder of right to use the facility containing metering equipment shall report such cases to JSC EMS within 24 hours following the breaking of the seal.

**7.5.3.** The transmission system user shall provide access to the facility for the appointed JSC EMS personnel in order to carry out the announced functional testing of the transmission system users' facility.

## 7.6. OBLIGATIONS OF SYSTEM USER AND TRANSMISSION SYSTEM OPERATOR IN FUNCTION TESTING

**7.6.1.** Functional testing is performed on the facilities of transmission system user:

- mandatorily, on commissioning of facility when testing technical requirements as stated in the connection approval, i.e. in within the agreement on connection to the transmission system;
- periodically, during the facility exploitation period;
- if necessary:
  - after substantial operational events or disturbances in transmission system operation;
  - after larger-scale maintenance works or change in the setting of operating parameters of equipment of interest for the transmission system operation;
- due to the needs of transmission system users;
- in the cases and periods as stipulated by interconnection rules.

**7.6.2.** Functional testings, as well as criteria for successful fulfilment of functional testings, are based on the technical requirements from the rules on interconnection operation. Functional testings of transmission system user facilities are organised and implemented in the presence of JSC EMS staff and user staff.

**7.6.3.** Transmission system user's facility shall be functionally tested in terms of the following aspects:

- verification of technical features referred to in the approval for connection (including both temporary and partial), i.e. the Contract on inter-connection;
- voltage control;
- primary control;
- secondary control;
- tertiary control;
- possibility of the generator black start;
- generator outage to auxiliary supply;
- functionality of the protection system;
- functionality of the communication and local control system;
- functionality of the power metering system;
- functionality of the stability devices;
- functionality of the stability devices; other issues stipulated by the Code.

7.6.4. JSC EMS shall independently, or upon a proposal of a transmission system user, make a protocol of functional testing, which shall as a rule include the following:

- cause for functional testing in accordance with the position 7.6.1;
- list of planned functional testing according to particular positions from the item 7.6.3.;
- functional testing methodology including also the required software simulations;
- period of functional testing;
- requirements for successful fulfilment of technical requirements of functional testing;
- form, content and development period for the report on functional testing;
- list of JSC EMS staff who shall have access to the transmission system user facility for the purpose of functional testing;
- obligations of transmission system user and EMS JSC regarding the implementation of activities from the protocol of functional testing.

**7.6.5**. JSC EMS and transmission system use shall harmonise and sign the protocol on functional testing at least 15 days before the period defined for the start of testing.

**7.6.5.** JSC EMS shall submit to the transmission system user a detailed functional testing program with defined conditions for the implementation of the testing at least 3 working days prior to the date defined for testing commencement. Exact date of functional testing is defined by JSC EMS after consultation with transmission system user.

**7.6.6.** Transmission system user shall submit to JSC EMS the detailed information on functional testing for the needs of the transmission system users, including also the indicative production and consumption plans, requirements for changes in topology of transmission system, and at least a month before the planned functional testing, while potential amendment to this information shall be submitted to EMS JSC within the shortest terms possible.

**7.6.7.** JSC EMS shall timely notify all transmission system users, for which the quality of power supply could be endangered during the functional testing, of the testing time and possible consequences for their facilities.

**7.6.8.** JSC EMS shall provide conditions ensuring safe operation of the transmission system during the functional testing. EMS JSC may delay or stop functional testing in case of unplanned events which may endanger the safety of the transmission system operator, safety of people or equipment of the transmission system users of EMS JSC.

**7.6.9.** In case the facility fails to meet the envisaged requirements during the functional testing, transmission system user shall also include into its functional testing report as proscribed by the protocol from the item 7.6.4, the following:

- explanation of the failure of its facility to meet stipulated requirements;
- measures to be undertaken in order to eliminate the causes which resulted in failure to meet functional testing requirements;
- deadline to implement said measures.

JSC EMS shall monitor the implementation of said measures.

**7.6.10.** Where functional testing results show that the facility endangers other transmission system users, JSC EMS shall timely inform them thereof and shall undertake all available measures to eliminate such risk as soon as possible.

## 7.7. TECHNICAL REGULATIONS, PROCEDURES AND DOCUMENTS

**7.7.1.** JSC EMS shall apply to its activities technical regulations, procedures and documents of the transmission system user.

**7.7.2.** The transmission system users shall be responsible for the accuracy of regulations, procedures and documents, and shall inform JSC EMS in a timely manner on all relevant changes. Otherwise, the transmission system users shall bear the consequences caused by the failure to inform JSC EMS in a timely manner.

**7.7.3.** At the JSC EMS request, the transmission system user shall provide the following for the existing facilities:

- single-line diagram of the facility with basic data regarding installed equipment;
- parameters necessary for the exchange of data in the real time;
- procedures in case its own dispatch centre is not available;
- other regulations, procedures and documents relevant for the use of the facility as assessed by JSC EMS;

and in the format required by JSC EMS.

**7.7.4.** The transmission system user shall submit to JSC EMS basic instructions on the operation of its facility (instructions relating to the operation of the facility, manner in which manipulations in the facility are carried out etc.).

**7.7.5.** In case such instructions are not provided, JSC EMS shall not be held responsible for consequences that may result from the lack of such information.

**7.7.6.** JSC EMS shall timely inform the transmission system user on the topical contents and changes regarding:

- the Code;
- technical documents referring to transmission facilities significant for the operation of facilities of such transmission system user.

## 7.8. TRAINING OF JSC EMS AND TRANSMISSION SYSTEM USERS PERSONNEL

**7.8.1.** JSC EMS is to train its personnel in the field of operational procedures, pursuant of internal acts of the enterprise, Rules on Interconnection Operation and this Code.

**7.8.2.** Program, method, scope, type and persons authorized for training of personnel of transmission system user is adopted and determined by JSC EMS by internal acts.

**7.8.3.** Upon request of transmission system user, JSC EMS can train personnel of these users, pursuant of internal acts of the enterprise and under the conditions and in a manner mutually agreed.

# CHAPTER 8: ELECTRICITY METERING

## 8.1. INTRODUCTION

**8.1.1.** This Chapter stipulates rights and responsibilities of EMS and of all transmission system users and participants in the Power Market, for the purpose of:

- metering of all input/output flows of electricity into the grid,
- meter readouts, and meter data acquisition from the electricity meter;
- data processing and distribution for the settlements in the Power Market.

**8.1.2.** The Rules define technical requirements for instrument transformers, electricity meters and ancillary equipment at all points of connection to the transmission system, or inter-connection, and define all the necessary data pertaining to a specific Metering Point.

## 8.2. SCOPE

**8.2.1.** Provisions of the Code apply to Metering Points at all points of electricity delivery in EMS transmission facilities, or in the facilities of transmission system user's directly connected, i.e. inter-connected to the transmission system.

**8.2.2.** Provisions of the Code also apply to Metering Points in 400/220 kV/kV, 400/110 kV/kV and 220/110 kV/kV transformer bays, at the lower voltage side within the transmission grid.

**8.2.3.** Provisions of the Codes also apply to Metering Points of self-consumption in the EMS facilities, except for those within the responsibility of the distribution system operator.

**8.2.4.** The provisions on electricity metering also refer to medium-voltage Metering Points in the distribution grid, if the transmission line is used for the delivery of electricity to the neighbouring power system, or in the cases of connected generator facilities of interest to the transmission system operation, with electricity meters read and maintained by transmission system operator.

## 8.3. USE OF METERING DATA

**8.3.1.** Pursuant to requirements of this Code, data collected from the meters shall be the key foundation for the following business operations:

- Balance of input/output electricity flows for the required settlement period, specified by the Metering Points, Voltage and, in case of interconnections, with physical power flows calculated to the state border;
- Calculated load profiles of power flows entering the transmission grid for the required settlement period, as a sum of load profiles ( 15’ average power) from all inputs to the transmission grid, broken down to the generation load profile and load profile of of all power inputs to the transmission grid through interconnections;
- Calculated load profiles of power flows exiting the transmission grid, as a sum of load profiles (15’ minute average power) from all outputs from the transmission grid for the required settlement period, where such profile is broken down to the consumption load profile and a load profile of all power outputs from the transmission grid through interconnectionsCalculated load profiles of transmission system losses for the required settlement period;

- Settlement and billing of access to the transmission system for each transmission system user;
- Harmonization of metering data on electricity exchange through interconnections and Accounting;
- Calculation of total monthly amount of energy losses in the transmission grid for the process of planning and procurement of electric energy to cover losses in the transmission grid.
- Calculation of imbalance settlement of all participants in the electricity market.
- Issuing Guarantees of Origin.

**8.3.2.** EMS delivers metering data for the grid users, without their prior consent or notification to:

- to grid user's Supplier, in the case of Full Supply contract;
- to grid user's Balance Responsible Party ;
- to relevant state institutions and bodies for the purpose of monitoring and transparency of the electricity market, in accordance with the regulations pertaining to energy sector.

## 8.4. METERING DATA

**8.4.1.** At each Metering Point, electricity meters are measuring and recording the following quantities:

- active energy consumed (A+);
- active energy delivered (A-);
- reactive energy consumed (R+);
- reactive energy delivered (R-).
- maximum demand for the calculation period - consumption direction (A +);
- maximum demand for the calculation period - delivery direction (A-).

**8.4.2.** Direction of energy flows, consumption (+), or delivery (-), is observed from the transmission system user perspective.

**8.4.3.** At each Metering Point, a load diagram profile is registered in the form of average 15' active power, or reactive power for each single interval within the settlement period.

**8.4.4.** Each metering data is associated with time stamp (minute, hour, day, year), stored in the electricity meter registers of electricity meter.

**8.4.5.** The daily period starts at 00:00h for Metering Points on interconnections and ends at 24:00h (CET), while for all other Metering Points the daily period starts at 07:00 am, and ends the next day at 07:00 am (CET).

**8.4.6.** The settlement period for all Metering Points of interconnection is the calendar month and is based upon the snapshot register values from main and control meters on the first day of the month at 00:00 h and on the last day of the month at 24:00 h. The settlement period for all other Metering Points in the transmission grid is based upon the snapshot register values from main and control meters on the first day of the month at 07:00 a.m., and on the first day of the following month at 07:00 a.m.

**8.4.7.** The snapshot register values for consumption and delivery of power to the grid and 15' load profiles of consumption and delivery of power to the grid, are the basic metering data required for the settlement referred to in Chapter 8.3 of this Code.

**8.4.8.** In case of disputes related to remotely acquired metering data, the relevant values are the data originated from the respective meter registers, read locally through the optical port of meter.

**8.4.9.** At each Metering Point it is necessary to enable visual readouts of the following data on the display of electricity meter:

- Current value of cumulative active energy registers in kWh (for secondary configuration) or in kWh or MWh (for primary configuration) and reactive energy in, KVArh or MVArh per each configured direction of power flow;
- last snapshot value of register of the meter and the current register value;
- 15' maximum demand of active and reactive power per each configured direction of power flow in W, kW or MW, namely VAR, KVAR or MVAR, for the current settlement period and for the previous settlement period;
- Current Date and Time on electricity meter;
- Current quadrant of active and reactive power;
- Presence of measuring voltages ;
- Respected *OBIS* code of the measurement value;
- Fatal Alarm;
- Active Time of Use Tariff (if tariff switching is done within electricity meter).

## 8.5. PLACEMENT OF A METERING POINT

**8.5.1.** If all technical preconditions are met, the Metering Point is located on the voltage of Delivery Point.

**8.5.2.** Where the Delivery Point and Metering Point are not on the same voltage, or if they are at the same voltage but they are distant from each other that the technical losses between them cannot be disregarded, it is necessary to use Correction Factor applied to metering data for the value of power losses from the Delivery Point to the Metering Point (transferred to the Delivery Point). The use of Correction Factor is carried out during the settlement process and is its integral part.

**8.5.3.** Correction Factor is determined by EMS based upon the technical specification of the equipment, calculation of technical losses between the Delivery Point and the Metering Point under average operational conditions. The Correction Factor is stipulated in:

- Connection Decision of the end user's or generator's facility;
- Contract for Inter-connection of Distribution and Transmission system;
- Operational Agreement for end user's or generator's facilities, when Correction Factor is changed during the course of the facility operation;
- Contract for access to the transmission system.

The method and conditions of change of Correction Factor is governed between EMS and the transmission system user.

## 8.6. DEFINING METERING EQUIPMENT

### 8.6.1. METERING EQUIPMENT AT METERING POINTS

**8.6.1.1.** At each Metering Point, the metering equipment includes:

- Instrument transformers;
- Electricity meters;
- Metering- Terminal Box

- Measurement and auxiliary electrical circuits;
- Communication and auxiliary equipment;
- Metering cabinet.

### 8.6.2. INSTRUMENT TRANSFORMERS

#### 8.6.2.1. Introduction

**8.6.2.1.1.** Voltage Transformers (VT) and Current Transformers (CT) shall be placed at each Metering Point for the purpose of Settlement or Control of power flows, compliant with the following standards: *IEC 60044-1, IEC 60044-2, IEC 60044-3* and *IEC 60044-5.*

#### 8.6.2.2. Accuracy Class

**8.6.2.2.1.** Minimal required Accuracy Class of Instrument Transformers depends on the type of Metering Point, and is provided in Table 8.1:

Table 8.1.

| Metering Point | Accuracy Class | |
|---|---|---|
| | CT | VT |
| Interconnection | 0.2 + 0.2 (*) | 0.2 |
| Generation<br>- 110kV, 220 kV and 400 kV Metering Points<br>- other Metering Points | <br>0.2 + 0.2 (*)<br>0.2 | <br>0.2<br>0.2 |
| Connection with DSO | 0.2 | 0.2 |
| End users (Granted power over преко1600) | 0.2 | 0.2 |
| End user (Granted power below 1600 kW) | 0.5 | 0.5 |
| Self-consumption of Generation | 0.2 + 0.2(*) | 0.2 |

(*) two measurement cores

#### 8.6.2.3. Current Transformers

**8.6.2.3.1.** For permanently permitted thermal current of the Current Transformer, is typically adopted the value of 120% of its primary rated current .

**8.6.2.3.2.** The Current Transformers with reconfigurable primary windings shall be installed on the Metering Point. EMS is responsible for selection of ratio on which the primary sides of the current instrument transformers is to be connected for the purpose of achieving maximum metering accuracy. In this respect, transmission system users shall implement in their facilities EMS decision, submitted in the form of official letter.

**8.6.2.3.3.** Measurement cores of Current Transformer are exclusively reserved for the galvanic connection of electricity meter. EMS is responsible to approve galvanic connection of any additional device, or power consumer, exclusively for the purpose of increase the load in the current circuit in order that Instrument Transformer operates within the measurement range for which its Accuracy Class is defined.

**8.6.2.3.4.** Galvanic connection clamps on the secondary of the Current Transformer are protected by EMS seal in order to prevent unauthorized access. Any intervention on the line between Current Transformer and Electricity meter is to be pre-approved by EMS and documented, and the report on intervention shall be delivered to EMS.

**8.6.2.3.5.** At Interconnection Metering Points and Generation Metering Points on 110kV, 220 kV and 400 kV, the Current Transformers shall be equipped with two measurement cores of the same characteristics, whereby:

- the first measurement core is intended exclusively for the galvanic connection of the main meter (EMS may approve any additional galvanic connection exclusively for the purpose of increase of load in current circuit in order for the Current Transformer to operate within the most favourable measurement range);
- the second measurement core is used for galvanic connection of the control meter (to this measurement core, EMS may approve galvanic connection of other devices as well, provided that the total secondary load is not exceeding the rated load of CT core).

On the Metering Points of all other voltages, the first measurement core of the Current Transformer is intended solely for galvanic connection of the main meter and, if necessary, of the control meter. EMS may approve each additional galvanic connection by an official letter, solely for the purpose of the secondary load increase in order for the Current Transformer to operate within the most favourable measurement range in which its Accuracy Class is defined.

**8.6.2.3.6.** EMS JSC shall determine the specifications of additional load. The use of the additional load is to be reduced to a minimum and exclusively for the Current Transformer on the existing Metering Points. In case of connection or interconnection of new facilities to the transmission system, additional load may not be used but the rated load of Current Transformer Core for electricity meteting shall be selected to ensure measurement in the optimal range in which CT accuracy class is defined.

**8.6.2.3.7.** Terminal contacts of the installed additional load shall be protected by EMS seal and by seal of the transmission system user.

**8.6.2.3.8.** Total load of each secondary winding of the Current Transformer, including also the connections lines, shall range from 25% to 100% of the total rated load of such winding.

**8.6.2.3.9.** The cross-section of the current circuits conductor, measured from the secondary connection clamps of the Current Transformer to the meter terminal box, has to be at least 2,5 $mm^2$ for the phase line length of less than 200 m, and 4 $mm^2$ for the phase line length larger than 100 m. The current phase lines shall have permanent markings on both ends.

**8.6.2.3.10.** The current circuits of electricity meters or group of electricity meters on each Metering Point are to haves galvanic connection to the secondary winding of each phase by the corresponding current transformer via separate feeder and conductors.

**8.6.2.3.11.** Terminal connections of the metering and auxiliary circuits shall be provided in such a manner to have an appropriate protection against mechanical and electrical influences.

### 8.6.2.4. Voltage Transformers

**8.6.2.4.1.** Voltage circuits and voltage circuits of other measurement and auxiliary devices have galvanic connection to the metering winding of the voltage transformer. For the purpose of selectivity, voltage circuits for the connection of electricity meters shall be connected via separate automatic voltage fuses machine with mandatory signal contact, housed in the distribution cabinet of the voltage transformer.

**8.6.2.4.2.** Total load of the windings of Voltage Transformer, including voltage circuit for the connection of electricity meters, must not exceed the rated load of the Voltage Transformer.

**8.6.2.4.3.** The secondary circuits of the Voltage Transformer, used exclusively for electricity meters, shall be protected by special voltage automatic fuses and signal contact which shall be installed as close as possible to the secondary connection clamps of the Voltage

Transformer (in the distribution cabinet in the very bay of this transformer). In addition, signalization shall be installed in the secondary circuits of the Voltage Transformer to indicate the presence of each phase voltage. The signal of voltage automatic fuse outage and the signal of the phase voltage presence shall be transferred to the local SCADA system in the operational room of the facility, where each event shall be registered along with a time stamp. In the facilities where a special alarm signal of the voltage automatic fuse outage cannot be installed, data from the meter logbook shall be used as identifier of this event. Voltage lines for the connection of meters shall be made in different colours per phase and marked by permanent marks on both ends.

**8.6.2.4.4.** The permitted relative voltage drop in secondary voltage circuits for the metering, measured from the Voltage Transformer to the electricity meter, shall be less than or equal to 0.1% of the secondary rated voltage of the Voltage Transformer. The cross-section of the voltage circuits' conductor for the metering shall be selected based upon the previously mentioned permitted relative voltage drop.

**8.6.2.4.5.** Total load of each secondary winding of the Voltage Transformer, including also the load in the connected conductors , shall be within the range from 25% to 100% of the total rated load of the secondary winding. If the Voltage Transformer is under-loaded (load below 25% of its rated load), the additional load shall be included into its secondary circuit, for the purpose of maintaining the required Accuracy Class for the purpose of the settlement or control metering.

**8.6.2.4.6.** Terminal connections of the metering and auxiliary circuits shall be provided in such a manner to have an appropriate protection against mechanical and electrical influences.

### 8.6.3. ELECTRICITY METERS

#### 8.6.3.1. Introduction

**8.6.3.1.1.** Each electricity meter shall have galvanic connection to the instrument transformers of characteristics defined in Chapter 8.6.2. Point of galvanic connection and separation of electricity meter from the rest of metering circuits is the Metering Terminal Box with 20 connectors.

**8.6.3.1.2.** In all Metering Points on interconnecting transmission lines at the voltage levels higher than or equal to 110 kV, as well as at the Metering Points of the electricity generation, the main meter and control meter of the same technical specifications and the same accuracy class, is to be installed. Data from the main meter is used for the Settlement.

**8.6.3.1.3.** Electricity meters for Active and Reactive energy shall comply with the national metrology regulations, the regulations for the delivery of electric energy, as well as with the following *IEC* standards:

- *IEC 62053-22* – Static electricity meters for Active energy (Accuracy Class 0.2S and 0.5S);
- *IEC 62053-23* – Static electricity meters for Reactive energy (Accuracy Class 2 and 3).

**8.6.3.1.4.** EMS seals have to be placed on the lid of the meter connection terminals and on the button for meter reset. EMS seals have to be placed on the lid of the meter connection terminals for all interconnection Metering Points,

#### 8.6.3.2. Accuracy Class

**8.6.3.2.1.** The minimal required Accuracy Class for electricity meters mentioned in Chapter 8.6.3.1. is depending to the type of Metering Point, and is provided in Table 8.2.

Table 8.2

| Metering Point | Accuracy Class | |
|---|---|---|
| | Active electricity meter | Reactive electricity meter |
| Interconnection | 0,2S + 0,2S (*) Generation | 2 + 2 (*) |
| Generation | 0,2S + 0,2S (*) Generation | 2 + 2 (*) |
| distributive facility | 0,2S | 2 |
| End users (Granted power over 1600 kW) | 0,2S | 2 |
| End user (Granted power below 1600 kW) | 0,5S | 3 |

(*) Main meter and control meter

**8.6.3.3. Auxiliary supply of electricity meters**

**8.6.3.3.1.** Internal supply necessary for the operation of electricity meter have to be provided from the auxiliary source of supply and voltage metering circuits brought to the connection terminals of the electricity meter. Typically, the electricity meter is supplied through the voltage metering circuits. The auxiliary source of power supply is an alternative to supply through metering voltage circuits. These two sources of meter power supply shall be separated galvanically.

**8.6.3.3.2.** In the case of failure of both sources of supply, the internal battery of the electricity meter shall provide supply of the internal meter real time clock, for at least three months.

**8.6.3.4. Data registration**

**8.6.3.4.1.** Electricity meter shall store snapshot values for all configured registers of Active and Reactive energy and maximum demand for at least twelve last months, after which the oldest values can be overwritten by the new ones. I.e. the data for the thirteenth month instead of the ones for the first month, etc. Metering data is to be stored in the non-volatile memory of the meter, to ensure safe keeping in the cases of lack of power supply.

**8.6.3.4.2.** Electricity meters shall be equipped with an infra-red communication port in accordance with the *IEC 62056-21* protocol for local readout of electricity meter registers.

**8.6.4. MONITORING DEVICES**

**8.6.4.1.** The dashboard shall display the aggregated alarm from electricity meter which incorporates the list of the following individual alarms:

- malfunction of the meter;
- loss of the metering phase voltage;
- loss of auxiliary power supply;

Each alarm of the electricity meter shall be separately marked with time stamp of occurrence in the meter logbook. These data shall be readable on either locally or remotely.

**8.6.4.2.** Aggregated alarm shall be grouped into the local signal loop and sent to the EMS dispatching centre.

**8.6.5. INTERNAL REAL TIME CLOCK IN ELECTRICITY METERS**

**8.6.5.1.** Electricity meter is to be equipped with an internal real time clock. These internal real time clocks are to be adjusted to current local time. This internal real time clock must have the possibility for the implementation of Daylight Saving Time applied in the territory of the Republic of Serbia.

**8.6.5.2.** If there is no signal of external synchronization available, the internal real time clock must not deviate more than 15 seconds during one month to the correct real time.

**8.6.5.3.** The internal real time clock can be synchronized either through remote communication with the electricity meter via distributed signal from EMS GPS LAN Time Server, or through distributed signal from the local device for distribution of the correct time.

**8.6.5.4.** The meter shall have an adjustable time synchronization window. The basic range of the synchronization window available for time synchronization is ± 3 minutes.

**8.6.5.5.** The Metering Points may also be equipped with GPS receiver which provides local synchronization of internal real time clock of the meter. EMS will shall decide in each particular case whether it is necessary to install a local GPS receiver, and if so, shall provide a GPS receiver.

**8.6.5.6.** EMS-performed remote synchronization of the electricity meter real time clock has a priority over the local real time clock synchronization.

### 8.6.6. COMMUNICATION

#### 8.6.6.1. Communication protocol

**8.6.6.1.1.** All values registered in the electricity meters shall be readable either:

- locally via optical port according to *IEC 62056-21* ;
- remotely via DLMS protocol according to *IEC 62056-42/46/53/61/62*.

**8.6.6.1.2.** Remote communication to the electricity meters or groups of meters from SRAAMD system (*System for Remote Acquisition and Accounting of Metered Data*), shall be realized through serial RS 485 communication ports on electricity meters.

#### 8.6.6.2. Communication media

**8.6.6.2.1.** For the purpose of reading electricity meters remotely one of the following communication media are provided:

- fibre optic cables in protective cables of power lines in transmission network (*OPGW/Ethernet*);
- *GSM/GPRS* mobile telecommunications network;
- public switched telephone network (PSTN).

**8.6.6.2.2.** One communication line may serve several electricity meters, and may also be used for multiple Metering Points if the electricity meters are grouped at close proximity, using different internal physical addresses, whereby the *RS 485* communication port shall be used exclusively by single meter communication at one time.

**8.6.6.2.3.** The communication media shall ensure permanent access to electricity meters for the purpose of remote readout.

#### 8.6.6.3. Communication interface

**8.6.6.3.1.** In order to be connected to the communication media, the electricity meter is to have communication interfaces which are compatible with the supporting devices such as modems, communication branches, multiplexers, OPGW terminal equipment etc.

**8.6.6.3.2.** Communication units may be internal (inside the meter) and external, as well as dedicated communication devices.

**8.6.6.3.3.** For external communication devices, connection with electricity meters is implemented via *RS 485* port.

### 8.6.7. INTEGRATION AND ENVIRONMENT

**8.6.7.1.** Electricity meters, monitoring and communication devices shall be integrated into a single system (for one or several Metering Points) with the purpose of:

- components protection through the housing and seals which prevent unauthorized access;
- temperature control in accordance with the environment in which the equipment is operating;
- protection against humidity, dust, shock and vibration from the environment;
- achieving electric and magnetic compatibility with the surrounding equipment;
- enabling the testing of each meter and communication interface without disrupting electricity flow with transmission grid.

**8.6.7.2.** For all Metering Points at one facility, an Auxiliary Power Supply shall be provided by 57-230 VAC external single-phase source of power supply, and 48-240 VDC 50 VA for the purpose of power supply to the meters and communication interfaces, connection lines between the components, including all necessary protection devices of metering and auxiliary circuits.

**8.6.7.3.** The Auxiliary Power Supply of the electricity meter and all other devices shall be protected by a separate fuses of 2A with switching function (double-pole switching).

**8.6.7.4.** Electricity meters, monitoring and communication devices for one or more Metering Points are to be placed in a single metering cabinet. Type, equipment specification and installation diagram of the metering cabinet shall be determined by EMS.

## 8.7. COMMISSIONING OF METERING EQUIPMENT

**8.7.1.** During commissioning, installation or replacement of the metering equipment, EMS performs the following activities:

- examination of the characteristics of the metering equipment;
- verification of the compliance tests performed by the supplier;
- configuration of the electricity meters data register;
- testing of the meter Accuracy Class;
- control of the validity of galvanic connection (of all metering and communication circuits) of the meter;
- verification of the availability of local and remote communication for the reading of values stored in the electricity meter;
- control of the validity of seals on the metering equipment;
- registration and identification of the metering equipment.

**8.7.2.** After commissioning, no unauthorized modifications to the metering equipment are allowed without prior written approval of EMS JSC. Every unauthorized modification to the equipment requires testing and repetition of commissioning activities in respect to all functions set forth in Point 8.7.1., while all the expenses shall be borne by the party responsible for the unauthorized modification.

## 8.8. CONFIGURATION OF METERING EQUIPMENT

**8.8.1.** Configuration of metering equipment includes:

- selection and defining of transmission ratios of instrument transformers installed at the Metering Point;
- selection of energy direction for metering and recording in the meter;

- meter configuration at the Metering Point according to the needs of energy settlement and for other calculations.

**8.8.2.** Transmission ratios of instrument transformers is defined by EMS according to the voltage of connection (inter-connection), and the transmission capacity of the equipment involved.

**8.8.3.** Meter configuration implies determination of internal parameters of the electricity meter in accordance with technical characteristics of the Metering Point and requirements set by EMS. Electricity meter configuration may be primary or secondary, depending on whether the electricity meter displays and stores primary or secondary energy quantities. Each type of meter configuration shall have its uniform marking (name).

**8.8.4.** The list of transmission ratios of all instrument transformers and configuration of electricity meters from all Metering Points is entered into the appropriate document according to the agreement between EMS and the transmission system users.

**8.8.5.** EMS is defining and implement parameters of the meters configuration necessary for its operation for each Metering Point, registers, device monitoring and communication lines for the purpose of:

- metering in accordance with the requested Accuracy Class;
- recording of energy values in the form of 15' time series;
- provision of local and remote communication from meter to all authorized parties entitled to access metering data.

**8.8.6.** Only EMS is authorized to introduce changes in configuration of the metering equipment.

**8.8.7.** EMS is responsible for the maintenance and update of configuration of the metering equipment to make it permanently suitable to the characteristics of connection point (inter-connection point).

**8.8.8.** EMS shall notify in writing the transmission system user of any changes made to configuration of the meter.

**8.8.9.** Transmission ratio of instrument transformers used for the calculation of primary values of electricity and power shall be properly entered into settlement system and may be changed only upon issued protocol for transmission ratio change, put up by the representatives of EMS and the transmission system user.

**8.8.10.** EMS can submit running meter configuration to the transmission system user as a document upon its formal request.

**8.8.11.** EMS shall register and store in its database all the source data for the running configuration of the meter.

## 8.9. TESTING AND CONTROL OF METERING EQUIPMENT

### 8.9.1. TESTING OF METERING EQUIPMENT

**8.9.1.1.** EMS shall examine adequacy and accuracy of the metering equipment at each Metering Point during its commissioning and operation, while the electricity meters are examined at least once a year.

**8.9.1.2.** The procedure of testing adequacy and accuracy of the metering equipment comprising the following activities:

- inspection of validation and intact status of all seals put on the metering equipment;

- checking of transmission ratio of current and voltage transformers;
- inspection of all connections between instrument transformer and meters;
- verification of proper meter operation, including the testing with use of meter standards;
- checking the status and configuration of electricity meters;
- checking the display of the meter;
- checking the functionality of the electricity meter's output contacts;
- verification of the local and remote communication to the meter.

**8.9.1.3.** If the test results indicate that one or more measuring component of the metering equipment is not complying to the technical requirements of the Connection Act , the owner of such defective component, shall replace that component as soon as possible upon received test results. In the case of malfunction of the equipment which has redundant equipment, this deadline is extended for a maximum of 30 days.

**8.9.1.4.** After replacement of old meter and installation of new one EMS is to run on site testing of the fresh installed equipment.

**8.9.1.5.** If EMS JSC or the transmission system user have doubts regarding the correctness of the metering equipment operation, EMS JSC shall organize the testing of the equipment in question as soon as possible starting from the moment when EMS JSC was informed on the doubt in the proper operaton of such metering equipment.

### 8.9.2. CONTROL OF ELECTRICITY METERS

**8.9.2.1.** EMS is performing control of the installed meters at least once per year.

**8.9.2.2.** For the purpose of control of meters EMS is conducting the following activities:

- visual examination of the proper operation of meter and the display of metering values in the registers of the meter;
- visual examination of seal status on the meter;
- comparison of energy values measured by the main meter with the values measured by the control meter (if such is existing ) – this deviation of energy between these two meters shall be within the limits set by the accuracy class of the main and control meters;
- acquisition of signals from the monitoring devices;
- analysis of signals and alarms recorded in the log books of the meter;
- analysis of the values of the phase voltages which are feeding the meter at the Metering Point;
- analysis of the voltage and current phase diagram and their proper sequence at the Metering Point;
- control of the deviation of on-site electricity meters accuracy by using portable reference standards;
- development of the report on electricity meters control.

**8.9.2.3.** The owner is obliged to control of meter operation in the facility via on-site monitoring and meter observation. In the case of appearance of alarm or a signal informing on deviations from regular meter operation, the transmission system user is responsible to report this to EMS as soon as possible.

### 8.9.3. CONTROL OF INSTRUMENT TRANSFORMERS

**8.9.3.1.** JSC EMS and the owner of instrument transformers shall conduct on-site control of installed instrument transformers in the periods specified by the Act regulating the activities of metering or when such is necessary (extraordinary control), or when are preconditions met

for such control to be successfully carried out (i.e. during facility repairs or disconnection of a metering point).

**8.9.3.2.** For the purpose of control of the instrument transformers the following activities are conducted:

- visual examination of instrument transformers;
- verification of the seal status of instrument transformers;
- verification of compliance of the primary connection of the current instrument transformer with the documentation;
- inspection of transmission ratio of the instrument transformer;
- inspection of secondary load of the instrument transformer;
- acquisition of signals from the monitoring device;
- analysis of the signals and alarms which are recorded in the logbooks in the facility;
- analysis of the values of phase voltage and current.

**8.9.3.3.** The owner of the instrument transformers is responsible to control the regular operation of the instrument transformer by on-site monitoring and reading of meter. In the case of malfunction or appearance of the signal which informs on deviations from the regular operation of the instrument transformer, the transmission system user is responsible to report this to EMS as soon as possible. The owner of the instrument transformers and EMS shall jointly analyse the event and decide whether it is necessary to replace the instrument transformer.

**8.9.3.4.** In the case of malfunction of the instrument transformer, the owner of the instrument transformer, or operator of the instrument transformer, shall be responsible for the replacement of such equipment. Defective instrument transformer shall be replaced in agreement with JSC EMS, as soon as possible starting from the moment when the its owner or its operator is informed about the doubt on the proper operation of metering equipment, with the same type of instrument transformer or similar type, according to standard period of the delivery for such type of equipment by the supplier and upon availability of transmission system to carry out such replacement.

## 8.10. METERING PROCEDURE

### 8.10.1. METERING DATABASE

**8.10.1.1.** EMS is keeping the record of meters, and record of measured values from metering devices for whom the provisions of the Grid Code applies.

**8.10.1.2.** The metering database is identifying the metering equipment in accordance to the unique identification *EIC Z* code used for::

- location of the connected facility to the transmission system;
- the connection point;
- transmission system user data;
- current supplier data, and the data of all previous suppliers of the transmission system user;
- balance responsible party data;
- transformer ratio for each Metering Point of the user;
- structure of the metering equipment, configuration and reports of maintenance works;
- identification of measured and registered values at the connection point;

- access credentials on the metering data and preventive actions to evade unauthorized access.

**8.10.1.3.** It is necessary at any time and in all conditions to know the origin of each metering data in use under responsibility of the Grid Code.

**8.10.1.4.** The maximum period between meter installation or changes to the metering equipment and update of the metering database is two weeks.

**8.10.1.5.** The metering database shall contain original values acquired by remote or local communication to the meter, correction factor used on metering data and substituted values in accordance to the previously mentioned rules. The purpose of the metering database is to enable:

- unique identification of metering equipment which correlates to any quantity and value acquired from that metering equipment by use of its relevant code in the database;
- determination the type of quantity (kW, kWh, mWh, KVAR, KVARH, MVARH) for the provided value;
- clear and unique identification of the original value, corrected value of losses and the substituted value;
- link to the original value for each corrected or substituted value;
- time flag related to the date of acquisition of original values and the date of data substitution.

**8.10.1.6.** EMS is making available the measured and calculated values from the metering database to the transmission system users for their facilities through which they receive and/or deliver power, as well as to their suppliers in accordance with the Act regulating the procedure of implementation of the right of final customers to access information on its own electricity consumption.

**8.10.1.7.** Transmission system users and their suppliers are having access to metering and settlement data via web platform for display of all metering data related to the user. Through this platform the users can review and download only the data related to their use of the transmission system, while the suppliers can download only data related to the Metering Points from the users they are supplying.

**8.10.1.8.** The metering database is containing all relating data to the metering equipment operation for the last 5 years.

**8.10.1.9.** Data older than 5 years is kept in the metering database archive. Archiving the metering database is carried out on a regular basis set by the regular maintenance of the database, while the period of keeping the data in the archive is ten years.

### 8.10.2. REMOTE ACQUISITION OF DATA

**8.10.2.1.** EMS is responsible for remote acquisition of metering data stored locally in the meter.

**8.10.2.2.** Such remote acquisition of data is carried out in accordance with the communication protocols defined in Chapter 8.6.6. of this Code, by using communication media and interfaces connected to the metering equipment itself.

**8.10.2.3.** In case of longer disruption of communication, JSC EMS shall carry out local reading of meters and transferr the acquired data directly to the database. This procedure shall be performed within period of time which enables all required metering data to be available for the Settlement.

**8.10.2.4.** EMS is reading the metering data regularly at each facility under defined period of time. The period of reading shall be set in accordance to the requirements of Settlement of access to the transmission system, the imbalance settlement, accordingly to the contractual obligations, having in mind the time necessary for the process of validation and substitution of data.

**8.10.2.5.** The time interval of the load profile reading from the meter is one day. Where the conditions regarding communication lines do not allow regular collection of metering data, EMS shall review the acquisition periods aiming to introducing more frequent meter reading.

### 8.10.3. DATA VALIDATION

**8.10.3.1.** EMS is verifying and confirming the feasibility of acquired metering data and validate the data prior to their storing into the database.

**8.10.3.2.** The purpose of the validity checking of metering data is to:

- check if there are some missing data or incomplete information after readout of the meters;
- check if there is ongoing control or maintenance of metering equipment, and if any local intervention was performed during the period for which data were acquired;
- check if there were any absence of auxiliary power supply in the period for which data were acquired;
- check if there is no deviations between local time base in the meter and system time reference during the entire settlement period;
- verify that all collected data are feasible to the expected loads at a given Metering Point.

**8.10.3.3.** During process of data validation, the metering data obtained from the main and control meters are compared, and the comparison of the energy calculated from the energy registries and from integration of load profiles. The metering data is also compared with data from the previous settlement period, as well as with data from the same month but from the previous years.

**8.10.3.4.** The permitted difference between the energy values calculated from the main and control meter shall be within the limits of declared accuracy class of the meters.

**8.10.3.5.** The permitted difference between energy calculated from the load profile and from energy registers shall be less than 0.1%.

### 8.10.4. DATA SUBSTITUTION

**8.10.4.1.** In the case of invalid data or if an malfunction in metering, EMS shall substitute the invalid or missing metering data.

**8.10.4.2.** JSC EMS shall substitute the invalid or missing metering data taking into account the following sequence of precedence:

- data registered in the control electricity meter, in case that such meter is an integral part of the metering equipment, and if data validation is performed;
- alternatively, data obtained from *SCADA* system in EMS if it existing for such Metering Point;
- estimation based upon the similar preceding period (rules on the selection of such periods is to be established by mutual agreement between EMS and the transmission system user).

**8.10.4.3.** In the cases stipulated by the Act regulating the conditions of power supply, substitution of metering data is carried out in accordance to such regulation.

**8.10.4.4.** EMS is documenting the substitution of metering data for the purpose of internal auditing and the control of settlement.

**8.10.4.5.** If during testing, or during regular or special control of the metering equipment is established that the metering or recording of metering data was incorrect, the metering data have to be substituted in the database in accordance to the provisions of substitution for the following period:

- from the starting day of malfunction, if the starting time of malfunction can be exactly identified;
- the period for which there are available data.

**8.10.4.6.** If the substitution of metering data is performed after the finish of settlement, it is necessary to make a correction of the settlement and to submit the substituted data to the user.

## 8.11. ACCESS TO THE METERING DATA

**8.11.1.** Direct access to metering data at the meter a via remote and local communication is granted only to EMS authorized persons for the purpose of configuration, maintenance, validation, data substitution and acquisition and to the users of metering data. The users of metering data are:

- transmission system user or his authorized representatives for the purpose of observation and collection of metering data related to its Metering Point;
- supplier of transmission system users;
- other responsible persons in accordance to the laws and regulations.

**8.11.2.** EMS is liable for the organization and delivering of access to metering data and for definition of the user's access rights, having in mind the safety of local data in the facility and in the metering database.

**8.11.3.** EMS have to delegate the right of remote access to metering data on the meter by means of defining the list of authorized users of the metering data in order to prevent conflicts among the authorized parties. EMS shall allocate the time window for the access to metering data taking into account the needs for acquisition of data by EMS and the other users of metering data in accordance to the principle of non-discrimination.

**8.11.4.** Non-compliance to the provisions governing the allocated time window for the access to metering data shall result in cancelling the right for the access thereto.

**8.11.5.** JSC EMS has to ensure safety of locally registered data on the meters, as well as safety of metering database and registers inside the meters.

**8.11.6.** JSC EMS may alter data registered in the meters, only for the period of meter testing. A report shall be made for any on-site intervention on electricity meters and such report shall contain data of unregistered or incorrectly registered electricity.

# CHAPTER 9: TRANSITIONAL AND FINAL PROVISIONS

**9.1.1.** The integral parts of the Code are the following Annexes:

- ANNEX A: Standard data;
- ANNEX B: The concept of Dispatch Centre's Interconnection.
- ANNEX C: List of data for real-time exchange.

**9.1.2.** The initiative for amendments and/or supplements to the Code may be filed by the JSC EMS, Agency, electricity producers, distribution system operator, public supplier, supplier and end user whose facility is connected to the transmission system.

**9.1.3.** The initiative for amendments or supplements to the Code shall be submitted to the chairman of the Commission, who shall deliver it to the Commission members.

**9.1.4.** Within 60 days following the day when the session was held at which the Commission reviewed the proposal for amendments or supplements to the Code, JSC EMS shall make a proposal for amendments or supplements to the Code and shall submit it to the Agency for obtaining an approval, or shall submit to the Agency an explanation elaborating the reason it shall not submit the mentioned proposal, together with the minutes of the Commission's session.

**9.1.5.** JSC EMS shall within one year following the entering into force of the Grid Code comply with the provisions of the Code all general and other acts, as well as all concluded agreements and contracts.

**9.1.6.** The Public Supplier's competencies and obligations shell be transferred to the Guarenteed Supplier upon its appointment pursuant to Articles 190 and 397 of the Energy Law.

**9.1.7.** Until transfer of the ownership over the facilities of transmission grid owned by transmission system user, JSC EMS manages a part of facilities of customers and generator, pursuant to Articles 1.2.2.-1.2.4. of the Code.

**9.1.8.** Underfrequency protection plan from the item 6.3.2.1. and requirements for accuracy in frequency measurement from 6.3.2.7. shall be applied latest by December 31, 2019.

**9.1.9.** On the day this Code enters into force, the Grid Code No. 001-00-ROU-11/2017-003 dated December 8, 2017 shall cease to be valid.

**9.1.10.** Upon receiving approval of the Energy Agency of the Republic of Serbia, the Code shall be published on the Internet page of JSC EMS and shall enter into force on the eighth day following the day of its publication.

# ANNEX A: STANDARD DATA

## A1. PLANNED CONSUMPTION OF ELECTRICITY IN THE FACILITY

Data in the following table shall be submitted as mandatory for the next five years and for the the tenth year:

| Month | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_{max}$ [MW] | | | | | | | | | | | | |
| energy [MWh] | | | | | | | | | | | | |
| | | | | | | | | | | TOTAL [MWh] | | |

Where $P_{max}$ is the maximum power in the observed time period.

If the electric facility has both production and consumption, the production and consumption balances shall be entered separately.

## A2. PLANNED PRODUCTION OF ELECTRICITY IN THE FACILITY

Data in the following table shall be submitted as mandatory for the next five years and for the the tenth year:

| Month | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| energy [MWh] | | | | | | | | | | | | |
| | | | | | | | | | | TOTAL [MWh] | | |

Production shall be considered to be net production at the connection point at which handover of energy is performed, i.e. it is necessary to deduct the amount of self-consumption.

## A3. GENERATION ADEQUACY

Data from the following table shall be submitted as mandatory for the next five years and for the tenth year, for each generating unit separately:

| Reference time | Power of generator at the connecting point | In case of unavailability, specify the reason |
|---|---|---|
| Third Wednesday in January at 10.30 a.m. | | |
| Third Wednesday in January at 7.00 p.m. | | |
| Third Wednesday in July at 10.30 a.m. | | |

## A4. GENERATOR AND SUPPORTING EQUIPMENT

Generator

| | | |
|---|---|---|
| nominal apparent power | | MVA |
| nominal active power | | MW |
| power factor | | |
| stator winding connection | | |
| nominal stator voltage | | kV |
| nominal stator current | | A |
| nominal exciting current | | A |
| exciting voltage at nominal load | | kV |
| negative (inverse) component of reactance | | p.u. |
| negative (inverse) component of resistance | | p.u. |
| zero (homopolar) component of reactance | | p.u. |
| zero (homopolar) component of resistance | | p.u. |
| stator leakage reactance | | p.u. |
| stator resistance | | p.u. |
| direct-axis synchronous reactance | | p.u. |
| quadrature-axis synchronous reactance | | p.u. |
| direct-axis transient reactance | | p.u. |
| direct-axis sub-transient reactance | | p.u. |
| quadrature-axis transient reactance | | p.u. |
| quadrature-axis sub-transient reactance | | p.u. |
| mechanical damping | | p.u. |
| aperiodic time constant of short-circuit current interruption | | s |
| direct-axis transient open-circuit time constant | | s |
| direct-axis sub-transient open-circuit time constant | | s |
| direct-axis transient short-circuit time constant | | s |
| direct-axis sub-transient short-circuit time constant | | s |
| quadrature-axis transient open-circuit time constant | | s |
| quadrature-axis sub-transient open-circuit time constant | | s |
| quadrature-axis transient short-circuit time constant | | s |
| quadrature-axis sub-transient short-circuit time constant | | s |
| inertia constant of a generating unit (N) | | s |
| Inertia constant ($T_j$) | | s |

Supplements:

1. Operating diagram of generator
2. No-load and short-circuit test curves

Generator exciting system

| | | |
|---|---|---|
| nominal DC exciting current | | A |
| nominal DC exciting voltage | | V |
| minimal DC exciting voltage | | V |
| maximum DC exciting voltage | | V |

| | | |
|---|---|---|
| maximum step of exciting current change | | A |
| minimal exciting current | | A |
| exciting type (mechanical or static) | | |

Supplements:
1. Structural block-diagram with parameters for all blocks
2. Basic data on forcing excitation (factor, duration…)
3. Electrical protections and their characteristics

## Primary (turbine) controller

| | | |
|---|---|---|
| Range of statism of the turbine controller | - | % |
| Primary control band | | $\%P_{nom}$ |
| Regulator insensitivity | | MHz |

Supplement
1. Structural block-diagram with parameters for all blocks

## Local equipment for secondary control

Supplement
1. Structural block-diagram with parameters for all blocks

## Self-consumption

1. Amount of self-consumption from the generation tap in the function of generator power
2. Amount of self-consumption of generator taken over from the transmission grid for the power of the generator

## A5. TRANSFORMERS

| | | |
|---|---|---|
| type | | |
| high voltage side | | |
| rated apparent power | | MVA |
| rated voltage | | kV |
| low voltage side 1 | | |
| rated apparent power | | MVA |
| rated voltage | | kV |
| low voltage side 2 | | |
| rated apparent power | | MVA |
| rated voltage | | kV |
| connection (vector group) | | |
| type of control | | |
| control band, control band step | | % |
| no-load current | | % |
| short-circuit voltage $u_{12}$ | | % |
| short-circuit voltage $u_{13}$ | | % |
| short-circuit voltage $u_{23}$ | | % |
| level of utilization | | % |
| copper losses | | kW |
| iron losses | | kW |

Supplements:

1. Representation of a transformer in a zero-sequence (homopolar) system- electrical scheme
2. Method of earthing the neutral point of the primary and secondary winding
3. Electrical protections and their characteristics

## A6. TRANSMISSION LINES AND CABLES

| | | |
|---|---|---|
| rated voltage | | kV |
| total length | | km |
| number of systems | | |
| number of conductors per phase | | |
| type of conductor | | |
| type of earth wire (earth wires) | | |
| direct resistance | | Ω |
| direct reactance | | Ω |
| direct susceptance | | S |
| zero (homopolar) resistance | | Ω |
| zero (homopolar) reactance | | Ω |
| zero (homopolar) susceptance | | S |

Supplement:

1. Electrical protections and their characteristics

## A7. CIRCUIT-BREAKERS

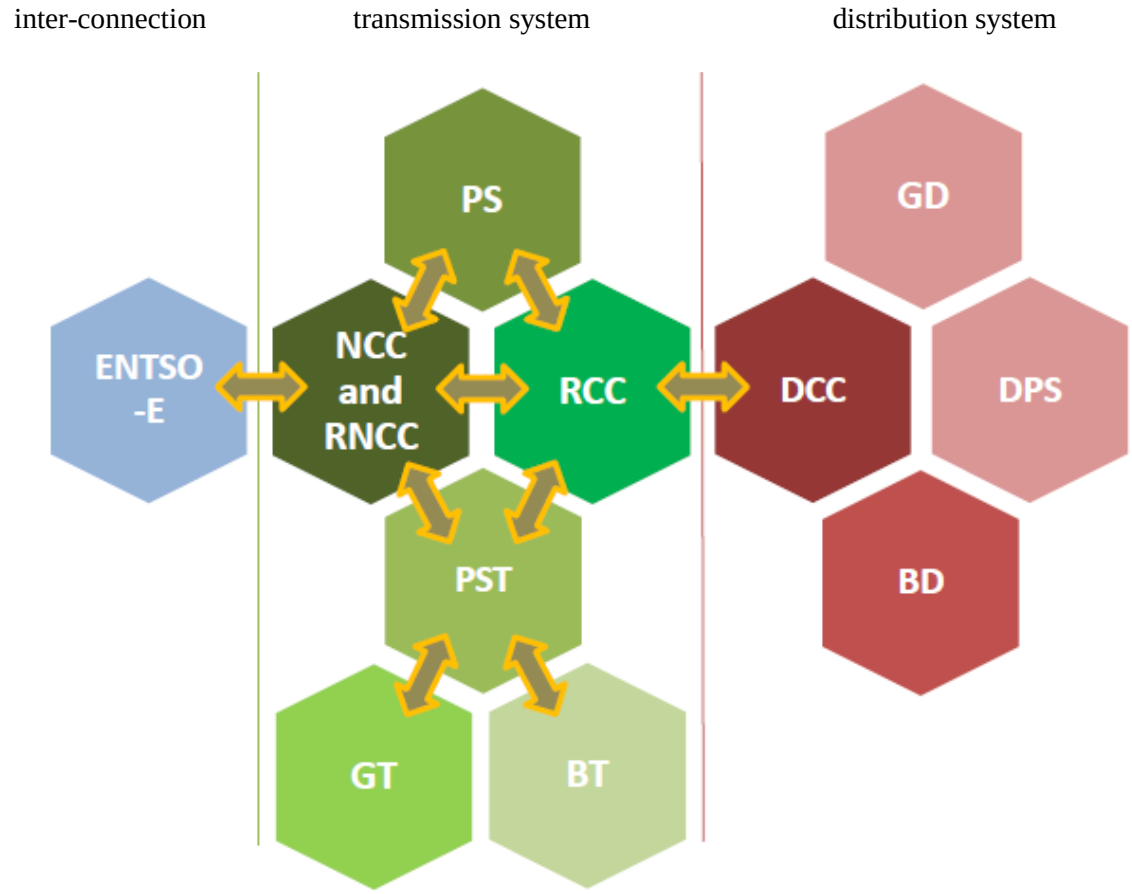
| | | |
|---|---|---|
| rated voltage | | kV |
| rated current | | A |
| rated power of switching the short circuit current | | kA |
| rated inrush current | | kA |

## A8. REACTIVE POWER COMPENSATION EQUIPMENT

| | | |
|---|---|---|
| type | | |
| rated power | | Mvar |
| rated voltage | | kV |

# ANNEX B: CONCEPT OF CONTROL CENTRE'S INTERCONNECTION

Figure B.1 - The Concept of Dispatch Centres' Interconnection (physical telecommunications lines)




Abbreviations in Figure B.1 have the following meaning:

- ENTSO-E – transmission system operators in *ENTSO-E;*
- NCC – national control centre of JSC EMS;
- RNCC – reserve national control centre of JSC EMS;
- RCC – regional control centre of JSC EMS;
- PS – transmission transformer substation/switching station;
- PST – power station in transmission system;
- GT – generation facility connected to the transmission system;
- BT – consumer facility connected to the transmission system;
- DPS – distribution power station 110/x kV;
- GD – generation facility connected to the distribution system 110 kV;
- BD – consumer facility connected to the distribution system 110 kV.

# APPENDIX C: DATA TO BE EXCHANGED IN REAL-TIME

## C.1. BAYS OF OVERHEAD LINES AND CABLES

| Type | Name | Description |
|---|---|---|
| M | Phase currents | A ($I_0$, $I_4$, $I_8$) |
| M | 3-Phase active power | MW (– inbound to busbars, + outbound from busbars) |
| M | 3-Phase reactive power | MVAr (–inbound to busbars, + outbound from busbars) |
| M | Line voltages | kV ($U_{04}$, $U_{48}$, $U_{08}$) |
| M | Frequency | Hz (two decimal digits at least) |
| M | Fault locator | km |
| S | Circuit-breaker | ON, OFF, in-between, fault |
| S | Disconnector | ON, OFF, in-between, fault |
| S | Ground disconnector | ON, OFF, in-between, fault |
| A | Voltage presence | energized, deenergized |
| A | Control | local/remote |
| A | Overload protection OFF | active, cleared |
| A | Auto reclose blocked | active, cleared |
| A | Auto reclose OFF | active, cleared |
| A | Auto reclose 1pole command | active, cleared |
| A | Auto reclose 3pole command | active, cleared |
| A | Auto reclose successful | active, cleared |
| A | Distance protection – definitive trip | active, cleared |
| A | Distance protection zone 1 – trip | active, cleared |
| A | Distance protection zone 2 – trip | active, cleared |
| A | Distance protection zone 3 – trip | active, cleared |
| A | Distance protection zone 4 – trip | active, cleared |
| A | Distance protection zone 5 – trip | active, cleared |
| A | Distance protection 3pole – trip | active, cleared |
| A | Distance protection phase L1 – pickup | active, cleared |
| A | Distance protection phase L2 – pickup | active, cleared |
| A | Distance protection phase L3 – pickup | active, cleared |
| A | Distance protection phases L1-L2 – pickup | active, cleared |
| A | Distance protection phases L1-L3 – pickup | active, cleared |
| A | Distance protection phases L2-L3 – pickup | active, cleared |
| A | Distance protection phases L1-L2-L3 – pickup | active, cleared |
| A | Distance protection reverse direction – trip | active, cleared |
| A | Distance protection non directional – trip | active, cleared |
| A | Distance protection zone Z1B – trip | active, cleared |
| A | Protection device – fault | active, cleared |
| A | Line differential protection – trip | active, cleared |
| A | Overload protection 1. stage blocked | active, cleared |
| A | Overload protection 2. stage blocked | active, cleared |
| A | Overload protection 1. stage – alarm | active, cleared |
| A | Overload protection 2. stage – alarm | active, cleared |
| A | Overload protection 1. stage – trip | active, cleared |
| A | Overload protection 2. stage – trip | active, cleared |
| A | Directional earth-fault overcurrent protection – trip | active, cleared |

| | | |
|---|---|---|
| A | Overcurrent protection – trip | active, cleared |
| A | Earth-fault overcurrent protection – trip | active, cleared |
| A | Breaker failure protection – trip | active, cleared |
| A | Circuit breaker pole discordance protection – trip | active, cleared |
| A | Backup line differential protection – trip | active, cleared |
| A | Backup overcurrent protection – trip | active, cleared |
| A | Backup earth-fault overcurrent protection – trip | active, cleared |
| A | Backup overcurrent protection 2. stage – trip | active, cleared |
| A | Trip circuit supervision – alarm | active, cleared |
| A | Circuit breaker - SF6 gas low pressure 1. stage – alarm | active, cleared |
| A | Circuit breaker – SF6 gas low pressure 2. stage – blocking | active, cleared |
| A | Teleprotection remote end distance protection signal received | active, cleared |
| A | Teleprotection remote end directional earth-fault overcurrent protection signal received | active, cleared |
| A | General trip | active, cleared |
| A | Distance protection blocked | active, cleared |
| A | Line differential protection blocked | active, cleared |
| A | Backup line differential protection blocked | active, cleared |
| A | Backup earth-fault overcurrent protection blocked | active, cleared |
| A | Test plug in test position | active, cleared |
| A | Circuit breaker – spring not charged | active, cleared |
| A | Current circuit supervision – fault | active, cleared |
| A | Voltage circuit supervision – fault | active, cleared |
| A | Cable oil pressure – high | active, cleared |
| A | Cable oil pressure – low | active, cleared |
| A | Cable oil pressure – general alarm | active, cleared |
| A | Cable termination/joint oil pressure – low | active, cleared |
| A | Cable oil pressure monitoring power supply – alarm | active, cleared |

## C.2. TRANSFORMERS 400, 220, 110/X KV AND TRANSFORMER BAYS

| Type | Name | Description |
|---|---|---|
| M | Phase currents – High voltage side | A ($I_0$, $I_4$, $I_8$) |
| M | Phase currents – Low voltage side | A ($I_0$, $I_4$, $I_8$) |
| M | 3-Phase active power | MW (–inbound to busbars, + outbound from busbars) |
| M | 3-Phase reactive power | MVAr (–inbound to busbars, + outbound from busbars) |
| M | Line voltages – High voltage side | kV ($U_{04}$, $U_{48}$, $U_{08}$) |
| M | Line voltages – Low voltage side | kV ($U_{04}$, $U_{48}$, $U_{08}$) |
| M | Tap position | Position No |
| S | Circuit-breaker | ON, OFF, in-between, fault |
| S | Disconnector | ON, OFF, in-between, fault |
| S | Ground disconnector | ON, OFF, in-between, fault |
| A | Control* | local/remote |
| A | Thermal image – trip | active, cleared |
| A | Transformer differential protection – trip | active, cleared |
| A | OLTC Buchholz relay – trip | active, cleared |
| A | Transformer Buchholz relay – trip | active, cleared |
| A | Restricted earth fault protection – trip | active, cleared |
| A | Transformer tank earth-fault protection – trip | active, cleared |
| A | Overcurrent protection 1. stage HV side – trip | active, cleared |
| A | Earth-fault overcurrent protection 1. stage HV side – trip | active, cleared |
| A | Overcurrent protection 1. stage LV side – trip | active, cleared |
| A | Earth-fault overcurrent protection 1. stage LV side – trip | active, cleared |
| A | Overcurrent protection 2. stage HV side – trip | active, cleared |
| A | Circuit breaker pole discordance protection – trip | active, cleared |
| A | Transformer oil thermometer – trip | active, cleared |
| A | Transformer pressure relief device – trip | active, cleared |
| A | Circuit breaker - SF6 gas low pressure 1. stage – alarm | active, cleared |
| A | Circuit breaker - SF6 gas low pressure 2. stage – blocking | active, cleared |
| A | Breaker failure protection – trip | active, cleared |
| A | Current overload protection 2. stage – trip | active, cleared |
| A | Earth-fault overcurrent protection star-point – trip | active, cleared |
| A | Grounding transformer oil thermometer – trip* | active, cleared |
| A | Grounding transformer Buchholz relay – trip* | active, cleared |
| A | Transformer distance protection – trip | active, cleared |
| A | General trip | active, cleared |

* not applicable on step-up transformers and auxiliary supply transformers

### C.3. COUPLING BAYS AND BUS-BARS 400, 220 AND 110 KV

| Type | Name | Description |
|---|---|---|
| M | Coupling bay phase current | A ($I_4$) |
| M | Bus-bars line voltage | kV ($\sqrt{3}U_4$ или $U_{48}$) |
| M | Bus-bars line frequency | Hz (two decimal digits at least) |
| I | Voltage presence | energized, deenergized |
| S | Circuit-breaker | ON, OFF, in-between, fault |
| S | Disconnector | ON, OFF, in-between, fault |
| S | Ground disconnector | ON, OFF, in-between, fault |
| A | Bus-bar protection – trip | active, cleared |
| A | Overcurrent protection – trip | active, cleared |
| A | Circuit breaker pole discordance protection – trip | active, cleared |
| A | Breaker failure protection – trip | active, cleared |

### C.4. COUPLING BAYS AND BUS-BARS X KV (X < 110)

| Type | Name | Description |
|---|---|---|
| I | Voltage presence | energized, deenergized |
| S | Circuit-breaker | ON, OFF, in-between, fault |
| S | Disconnector | ON, OFF, in-between, fault |
| S | Ground disconnector | ON, OFF, in-between, fault |
| I (A) | Bus-bar protection – trip | active, cleared |

### C.5. HYDRO AND TURBO-GENERATOR UNITS

| Type | Name | Description |
|---|---|---|
| M | Phase current | A ($I_4$) |
| M | Line voltage | kV ($U_{48}$) |
| M | 3-Phase active power | MW (- inbound, + outbound) |
| M | 3-Phase reactive power | MVAr (-inbound, + outbound) |
| M | 3-Phase apparent power | MVA |
| M | Power rate-of-change in the secondary regulation | MW/min (+ power rise) |
| M | Desired active power | MW |
| M | Maximal active power in secondary control | MW |
| M | Minimal active power in secondary control | MW |
| M | Maximal active power in tertiary control | MW |
| M | Minimal active power in tertiary control | MW |
| A | AGC status | ON, OFF |
| A | Primary control status | ON, OFF |
| A | Power generation unit general trip | active, cleared |
| S | Circuit-breaker | ON, OFF, in-between, fault |
| S | Disconnector | ON, OFF, in-between, fault |
| S | Ground disconnector | ON, OFF, in-between, fault |

### C.6. WIND PARKS

| Type | Name | Description |
|---|---|---|
| M | 3-Phase active power per wind-generator | MW (- inbound, + outbound) |
| M | 3-Phase reactive power per wind-generator | MVAr (-inbound, + outbound) |
| M | No# of wind-generators in operation | |
| M | No# of wind-generators out of operation due to low | |

| | | |
|---|---|---|
| | wind speed | |
| M | No# of wind-generators out of operation due to high wind speed | |
| M | No# of wind-generators out of operation due to other reasons (malfunction, overhaul, testing) | |
| M | Wind speed at a height where wind generators are installed, from 0 to 50 m/s | m/s |
| M | Wind direction, from 0 to 360° | ° |
| M | Air temperature, from -40 to 60°C | °C |
| M | Air pressure, from 735 to 1060 mbar | mbar |
| M | Active power base point | MW |
| M | Voltage control base point (voltage/reactive power/cos φ) | kV/MVAr/- |
| A | Active power base point indication | local/remote |
| A | Voltage control base point indication | local/remote |

**Legend:**

M – measurement; S – Status; A – Alarm; I – Indication (2-bites).