GREATER MEKONG SYSTEM REGIONAL GRID CODE

Operational Security Code (draft)

4 of 10 Code Documents

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Note: A *section titled "ANNEX: Code – History of Comments" is attached to each Code. It provides a log of every comment and subsequent consideration taken on the Code.*

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1. General Provision

1.1 Subject Matter and Scope

(1) This Network Code defines the Operational Security requirements and principles for Transmission Systems applicable to all TSOs, DSOs and Significant Grid Users in Normal and Alert System State. Furthermore, this Network Code identifies the general provisions in relation to the Emergency State, Blackout State and Restoration.

(2) This Network Code aims at:

a) determining common Operational Security requirements and principles;

b) ensuring conditions for maintaining Operational Security throughout the GMS; and

c) coordinating system operation in a common and coherent way throughout the GMS.

(3) The provisions of this Network Code shall not apply to the Transmission System or parts of the Transmission System of a Member State which is not operating synchronously with or which is temporarily disconnected from the rest of the Synchronous Area.

(4) For the purpose of this Network Code, Existing Power Generating Modules shall be classified as type A, B, C and D according to the criteria defined in Section 2 [Requirements for Generators] of Connection Code, for New Power Generating Modules. For the purpose of this Network Code, existing Demand Facilities shall be classified according to the criteria defined in Connection Code [Section 4 – DC]. The Significant Grid Users within the scope of this Network Code are:

a) Existing and New Power Generating Modules of type B, C and D according to the criteria defined in Connection Code [Section 2 “Requirements for Generators” – RfG];

b) Existing and new Transmission Connected Demand Facilities according to the criteria defined in Section 4 [Demand Connection] of Connection Code and all Existing and New Transmission Connected Closed Distribution Networks;

c) Significant Demand Facilities, Closed Distribution Networks and Aggregators according to Connection Code [Section 4 “Demand Connection” – DC], in the case where they provide Demand Side Response (DSR) directly to the TSO;

d) Redispatching Aggregators and Providers of Active Power Reserve according to the Network Code on Load-Frequency Control and Reserves [LFCR].

(5) In the implementation of the technical and other requirements set in this Network Code, each TSO shall comply with good industry practice.

1.2 Definitions

(1) For the purposes of this Regulation, the definitions of the GMS Glossary of Terms shall apply in particular:

- **Connection Point** – is the interface at which:
  a. the Power Generating Module is connected to a Transmission System or Distribution Network;
  b. the Demand Facility is connected to a Transmission Network, or Distribution Network, or;
  c. the Distribution Network is connected to a Transmission Network, or;
  d. the Closed Distribution Network providing Demand Side Response (DSR) is connected to the Distribution Network.
- **Operational Security** – means the Transmission System capability to retain a Normal State or to return to a Normal State as soon and as close as possible, and is characterized by thermal limits, voltage constraints, short-circuit current, frequency limits and stability limits.
- **Remedial Action** – means any measure applied by a TSO in order to maintain Operational Security. In particular, Remedial Actions serve to fulfil the (N-1) Criterion and to maintain Operational Security Limits.

(2) In addition the following definitions shall apply:

(N-1) Criterion – means the rule according to which elements remaining in operation within TSO's Responsibility Area after a Contingency from the Contingency List must be capable of accommodating the new operational situation without violating Operational Security Limits.

(N-1) Situation – means the situation in the Transmission System in which a contingency from the Contingency List has happened.

Active Power Reserve – means the Active Power which is available for maintaining the frequency.

Alert State – means the System State where the system is within Operational Security Limits, but a Contingency from the Contingency List has been detected, for which in case of occurrence, the available Remedial Actions are not sufficient to keep the Normal State.

Area Control Error (ACE) – means the sum of the instantaneous difference between the actual and the set-point value of the measured total power value and Control Program including Virtual Tie-Lines for the power interchange of a LFC Area or a LFC Block and the frequency bias given by the product of the K-Factor of the LFC Area or the LFC Block and the Frequency Deviation.

Automatic Voltage Control – means the automatic control actions at the generation node, at the end nodes of the AC lines or High-Voltage DC lines, on transformers or other means, designed to maintain the set voltage level or the set value of Reactive Power.

Blackout State – means the System State where the operation of part or all of the Transmission System is terminated.

Contingency – means the identified and possible or already occurred Fault of an element within or outside a TSO's Responsibility Area, including not only the Transmission System elements, but also Significant Grid Users and Distribution Network elements if relevant for the Transmission System Operational Security. Internal Contingency is a Contingency within the TSO's Responsibility Area. External Contingency is a Contingency outside the TSO's Responsibility Area, with an Influence Factor higher than the Contingency Influence Threshold.

Contingency Analysis – means computer based simulation of Contingencies from the Contingency List.

Contingency Influence Threshold – means a numerical limit value against which the Influence Factors must be checked. The outage of an external Transmission System element with an Influence Factor higher than the Contingency Influence Threshold is considered having a significant impact on the TSO's Responsibility Area. The value of the Contingency Influence Threshold is based on the risk assessment of each TSO.

Contingency List – means the list of Contingencies to be simulated in the Contingency Analysis in order to test the compliance with the Operational Security Limits before or after a Contingency took place.

Control Program – means the set-point value, also called schedule, for the netted power interchange of a LFC Area over Interconnectors.

Critical Fault Clearing Time – means the maximum Fault duration for which the Transmission System remains stable.

Declared Availability – means declaration and notice prepared in respect of a Significant Grid User, submitted to the TSO setting out the values and times applicable to those values of availability and Ancillary Services capability.

Disturbance – means an unplanned event that may cause the Transmission System to divert from Normal State.

Dynamic Stability Assessment (DSA) – means the Operational Security Assessment in terms of Dynamic Stability.

Dynamic Stability – is a common term including the Rotor Angle Stability, Frequency Stability and Voltage Stability.

Emergency State – means the System State where Operational Security Limits are violated and at least one of the operational parameters is outside of the respective limits.

Exceptional Contingency – means the loss of a busbar or more than one element such as, but not limited to, a common mode Fault with the loss of more than one Power Generating Module; a common mode Fault with the loss of more than one AC or DC line; a common mode Fault with the loss of more than one transformer.

Fault – means all types of short-circuits: single, double and triple-phase, with and without earth contact. It means further a broken conductor, interrupted circuit or an intermittent connection, resulting in a permanent non-availability of the affected Transmission System element.

Frequency Containment Reserves (FCR) – means the Operational Reserves activated to contain System Frequency after the occurrence of an imbalance.

Frequency Deviation – means the difference between the actual System Frequency and the Nominal Frequency of the Synchronous Area, which can be negative or positive.

Frequency Restoration Control Error (FRCE) – means the control error for the FRP which is equal to the ACE of a LFC Area or is equal to the Frequency Deviation where the LFC Area geographically corresponds to the Synchronous Area.

Frequency Restoration Process (FRP) – means a process that aims at restoring frequency to the Nominal Frequency and for Synchronous Area consisting of more than one LFC Area power balance to the scheduled value;

Frequency Stability – means the ability of the Transmission System to maintain stable frequency in N – Situation and after being subjected to a disturbance.

Influence Factor – means a numerical value used to quantify the highest effect of the outage of an external Transmission System element on any Transmission System branch. The worse the effect, the higher the influence factor value is.

K – Factor – means a factor used to calculate the frequency bias component of the ACE of a LFC Area or a LFC Block.

Load-Frequency Control Area (LFC Area) – means a part of a Synchronous Area or an entire Synchronous Area, physically demarcated by points of measurement of Interconnectors to other LFC Areas, operated by one or more TSOs fulfilling the obligations of a LFC Area.

Load-Frequency Control Block (LFC Block) – means a part of a Synchronous Area or an entire Synchronous Area, physically demarcated by points of measurement of Interconnectors to other LFC Blocks, consisting of one or more LFC Areas, operated by one or more TSOs fulfilling the obligations of a LFC Block.

Local – means the qualification of an Alert, Emergency or Blackout State when there is no risk of extension of the consequences outside of the Responsibility Area of a single TSO.

Maximum Steady-State Frequency Deviation – means the maximum expected Frequency Deviation after the occurrence of an imbalance equal or less than the Reference Incident at which the System Frequency is designed to be stabilized.

Nominal Frequency – means the rated value of the System Frequency.

Normal State – means the System State where the system is within Operational Security limits in the N-Situation and after the occurrence of any Contingency from the Contingency List, taking into account the effect of the available Remedial Actions.

N – Situation – means the situation where no element of the Transmission System is unavailable due to a Fault.

Observability Area – means a TSO's own Transmission System and the relevant parts Distribution Networks and neighbouring TSOs' Transmission Systems, on which TSO implements real-time monitoring and modelling to ensure Operational Security in its Responsibility Area.

Operational Reserves – means the spinning and non-spinning reserves that are accessible to at least one TSO.

Operational Security Analysis – means the entire scope of the computer based, manual and combined activities performed in order to assess Operational Security of the Transmission System, including but not limited to: processing of telemetered real-time data through State Estimation, real-time load flows calculation, load flows calculation during operational planning, Contingency Analysis in real-time and during operational planning, Dynamic Stability Assessment, real-time and offline short circuit calculations, System Frequency monitoring, Reactive Power and voltage assessment.

Operational Security Limits – means the acceptable operating boundaries: thermal limits, voltage limits, short-circuit current limits, frequency and Dynamic Stability limits.

Operational Security Performance Indicators – are used for monitoring of the Operational Security in terms of Faults, incidents, disturbances and other events which influence Operational Security.

Operational Security Ranking – is used for monitoring of the Operational Security on the basis of the Operational Security Performance Indicators.

Ordinary Contingency – means the loss of a Transmission System element such as, but not limited to: a single line, a single transformer, a single phase-shifting transformer, a voltage compensation installation connected directly to the Transmission System; it also means the loss of a single Power Generating Module connected directly to the Transmission System, the loss of a single Demand Facility connected directly to the Transmission System, or the loss of a single DC line.

Out-of-Range Contingency – means the simultaneous loss, without a common mode Fault, of several Transmission System elements such as, but not limited to: two independent lines, a substation with more than one busbar, a tower with more than two circuits, one or more Power Generating Facilities with a total lost capacity exceeding the Reference Incident.

Ramping Rate – means the rate of change of Active Power by a Power Generating Module, Demand Facility or DC Interconnector.

Reactive Power Reserve – means the Reactive Power which is available for maintaining voltage.

Redispatching Aggregator – means a legal entity which is responsible for the operation of a number of Power Generating Modules by means of generation aggregation for the purpose of offering Redispatching.

Reference Incident – means the maximum instantaneously occurring power deviation between generation and demand in a Synchronous Area in both positive and negative direction, considered in the FCR dimensioning.

Regional Power Coordination Centre (RPCC) – means the regional organisation that shall promote the synchronized operation of the national power system operations towards a unified, fair and transparent regional electricity market with the ultimate goal of providing the GMS Countries with stable and reliable electricity supply at the most economic costs. The governance structure of RPCC comprises four bodies, namely Board of RPCC, Executive Director, Technical Groups, and RPCC Administration.

Responsibility Area – means a coherent part of the interconnected Transmission System including Interconnectors, operated by a single TSO with connected Demand Facilities or Power Generating Modules, if any.

Restoration – means the System State in which the objective of all activities in Transmission System is to re-establish the system operation and maintain Operational Security after a Blackout.

Rotor Angle Stability – means the ability of synchronous machines to remain in synchronism under N – Situation and after being subjected to a disturbance.

Security Plan – means the plan containing a risk assessment of critical TSO's assets to major physical and cyber-threat scenarios with an assessment of the potential impacts.

Significant Grid User (SGU) – means the existing and new Power Generating Facility and Demand Facility deemed by the TSO as significant because of their impact on the Transmission System in terms of the security of supply including provision of Ancillary Services.

Stability Limits – means the permitted operating boundaries of the Transmission System in terms of respecting the constraints of Voltage Stability, Rotor Angle Stability and Frequency Stability.

State Estimation – means the methodology and algorithms used to calculate a reliable set of measurements defining the state of the Transmission System out of the redundant set of measurements.

Synchronous Area – means an area covered by interconnected TSOs with a common System Frequency in a steady-state.

Synchronous Area Agreement – means a multi-party agreement between all TSOs of a Synchronous Area if the Synchronous Area consists of more than one TSO. If a Synchronous Area consists of only one TSO, the Synchronous Area Agreement means a formal declaration of the obligations defined in this Network Code.

System Defence Plan – means the summary of all technical and organisational measures to be undertaken to prevent the propagation or deterioration of an incident in the Transmission System, in order to avoid a widespread disturbance and Blackout State.

System Frequency – means the electric frequency of the system that can be measured in all parts of the Synchronous Area under the assumption of a coherent value for the system in the time frame of seconds, with only minor differences between different measurement locations.

System Operator Employee – means the person who is a TSO employee in charge of system operation and control of the Transmission System in real-time, or the person who is a TSO employee in charge of operational planning.

System Protection Scheme (SyPS) – means the set of coordinated and automatic measures designed to ensure fast reaction to Disturbances and to avoid the propagation of Disturbances in the Transmission System.

System State – means the operational state of the Transmission System in relation to the Operational Security Limits: Normal, Alert, Emergency, Blackout and Restoration System States are defined.

Topology – means necessary data about the connectivity of the different Transmission System or Distribution Network elements in a substation. It includes the electrical configuration and the position of circuit breakers and isolators.

Transitory Admissible Overloads – means the temporary overloads of Transmission System elements which are allowed for a limited period and which do not cause physical damage to the Transmission System elements and equipment as long as the defined duration and thresholds are respected.

Virtual Tie-Line – means an additional input of the controllers of the involved areas that has the same effect as a measuring value of a physical Tie-Line and allows exchange of electric energy between the respective areas.

Voltage Stability – means the ability of a Transmission System to maintain acceptable voltages at all buses in the Transmission System under N – Situation and after being subjected to a Disturbance.

Wide Area – means the qualification of an Alert, Emergency or Blackout State when there is a risk of propagation to the interconnected Transmission Systems.

1.3 Regulatory Aspects

(1) The requirements established in this Network Code and their applications are based on the principle of proportionality, non-discrimination and transparency as

well as the principle of optimization between the highest overall efficiency and lowest total cost for all involved parties.

(2) Notwithstanding the above, the application of non-discrimination principle and the principle of optimization between the highest overall efficiency and lowest total costs while maintaining Operational Security as the highest priority for all involved parties, shall be balanced with the aim of achieving the maximum transparency in issues of interest for the market and the assignment to the real originator of the costs.

(3) The terms and conditions or actions necessary to ensure Operational Security or their methodologies shall be established by TSOs in accordance with the principles of transparency, proportionality and non-discrimination.

(4) This Network Code relies on the capabilities required in the Section 2 of the Connection Code, “Requirements for Generators”, and Section 4, “Demand Connection”. The Power Generating Facilities, Demand Facilities and HVDC links that are not a subject of the provisions in Section 2 & 4 of the Connection Code shall continue to be bound by those technical requirements that apply to them pursuant to legislation in force in the respective GMS Member State or contractual arrangements in force.

1.4 Regulatory Approvals

(1) National Regulatory Authorities or, when explicitly foreseen in national law, other relevant national authorities shall be responsible for approving the methodologies and conditions establishing the framework for the adoption by TSOs of terms and conditions or actions necessary for Operational Security as referred to in Section 1.4 (2) and (3) hereunder.

(2) For the purpose of this Network Code [OS], each TSO shall submit the following methodologies and conditions to the National Regulatory Authority or, when explicitly provided for in national law, other relevant national authority for approval:

a) modifications of the Power Generating Module Capabilities pursuant to Section 2.2 paragraph (4), Section 2.3 paragraph (3) and Section 4.1 paragraph (8);

b) methodology for the definition of the Low Frequency Demand Disconnection Scheme pursuant to Section 2.7 paragraph (7) and methodology for the definition of actions for over-frequency pursuant to Section 2.7 paragraph (8);

c) enhancements of the means from Section 4.2 paragraph (1)(a)-(e) pursuant to Section 4.2 paragraph (1);

d) criteria for requesting a compliance test pursuant to Section 4.1 paragraph (8);

e) list of high priority Significant Grid Users referred to in Section 4.2 paragraph (10); and

f) exemptions from Significant Grid Users' obligation to provide data directly to the TSOs, according to Section 3.11 paragraph (2).

(3) For the purpose of this Network Code, each TSO shall submit the following methodologies and conditions established in cooperation with the other TSOs of the same Synchronous Area to the relevant National Regulatory Authority or,

when explicitly provided for in national law, other relevant national authority for approval:

a) methodology developed for the definition of minimum inertia required to maintain Operational Security and to prevent violation of Stability Limits identified pursuant to Section 2.8 paragraph (3) and (8); and

b) key organizational requirements, roles and responsibilities in relation to the data exchange pursuant to Section 3.1 paragraph (5) of this Network Code [OS].

(4) National Regulatory Authorities shall, no later than six months after having received the methodologies or conditions establishing the framework for the adoption by TSOs of terms and conditions or actions necessary to ensure Operational Security, provide TSOs with an approval or request to amend the proposed methodology or condition.

(5) Where the concerned National Regulatory Authorities have not been able to reach an agreement within a period of six months from when the case was referred to the last of those National Regulatory Authorities, or upon a joint request from the competent National Regulatory Authorities, the Board of RPCC shall decide upon these regulatory issues that fall within the competence of National Regulatory Authorities and submit the decision to the RPTCC Meeting for its application.

1.5 Recovery of costs

(1) The costs related to the obligations referred to in this Network Code, which have to be borne by regulated Network Operators, shall be assessed by National Regulatory Authorities.

(2) Costs assessed as efficient, reasonable and proportionate shall be recovered as determined by National Regulatory Authorities.

(3) If requested by National Regulatory Authorities, regulated Network Operators shall, within three months of such a request, use best endeavours to provide such additional information as reasonably requested by National Regulatory Authorities to facilitate the assessment of the costs incurred.

1.6 Confidentiality obligations

(1) Each TSO, DSO, Power Generating Facility Operator, Demand Facility Operator and Owners of these Facilities shall preserve the confidentiality of the information and data submitted to them pursuant to this Network Code and shall use them exclusively for the purpose they have been submitted in compliance with the Network Code.

(2) Without prejudice to the obligation to preserve the confidentiality of commercially sensitive information obtained in the course of carrying out its activities, each TSO shall in compliance with the provisions of this Network Code, provide to the other TSOs, or where required DSOs, information referred to in Section 3 of this Network Code, to ensure the secure and efficient operation, coordinated development and interoperability of the interconnected system.

(3) In accordance with Section 3.1 paragraph (10) of this Network Code [OS], each TSO may have to provide confidential information to the RPCC Administration. The RPCC Administration shall preserve the confidentiality of the information and

data submitted to them in connection with this Network Code and shall use them exclusively for the purpose they have been submitted.

1.7 Agreement with TSOs not bound by this Network Code

(1) No later than 12 months after entering into force of this Network Code, all TSOs shall implement a Synchronous Area Agreement to ensure that TSOs with no legal obligation to respect this Network Code, belonging to the Synchronous Area, also cooperate to fulfil the requirements.

(2) If an agreement according to paragraph (1) or (2) of this Section cannot be implemented, the respective TSOs shall implement, no later than by [date – 14 months after entry into force], processes to ensure compliance with the requirements of this Network Code within its Responsibility Area.

2. Operational Security Requirements

2.1 System States

(1) Each TSO shall in real-time operation differentiate five System States, based on the Operational Security Limits according to Section 2.3 and Section 2.5, while respecting the Contingency Analysis provisions according to Section 2.6 and the frequency control management provisions according to Section 2.2. On this basis, each TSO shall classify the System State of its Transmission System applying the following criteria:

a) Normal State:

i. Voltage and power flows are within the Operational Security Limits defined according to Section 2.3 and Section 2.5 in accordance with paragraph (5) of this section and frequency is within the frequency limits for the Normal State as defined in Load Frequency Control and Reserves Code [LFCR];

ii. Active and Reactive Power reserves are sufficient to withstand Contingencies from the Contingency List defined according to Section 2.6; and

iii. Operation of its Responsibility Area is and will remain within Operational Security Limits even after a Contingency from the Contingency List defined according to Section 2.6 and after effects of Remedial Actions;

b) Alert State:

i. Voltage and power flows are within their Operational Security Limits defined according to Section 2.3 and Section 2.5 in accordance with paragraph (5) of this section; and

ii. at least one of the following conditions is fulfilled:

a. Active Power Reserve requirements are not fulfilled with lack of more than 20% of the required amount of any of the following: FCR, FRR and RR according to the dimensioning in the Load Frequency Control and Reserves Code [LFCR], for more than 30 minutes and with no means to replace them;

b. Frequency is within the frequency limits for the Alert State as defined in Load Frequency Control and Reserves Code [LFCR];

c. at least one Contingency from the Contingency List defined according to Section 2.6 can lead to deviations from Operational Security Limits, even after effects of Remedial Actions;

c) Emergency State:

i. There is at least one deviation from Operational Security Limits and times defined according to Section 2.3 and 2.5 in accordance with paragraph (5) of this section; or

ii. Frequency is outside the frequency limits for the Normal State and outside the frequency limits for the Alert State as defined in Load Frequency Control and Reserves Code [LFCR]; or

iii. At least one measure of the System Defence Plan is activated; or

iv. There is a complete loss of all tools and facilities defined according to paragraph (15) of this section for more than 30 minutes;

d) Blackout State:

i. Loss of more than 50% of load in the TSO Responsibility Area; or

ii. Total absence of voltage for at least 3 minutes in the TSO Responsibility Area and triggering Restoration plans;

e) Restoration:

i. Procedures are implemented to bring frequency, voltage and other operational parameters within the Operational Security Limits defined according to Sections 2.2, 2.3 and 2.5 of this Network Code [OS] in accordance with paragraph (5) of this section; and

ii. Demand Facilities are connected at a pace decided by the TSOs in charge of Restoration, depending on the technical capability and feasibility of the Transmission System resources and Significant Grid Users which are Power Generating Facilities.

(2) In order to determine the System State, each TSO shall at least every 30 minutes perform Contingency Analysis in real-time, monitoring the parameters against a common set of criteria defined according to paragraph (1) above, while taking into account the effect of potential Remedial Actions and measures of the System Defence Plan.

(3) Each TSO shall monitor in real-time the following parameters within its Responsibility Area based on real-time telemetry and measurements from its Observability Area, taking into account the structural and real-time data defined in Section 3 “Data Exchange” of this Network Code:

a) Active and Reactive Power flows;

b) Busbar voltages;

c) Frequency and Frequency Restoration Control Error of its Load Frequency Control (LFC) Area;

d) PMU data;

e) Active and Reactive Power reserves; and

f) Generation and consumption.

(4) Each TSO shall use all available economically efficient and feasible means under its control to maintain in real-time its Transmission System in a Normal State. For this purpose, each TSO shall plan Remedial Actions according to the requirements defined in this Network Code [OS] and implement them when necessary, in line with the provisions of the Market Code [Operational Aspects], Section 2 – [GMS Network Code on Capacity Allocation, Forward Capacity Allocation and Congestion Management – CAMC], and paragraph 12 of this section [Operational Security Code – OS].

(5) For each element of its Transmission System, each TSO shall define before its use in operation the Operational Security Limits for:

a) Voltage ranges according to Section 2.3;

b) Short-circuit current ranges according to Section 2.4; and

c) Current limits in terms of thermal rating including the Transitory Admissible Overloads.

(6) When defining the Operational Security Limits, each TSO shall take into account the capabilities required for Significant Grid Users, which are Power Generating Modules in the Connection Code [Section 2 “Requirements for Generators” – RfG]; for Significant Grid Users, which are Demand Facilities and Closed Distribution Networks in in the Connection Code [Section 4 “Demand Connection” – DC]; and the capabilities required in the national grid codes for those Significant Grid Users who are not subject or are derogated from Connection Code [Section 2 – RfG)] and Connection Code [Section 4 – DC], in order to ensure that voltage and frequency ranges in Normal and Alert States do not lead to their disconnection.

(7) In the case of a change in any equipment or device of an element of its Transmission System, each TSO shall validate and when necessary update the Operational Security Limits.

(8) For each Interconnector, each TSO shall coordinate with the interconnected TSO, the common definition of Operational Security Limits including: current limits in terms of thermal rating and Transitory Admissible Overload and voltage ranges defined according to Section 2.3 paragraph (12).

(9) In real-time operation, if its Transmission System is in the Alert State, each TSO shall in coordination with the TSOs with which it has a multi-party agreement concluded in accordance with Section 3.5 of this Network Code [OS], and with DSOs and Significant Grid Users directly connected to its Transmission System:

a) Implement the pre-fault Remedial Actions which are rendered necessary to restore the Normal State and to prevent the propagation of the Alert State outside of its Responsibility Area; and

b) Identify the post-fault Remedial Actions which shall be implemented in case of occurrence of a Contingency.

(10) In real-time operation, if its Transmission System is in Emergency State, each TSO shall, in coordination with the TSOs with which it has a multi-party agreement concluded in accordance with Section 3.5 of this Network Code [OS], and with DSOs and Significant Grid Users who are involved in system defence and restoration, implement the measures of the System Defence Plan which are rendered necessary to restore the Alert or Normal State, and to prevent the propagation of Emergency State outside of its Responsibility Area.

(11) In real-time operation, if its Transmission System is not in a Normal State and if that System State is qualified as Wide Area the TSO shall:

a) Inform all TSOs about the System State of its Transmission System via an IT tool for real-time data exchange at GMS level;

b) Provide additional information on the elements of its Transmission System which are part of the Observability Area of the other TSOs, to those TSOs; and

c) Coordinate the joint Remedial Actions with the TSOs with which it has a multi-party agreement concluded in accordance with Section 3.5 of this Network Code [OS].

(12) In real-time operation or during operational planning, when preparing and implementing a Remedial Action including Redispatching or Countertrading pursuant to the Market Code [Operational Aspects], Section 2 – “Capacity Allocation, Forward Capacity Allocation and Congestion Management Code”, or a measure of the System Defence Plan which has an effect on other TSOs, a TSO shall cooperate with those TSOs in order to assess the impact of such Remedial Action or a measure of the System Defence Plan within and outside of its

Responsibility Area and to coordinate with those TSOs with which it has a multi-party agreement concluded in accordance with Section 3.5 of this Network Code [OS]. Each TSO involved in the coordination shall provide to other involved TSOs all the information necessary for this cooperation.

(13) When preparing a Remedial Action, including Redispatching or Countertrading pursuant to the Market Code [Operational Aspects], Section 2 – "Capacity Allocation, Forward Capacity Allocation and Congestion Management Code", or a measure of the System Defence Plan a TSO shall, in the case of mutual implications, cooperate with the Significant Grid Users and DSOs with Connection Point directly to the Transmission System. Each TSO shall ex-ante cooperate with the DSOs involved with the Remedial Action or the measure of the System Defence Plan, to assess the impact of the Remedial Action on the Distribution Network, and coordinate with those DSOs to select the Remedial Action or the measure of the System Defence Plan which enhances Operational Security for all involved parties. Each affected DSO shall ex-ante provide all the information necessary for this cooperation.

(14) When implementing a Remedial Action or a measure of the System Defence Plan, each Significant Grid User or DSO with Connection Point directly to the Transmission System shall execute the instructions given by the TSO to maintain Operational Security of the Transmission System, without undue delay. If the TSO does not instruct SGUs connected to the Distribution Network, DSOs shall communicate the instructions of the TSO to the Significant Grid Users.

(15) Each TSO shall design its systems in order to ensure the availability, reliability and redundancy of the following critical tools and facilities, which are required for system operation:

a) Facilities for monitoring the System State of the Transmission System, including State Estimation applications;

b) Means for controlling switching;

c) Means of communication with control centres of other TSOs;

d) Tools for Operational Security Analysis.

Where the above tools and facilities involve the DSOs with Connection Point directly to the Transmission System or Significant Grid Users which are involved in balancing, ancillary services, system defence, restoration or delivery of real-time operational data according to Section 3.5, 3.7, 3.11, 3.12, 3.13 and 3.14 of this Network Code [OS], the TSO, the DSOs with Connection Point directly to the Transmission System and those Significant Grid Users shall cooperate and coordinate in ensuring the availability, reliability and redundancy of these tools and facilities.

(16) Each TSO shall adopt a business continuity plan detailing TSO's responses to a loss of critical tools and facilities, containing provisions for maintenance, replacement and development of critical tools and facilities. The business continuity plan shall be reviewed at least annually and updated as necessary or following any significant change of critical tools and facilities or relevant system operation conditions. The business continuity plan contents shall be shared with DSOs and Significant Grid Users to the extent to which they are affected.

Each TSO shall establish a confidential Security Plan containing a risk assessment of critical assets owned or operated by the TSO, to major physical or cyber threat scenarios to be conducted by the Member State with an assessment of the potential impacts. Each TSO shall have in place organizational, logistical and other physical measures which shall cover the major findings from the risk

assessment. The plan shall be kept under regular review to limit the impact of threats and maintain the secure operation of the TSO's network and IT systems and the GMS interconnected Transmission Systems. These reviews can lead to the setting up of intruder detection, access control, procedures, training, alert processes, preventive procedures, restoration plans and other counter-measures.

2.2 Frequency control management

(1) Each TSO shall contribute to the Load-Frequency Control Structure according to the requirements for frequency quality defining parameters and provisions for Active Power Reserves as defined in the Load Frequency Control and Reserves Code [LFCR].

(2) In the case where the frequency is beyond the Maximum Steady-state Frequency Deviation, but within the range 49 – 51 Hz, all TSOs of the Synchronous Area shall apply commonly agreed Remedial Actions following coordinated procedures agreed among all TSOs of that Synchronous Area in order to recover frequency back within the range of Maximum Steady-state Frequency Deviation. The description of such coordinated procedures shall be published at the RPCC website 12 months after entry into force of this Network Code.

(3) In the case where the frequency is outside of the range 49 – 51 Hz, all TSOs of the Synchronous Area shall apply commonly agreed measures of the System Defence Plan following coordinated procedures agreed among all TSOs of that Synchronous Area in order to recover and restore frequency within the time ranges specified in the Connection Code, Section 2 [RfG] and Section 4.1 "Frequency Requirements" of the Connection Code [Section 4 – DC]. These coordinated procedures shall be published on the RPCC website 12 months after entry into force of this Network Code.

(4) Significant Grid Users, which are Power Generating Modules subject to the requirements of the Connection Code [Section 2 – RfG], shall remain connected at least within the frequency and time ranges defined in the Section 2.2 "Frequency Requirements" of the Connection Code [Section 2 – RfG] when generating electrical power. All Significant Grid Users, which are Power Generating Modules, which are not subject to or derogated from the requirements of the Connection Code [Section 2 – RfG], shall inform their TSOs and DSOs if connected to the Distribution Network, about their performance in comparison with the frequency requirements in the Connection Code [Section 2 – RfG] and in so doing they shall within 12 months after the entry into force of this Network Code declare the frequencies and time ranges they can withstand without disconnection. Where the TSO requires modifications by a Power Generating Module not subject to or derogated from the requirements of the Connection Code [Section 2 – RfG] to improve its performance, then this requirement shall be done according to the relevant Clause of the Connection Code [Section 2 – RfG] on the applicability of any requirement proposed by the relevant TSO to the National Regulatory Authority.

(5) While being in Emergency State, the system frequency can exceed the range of 49 – 51 Hz. TSOs shall take into account that Significant Grid Users, which are Power Generating Modules and Demand Facilities subject to the Connection Code [Section 2 – RfG] and [Section 4 – DC], can disconnect after the time periods required in the Connection Code [Section 2 – RfG] and [Section 4 – DC] and take this into account in planning of Remedial Actions and measures of the System Defence Plan. For Significant Grid Users, which are Power Generating Modules not subject to or derogated from the requirements of the Connection

Code [Section 2 – RfG], the TSOs shall take into account the frequency values at which each of these system users will disconnect.

(6) Each Significant Grid User with Connection Point directly to the Transmission System shall adopt the criteria and conditions including requirements for permission to re-synchronize, defined by the TSO for re-synchronization.

(7) Each DSO with Connection Point directly to the Transmission System shall adopt the criteria and conditions including requirements for permission to re-synchronize, defined by the TSO for re-synchronization of the Significant Grid Users with Connection Point to its Distribution Network. Each DSO with Connection Point directly to the Transmission System shall, in turn, ensure that those criteria and conditions are agreed upon with the Significant Grid Users with Connection Point directly to the Distribution Network.

(8) Notwithstanding the provisions of paragraph (6) and (7) of this section, each DSO with Connection Point directly to the Transmission System shall automatically disconnect at specified frequencies and in predefined Active Power steps, defined by the TSO. Notwithstanding the provisions of paragraph (6) and (7) of this section, each Significant Grid User, which is a Power Generating Module, shall automatically disconnect at specified frequencies, defined by the TSO.

(9) Each TSO making use of the provisions from paragraph (6), (7) and (8) of this section shall coordinate the frequency related Remedial Actions with all other TSOs of its Synchronous Area and shall ensure the necessary coordination with involved DSOs.

(10) Each TSO shall operate its LFC Area with sufficient upward and downward Active Power Reserve, which may include shared or exchanged reserves, to face imbalances of demand and supply within its LFC Area. Each TSO shall control the Frequency Restoration Control Error as defined in the Load Frequency Control and Reserves Code [LFCR] in order to reach the required frequency quality within the Synchronous Area in cooperation with the TSOs in the same Synchronous Area. All TSOs within a Synchronous Area shall establish the methodologies used within this Synchronous Area to determine the required upward and downward Active Power reserve in accordance with the provisions of the Load Frequency Control and Reserves Code [LFCR].

(11) Each TSO shall monitor close to real-time generation and exchange schedules, power flows, node injections and withdrawals and other parameters within its LFC Area relevant for anticipating a risk of a frequency deviation and when needed take joint measures to limit their negative effects on the balance between generation and demand in coordination with other TSOs of its Synchronous Area.

(12) Each TSO shall activate, or set up the conditions necessary to ensure the activation of Active Power Reserves at different time-frames according to the provisions of the Load Frequency Control and Reserves Code [LFCR] in order to maintain:

a) The scheduled Active Power exchange of its LFC Area;

b) System Frequency and Frequency Restoration Control Error.

(13) In the case of a scheduled exchange or sharing of reserves, the TSO within whose Responsibility Area the reserves are connected and the TSO receiving the reserves, together with TSOs which connect the aforementioned TSOs in the case they are not directly connected, shall carry out a common Operational Security Analysis and adopt the necessary measures to ensure that the resulting power flows do not endanger the Operational Security Limits during the exchange

of reserves or activation of reserve according to the provisions of the Load Frequency Control and Reserves Code [LFCR].

(14) Each TSO shall be entitled to use actions to improve System Frequency quality as defined in the [GMS Network Code on Load Frequency Control and Reserves – LFCR]. These actions can include restrictions on the Ramping Rates of Significant Grid Users and HVDC interconnectors.

2.3 Voltage control and Reactive Power management

(1) In accordance with Section 2, paragraph (4) of this Network Code [OS], each TSO shall use all available economically efficient and feasible means under its control to maintain the Transmission System steady-state voltage at the Connection Points within the ranges of Operational Security Limits as specified in the Table 2-1, in Normal State and after the occurrence of a Contingency from the Contingency List defined according to Section 2.6 paragraph (1).

Table 2-1 - Voltages ranges for reference voltages defined by TSOs

Synchronous area	Reference Voltage	Voltage range	Time duration
Interconnected GMS	V ≤230kV	0.90 pu – 1.10 pu	Unlimited
	V>230kV	0.90 pu – 1.05 pu	Unlimited

The Voltage base for pu values shall be defined by each TSO and in accordance with provisions for Interconnectors in Section 2.1, paragraph (8) of this Network Code [OS].

In the Responsibility Area of those TSO that decide in accordance with Table 2.5 of the Connection Code [Section 2 – RfG] that Power Generating Modules connected to nominal voltages between 300 kV and 400 kV shall stay connected for an unlimited time in the voltage range from 0.90 to 1.05 pu.

For voltage ranges below 110 kV, the responsible TSO shall agree the applicable voltage ranges with DSOs and Significant Grid Users with Connection Point directly to the Transmission System.

(2) Each TSO can agree wider voltage ranges or limited times for operation with connected DSOs and Significant Grid Users with Connection Point directly to the Transmission System, while respecting the provisions of Section 2.1, paragraph (8) of this Network Code [OS].

(3) Significant Grid Users which are Power Generating Modules of type D subject to the requirements of the Connection Code [Section 2 – RfG] shall remain connected at least within the voltage and time ranges defined according to Section 2.3 of the Connection Code [Section 2 – RfG]. All Significant Grid Users which are Power Generating Modules with Connection Point directly to the Transmission System who are not subjected to or derogated from the Section 2.3 of the Connection Code [Section 2 – RfG] shall inform their TSO about their capabilities compared to the voltage requirements in the Connection Code [Section 2 – RfG] and in so doing they shall declare the voltages and time they can withstand without disconnection. Each TSO can require modifications of the capability of such a Significant Grid User which is a Power Generating Module if this is necessary for maintaining Operational Security and this requirement shall

be fulfilled according to the relevant Clause of the Connection Code [Section 2 – RfG] on the applicability of any requirement proposed by the relevant TSO to the National Regulatory Authority.

(4) Significant Grid Users which are Demand Facilities subject to the requirements of Section 4.2 of the Connection Code [Section 4 – DC] shall not disconnect due to a Disturbance at least within the voltage and time ranges defined in this Section. All Significant Grid Users which are Transmission Connected Demand Facilities who are not subjected to or derogated from the Section 4.2 of the Connection Code [Section 4 – DC] shall inform their TSO about their capabilities compared to the voltage requirements in the Connection Code [Section 4 – DC] and in so doing they shall declare the voltages and time they can withstand without disconnection. Each TSO can require modifications of the capability of such a Significant Grid User which is a Demand Facility if this is necessary for maintaining Operational Security and this requirement shall be fulfilled according to the relevant Clause of the Connection Code [Section 4 – DC] on the applicability of any requirement proposed by the relevant TSO to the National Regulatory Authority.

(5) If voltages at a Connection Point to the Transmission System are outside the ranges from Table 2.1, each TSO shall apply voltage control and Reactive Power management measures in order to restore voltages within the ranges from Table 2.1 and within the time ranges specified according to Section 2.3 of the Connection Code [Section 2 – RfG] and Section 4.2 of the Demand Code [Section 4 – DC].

(6) In Emergency State, if voltages at the Connection Points of Power Generating Modules of type D to the Transmission System exceed the ranges from Table 2.1, TSOs shall take into account that Significant Grid Users connected to the Transmission System and who are affected by the Connection Code [Section 2 – RfG] and [Section 4 – DC] might disconnect after the time periods required in Section 2.3 of the Connection Code [Section 2 – RfG] and Section 4.2 of the Connection Code [Section 4 – DC] and take this into account in defining Remedial Actions and measures of the System Defence Plan.

(7) For Significant Grid Users with Connection Point to the Transmission System and who are not subject to or who are derogated from the Connection Code [Section 2 – RfG] or [Section 4 – DC], the TSOs shall take into account in their Operational Security Analysis the voltage values at which each of these Significant Grid Users may disconnect.

(8) Each TSO shall implement the provisions from the paragraph (1) to (7) of this section of the Network Code [OS] in a coordinated way at the level of Synchronous Area.

(9) Each TSO shall ensure Reactive Power reserve, with adequate volume and time response, in order to keep the voltages within its Responsibility Area within the Operational Security Limits ranges defined in Table 2.1.

(10) A Significant Grid User, which is a Demand Facility, shall automatically or manually disconnect at specified voltages in the specified timeframe defined by the TSO or by the DSO if this Demand Facility has Connection Point to the Distribution Network. Each TSO making use of the provision in this paragraph (10) shall respect its multi-party agreements concluded in accordance with Section 3.5 of this Network Code [OS] and shall ensure the coordination with involved DSOs.

(11) In accordance with the provisions of Section 2.1, paragraph (8) of this Network Code [OS], TSOs interconnected with AC Interconnectors shall define the voltage

and/or Reactive Power flow limits on these Interconnectors commonly, in order to use the Reactive Power resources in the most effective way and ensure adequate voltage control.

(12) Each TSO shall coordinate Operational Security Analysis with other TSOs in accordance with the multi-party agreements concluded in accordance with Section 3.5 of this Network Code [OS] in order to ensure the respecting of the Operational Security Limits for voltage ranges in its Responsibility Area and within the Responsibility Areas of these TSOs.

(13) Each TSO shall define the Reactive Power set-points, power factor ranges and voltage set-points for voltage control in accordance with the Connection Code [Section 4 – DC], which shall be maintained by the Significant Grid Users or DSOs with Connection Point directly to the Transmission System, while respecting the provisions of Section 2.1, paragraph (13) of this Network Code [OS]. DSOs shall in turn be able to define voltage control instructions to Significant Grid Users connected to the Distribution Network in order to respect the instructions of the TSO.

(14) Each TSO shall be entitled to use all available Reactive Power resources with Connection Point to the Transmission System within its Responsibility Area to ensure effective Reactive Power management and maintaining the ranges of voltage Operational Security Limits defined in this Network Code.

(15) Each TSO shall operate or direct the operation of Reactive Power resources within its Responsibility Area including blocking of automatic voltage/Reactive Power control of transformers, voltage reduction and Low Voltage Demand Disconnection, in order to maintain Operational Security Limits and to prevent voltage collapse of the Transmission System.

(16) Each TSO shall coordinate and define the voltage control actions with the Significant Grid Users with Connection Point directly to the Transmission System, the DSOs with Connection Point directly to the Transmission System, and with neighbouring TSOs. TSOs in coordination with DSOs shall be entitled to direct Significant Grid Users with Connection Point to the Distribution Network to follow voltage control instructions if this is relevant for the voltage and Reactive Power management of the Transmission System.

(17) Each TSO shall maintain voltage ranges and each DSO and Significant Grid User, which is a Transmission Connected Demand Facility, shall maintain the power factor or Reactive Power flows at Connection Points within the ranges specified in paragraph (13) of Section 2.2 of this Network Code PS] and in Section 4.4 of Connection Code [Section 4 – DC], unless an agreement is defined between the TSO and the DSO foreseeing the active voltage control by the DSO in accordance with Section 4.4 of Connection Code [Section 4 – DC], or unless another value is defined in accordance with national legislation for Significant Grid Users which are Transmission Connected Demand Facilities who are not subject to or are derogated from the Connection Code [Section 4 – DC].

(18) If voltage deterioration jeopardizes Operational Security or threatens to develop into a voltage collapse in either N or (N-1) Situation the TSO shall be entitled to instruct the DSOs, Closed Distribution Networks and Significant Grid Users with Connection Point directly to the Transmission System, to block automatic voltage and Reactive Power control of transformers or to follow other voltage control instructions. As a consequence of these measures directed by the TSO, the DSO may have to disconnect Significant Grid Users, which are Demand Facilities in order to avoid jeopardising the Transmission System. This is part of the Defence Plan.

2.4 Short-circuit current management

(1) In accordance with Section 2.1, paragraph (5) of this Network Code [OS], each TSO shall define the maximum short-circuit current at which the rated capability of circuit breakers and other equipment is exceeded and the minimum short-circuit current for correct operation of protection equipment. Each TSO shall apply operational measures to prevent or relieve a deviation from these short-circuit current limits.

(2) In accordance with Section 2.1, paragraph (4) of this Network Code [OS], each TSO shall use all available economically efficient and feasible means under its control to maintain the short-circuit current within the limits defined in paragraph (1) of Section 2.4 of this Network Code [OS] for the Contingencies of the Contingency List at all times and for all protection equipment. A deviation from these conditions is allowed only during switching sequences.

(3) Each TSO shall perform short-circuit current and power calculation according to the best available data and its own practice approaches or according to agreed international standards.

(4) When assessing the compliance with the limits defined according to paragraph (1) of Section 2.4 of this Network Code [OS], each TSO shall consider operational conditions that provide the highest conceivable level of short-circuit current, considering also the short-circuit contribution from other Transmission Systems, Distribution Networks and Closed Distribution Networks.

(5) Each TSO shall perform short-circuit calculations in order to evaluate the impact of directly interconnected TSOs, Transmission Connected Distribution Networks and Transmission Connected Closed Distribution Networks, on the short-circuit current level. Where a Transmission Connected Distribution Network or Transmission Connected Closed Distribution Network has an impact on short-circuit current levels it has to be modelled in the Transmission System short-circuit calculations.

2.5 Power flow management

(1) Each TSO shall define Operational Security Limits for power flows on each Transmission System element within its own Responsibility Area in accordance with paragraph (5) and (8) of Section 2.4 of this Network Code [OS].

(2) Each TSO shall maintain Active Power flows within the Operational Security Limits defined in accordance with paragraph (5) of Section 2.4 of this Network Code [OS] when the system is in Normal State and after the occurrence of a Contingency from the Contingency List defined according to paragraph (1) Section 2.5 of this Network Code [OS].

(3) Each TSO shall perform Operational Security analysis based on the forecast and real-time operational parameters from its Observability Area. Each TSO shall coordinate Operational Security analysis with the other TSOs in accordance with the multi-party agreements concluded in accordance with Section 3.5 of this Network Code [OS], in order to ensure the respecting of the Operational Security Limits for power flows in its Responsibility Area.

(4) Each TSO shall be entitled to use Redispatching of available Significant Grid users with Connection Point directly to the Transmission System or to the Distribution Network to maintain Operational Security.

(5) In the (N-1) Situation in Normal State, each TSO shall keep power flows within the Transitory Admissible Overloads, preparing and executing Remedial Actions including Redispatching, to be applied within the time allowed for Transitory Admissible Overloads.

2.6 Contingency analysis and handling

(1) Each TSO shall define the Contingency List, including Internal and External Contingencies within its Observability Area, for which it shall be checked whether any of these Contingencies endangers the Operational Security of the TSO's Responsibility Area. The Contingency List shall at least include Ordinary Contingencies and may include Exceptional Contingencies defined according to paragraph (5) Section 2.6 of this Network Code [OS].

(2) In order to identify the Contingencies, which endanger the Operational Security of its Responsibility Area, and to identify the necessary Remedial Actions, each TSO shall perform Contingency Analysis in its Observability Area in real-time operation and in operational planning.

(3) Each TSO shall perform Contingency Analysis on the basis of the real-time system operation parameters periodically, according to paragraph (2) of Section 2.1 of this Network Code [OS] and in operational planning according to the provisions defined in this Network Code [OS]. Each TSO shall ensure that potential deviations from the Operational Security Limits in its Responsibility Area, which are identified by the Contingency Analysis, do not endanger the Operational Security of its Transmission System or of the interconnected Transmission Systems. In accordance with its own rules and procedures, a TSO can decide not to apply costly Remedial Actions if the effects of the Contingencies are Local and they do not impact the Operational Security of the interconnected Transmission Systems.

(4) Each TSO shall assess the risks associated with the potential effects of Contingencies and prepare Remedial Actions after testing each Contingency from its Contingency Lists and after assessing whether it can maintain its Transmission System within the Operational Security limits in the (N-1) Situation. The starting point for the Contingency Analysis in the N – Situation shall at any time be the up-to-date Topology of the Transmission System including planned outages. In the case of an (N-1) Situation caused by an unplanned outage, each TSO shall apply Remedial Actions in order to ensure that the Transmission System is restored within Operational Security Limits as soon as reasonably practicable and that this (N-1) Situation becomes the new N – Situation.

(5) Each TSO shall include Internal and External Contingencies in the Contingency List. External Contingencies shall be defined in line with the methodology developed according to the provisions in this Network Code [OS]. Each TSO shall differentiate between Ordinary, Exceptional and Out-of-Range Contingencies, taking into account their probability of occurrence. In the treatment of so classified Contingencies, each TSO shall apply the following principles:

a) Each TSO shall classify Contingencies for its own Responsibility Area;

b) When and as long as conditions significantly increase the probability of an Exceptional Contingency, the TSO shall include this Exceptional Contingency in its Contingency List. The TSO shall determine the Remedial Actions necessary to maintain its Transmission System within Operational Security Limits or to mitigate the impact of Exceptional Contingencies as far as reasonably practical and economically efficient;

c) When and as long as out of the ordinary conditions increase the probability of an Out-of-Range Contingency, the TSO shall use all available economically efficient and feasible means under its control to prepare Remedial Actions to mitigate the impact of these very exceptional conditions;

d) Each TSO shall determine the Ordinary and Exceptional Contingencies based on the up-to-date topology;

e) In order to account for Exceptional Contingencies with high impact on its own or neighbouring Transmission Systems, or with a high probability of occurrence, each TSO shall include such Exceptional Contingencies in its Contingency List. The included Exceptional Contingencies shall be reassessed and if necessary the Contingency List readjusted in the case of significantly changed operational conditions; and

f) Each TSO shall contribute to the development of a common methodology and criteria for coordination and, as far as technically feasible and economically efficient, harmonization of the key principles for establishment of Contingency Lists across the Synchronous Areas.

(6) Each TSO shall prepare Remedial Actions including Redispatching pursuant to paragraph (12) and (13) of Section 2.1 of this Network Code [OS], or Countertrading to cope with any Contingency from its Contingency List for which potential deviation from Operational Security Limits is identified in accordance with paragraph (5) of Section 2.1 of this Network Code [OS].

(7) Each TSO shall, upon any relevant change in real-time operation or in Transmission System topology, reassess the Contingencies from its Contingency List to be taken into account according to paragraph (5) of Section 2.6 of this Network Code [OS] in Normal State and adjust the prepared Remedial Actions.

(8) Each TSO shall apply Remedial Actions upon identification of a Contingency during Contingency Analysis, for which there is a danger of not being able to cope efficiently and in a timely manner with the conditions occurring after that Contingency.

(9) If after a Contingency the Transmission System is not compliant with the (N-1) Criterion, the TSO shall initiate Remedial Actions to recover compliance with the (N-1) Criterion as soon as reasonably practicable. If there is a risk of a post-Contingency Disturbance propagation involving interconnected TSOs, the TSO shall initiate Remedial Actions as soon as possible. Non-compliance with the (N-1) Criterion is acceptable:

a) During switching sequences;

b) As long as there are only Local consequences within the TSO's Responsibility Area; or

c) During the time period required to activate the Remedial Actions.

(10) Each TSO shall ensure that its Observability Area used for Contingency Analysis is based upon sufficiently accurate real-time data to allow for convergence of load-flow calculations.

(11) Each DSO with Connection Point directly to the Transmission System and Significant Grid User which is a Power Generating Facility of type B, C or D according to Section 2.1 of the Connection Code [Section 2 – RfG] shall deliver all information for Contingency Analysis as requested by the TSO, including forecast and real-time data, with possible data aggregation according to Section 3.12 paragraph (3) of this Network Code [OS].

(12) Each TSO shall coordinate its Contingency Analysis in terms of coherent Contingency Lists at least with the TSOs from its Observability Area and in accordance with the multi-party agreements concluded in accordance with Section 3.5 of this Network Code [OS]. Each TSO shall cooperate at least with other TSOs from its Observability Area and deliver all information for Contingency Analysis including forecast and real-time data according to the provisions in Section 3 “Data Exchange” of this Network Code [OS].

(13) Each TSO within RPCC activities shall contribute to establishing the Common Grid Model. This contribution shall include the data for the Common Grid Model according to the defined contents and timeframes according to the provisions in Section 3 “Data Exchange” of this Network Code [OS] consistent with this network Code [OS] and Market Code [Section 2 “Capacity Allocation, Forward Capacity Allocation and Congestion Management Code” – CACM].

(14) Each TSO shall inform the TSOs from its Observability Area, about their External Contingencies taken into account in its Contingency list.

(15) Each TSO shall inform and coordinate with the relevant TSOs, prior to implementation, any significant topological changes in parts of its Responsibility Area involving Transmission System elements which are included as External Contingencies of Contingency Lists of other TSOs.

2.7 Protection

(1) Each TSO shall install the necessary protection and backup protection equipment within its Transmission System in order to efficiently and effectively protect Transmission System elements and to coordinate with the protection of the equipment of Significant Grid Users, from effects of Faults in the Transmission System. At the connection point, the related TSOs must cooperate to define the protection schemes for connecting elements.

(2) Each TSO shall at least every five years review and analyse the protection strategy and concepts and when necessary adapt the protection functions to ensure the correct functioning of the protection and the maintaining of Operational Security. After every protection operation having impact outside of its own Responsibility Area, each TSO shall assess whether the protection system in its Responsibility Area worked as planned and shall undertake corrective actions if necessary.

(3) Each TSO shall operate the protection of its Transmission System with Set-Points that ensure reliable, fast and selective fault clearing, including backup protection for Fault clearing in case of malfunction of the main protection system.

(4) Each TSO shall install the necessary protection and backup protection equipment within its Transmission System in order to automatically prevent Disturbance propagation which can endanger the Operational Security of the interconnected Transmission System.

(5) Each TSO shall coordinate with interconnected TSOs the protection Set-Points for the Interconnectors and inform and coordinate with those TSOs before changing the settings.

(6) If a TSO is using a System Protection Scheme (SyPS), the TSO shall:

a) Perform analysis in order to ensure that each SyPS acts selectively, reliably and effectively. In the analysis of SyPS, the TSO shall evaluate the consequences for the Transmission System in the event of an incorrect SyPS function, taking into account the interaction with affected TSOs;

b) Verify that the SyPS has a comparable reliability to the protection systems used for the primary protection of Transmission System elements;

c) Operate the Transmission System with the SyPS within the Operational Security Limits determined according to paragraph (5) and (6) of Section 2.1 of this Network Code [OS]; and

d) Coordinate SyPS functions, activation principles and Set-Points with interconnected TSOs and affected DSOs, Closed Distribution Network and Significant Grid Users with Connection Point directly to the Transmission System.

(7) While respecting the provisions of the Connection Code [Section 4 – DC], each TSO shall define a Low Frequency Demand Disconnection Scheme with common principles and in coordination with the respective DSOs and the TSOs of its Synchronous Area. Each DSO or where relevant TSO shall implement the Low Frequency Demand Disconnection scheme in its area of responsibility and shall inform the TSOs of a Synchronous Area in the case of a change to the conditions and settings.

(8) While respecting the provisions of the Connection Code [Section 2 – RfG], each TSO shall define and implement actions for over-frequency in cooperation with Significant Grid Users, which are Power Generating Facility Owners, and in coordination with the TSOs of its Synchronous Area.

(9) Every year, at the connection point, related TSOs will provide the total impedance of each side.

2.8 Dynamic stability management

(1) Each TSO shall monitor the dynamic state of the Transmission System in terms of Voltage, Frequency and Rotor Angle Stability by off-line studies, wide area measurements, or other approaches according to paragraph (5) of Section 2.8 of this Network Code [OS] including the exchange of relevant data with other TSOs if necessary, in order to be able to take the necessary Remedial Actions when the Transmission System Operational Security is at a risk.

(2) Each TSO shall ensure, in the case of stability problems due to poorly damped inter-area oscillations affecting several TSOs, that coordinated Dynamic Stability Analysis shall be performed on the Synchronous Area level as soon as reasonably practical. Each TSO is obliged to provide data as requested for this analysis.

(3) Each TSO shall perform Dynamic Stability Assessment (DSA) studies in order to identify the Stability Limits and potential stability problems in its Transmission System. DSA studies shall be coordinated between the TSOs within each Synchronous Area and shall be done for the whole or relevant parts of the Synchronous Area. These studies can be offline. TSOs must cooperate with each other to define the exchanged information from Wide Area Monitoring (WAM) systems of each TSO.

(4) Where a TSO identifies a potential mutual influence of Voltage, Rotor Angle or Frequency Stability with other interconnected Transmission Systems, the affected TSOs shall contribute to the coordination of approaches to the DSA, including provision of data needed for DSA, preparation of joint Remedial Actions including the cooperation procedures between the TSOs required to relieve wide area oscillations.

(5) In deciding the approach for DSA, each TSO shall apply the following rules:

a) If with respect to the Contingency List, steady-state limits are reached before Stability Limits, the TSO shall base its DSA only on the offline stability studies carried out in the longer term operational planning phase;

b) If under planned outage conditions, with respect to the Contingency List, steady-state limits and Stability Limits are close to each other or Stability Limits are reached before steady-state limits, the TSO shall perform a DSA in the day ahead operational planning phase whilst these outage conditions remain. The TSO shall prepare Remedial Actions to be used in real-time operation if necessary; and

c) If the network is in the N – Situation with respect to the Contingency List and Stability Limits are reached before steady-state limits, the TSO shall perform a DSA in all phases of operational planning and have a capability to re-assess the Stability Limits as soon as reasonably practical after a significant change in conditions is detected.

(6) If the DSA indicates a violation of Stability Limits, the TSOs having the violation shall implement measures to keep the Transmission System stable. These measures may involve Significant Grid Users, which are Power Generating Modules.

(7) Each TSO shall ensure that the Fault clearing times for Faults that may lead to Wide Area system instability are less than the Critical Fault Clearing Time calculated by the TSO in its Dynamic Stability Assessment studies carried out according to Section 2.8 of this Network Code [OS].

(8) In relation to the minimum inertia required for the Synchronous Area:

a) All TSOs of that Synchronous Area shall conduct the studies to identify if a need exists for the definition of the minimum required inertia, not later than two years after entering into force of this Network Code and shall conduct a periodic review and update of these studies every two years and preferably each year in consideration of the rapid demand growth in the GMS;

b) Based on the results of the studies from paragraph (8) (a) of Section 2.8 of this Network Code [OS], all TSOs from a Synchronous Area shall develop and implement the methodology for the definition of minimum inertia required to maintain Operational Security and to prevent violation of Stability Limits identified pursuant to paragraph (3) of Section 2.8 of this Network Code [OS]; this methodology shall be developed not later than six months after first completion of the studies from paragraph (8) (a) of Section 2.8 of this Network Code [OS], which showed the need for the definition of a required minimum inertia and shall be regularly updated not later than six months after each new update of the studies from paragraph (8) (a) of Section 2.8 of this Network Code [OS] is available; and

c) Each TSO shall be entitled to define and deploy in operation the minimum inertia in its own Responsibility Area, according to the defined methodology and obtained results in paragraph (8) (b) of Section 2.8 of this Network Code [OS].

3. Data Exchange

3.1 General requirements

(1) Each TSO shall use the best available data and information, which reflect as closely as possible the real and forecasted situation in the Transmission System.

(2) Each TSO shall minimize inaccuracies and uncertainties and continuously ensure high quality of the data and information used.

(3) Each TSO shall be entitled to gather the information, which is required for the Operational Security Analysis and related to the following items, as further detailed in Section 3.2 to 3.14 of this Network Code [OS]:

a) Generation;

b) Consumption;

c) Schedules;

d) Balance positions;

e) Planned outages and substation topologies; and

f) Own forecasts.

This information shall be transformable into the injections and withdrawals at each node of the TSO's own Transmission System model and shall respect requirements described in this Network Code [OS] to be gathered in a Common Grid Model.

(4) Each TSO shall determine the scope of the data exchange with the Significant Grids Users defined in this Section 3 of this Network Code [OS], according to the following categories:

a) Structural data;

b) Scheduling and forecast data;

c) Real-time data; and

d) Individual instructions by TSOs or DSOs.

(5) All TSOs shall make a common proposal regarding key organisational requirements, roles and responsibilities in relation to the data exchange, within 6 months after entry into force of this Network Code. The agreed proposal shall be published in the RPCC website and shall encompass the following issues:

a) Obligations among the TSOs to communicate without undue delay to all neighbouring TSOs any changes in the protection settings, thermal limits and technical capacities at the Interconnectors between their Responsibility Areas;

b) Obligations of the DSOs directly connected to the Transmission System to inform within the agreed timescales their TSOs of any changes in the data and information scope and contents from this Section 3 of this Network Code [OS];

c) Obligations for the adjacent DSOs and/or between the downstream DSO and upstream DSO to inform each other within agreed timescales of any change in the data and information scope which are defined in this Section 3 of this Network Code [OS];

d) Obligations of the Significant Grid Users to inform their TSO or DSO within the timescales, about any relevant change in the scope and contents of the relevant data from Section 3 of this Network Code [OS];

e) Detailed contents of the data and information referred to in this Section 3 and in a coherent way with the data exchange provisions in other Network Codes. These detailed definitions shall include but not be limited to: main principles, type of data, communication means, format and standards to be applied, timing and responsibilities;

f) The time stamping and periodicity for the data and information to be provided by DSOs and Significant Grid Users, to be used by the TSO's systems at the different timescales.

At least the frequency of information exchange for real-time data, scheduled data and update of structural data shall be defined; and

g) Reporting formats of the data and information referred to in this Section 3 of the Network Code [OS] and in a coherent way with the data exchange provisions in other Network Codes.

(6) TSOs and DSOs shall cooperate in order to define and agree on effective processes for providing and managing data exchanges between them, including, where required for efficient network operation, the provision of data related to Distribution Networks and Significant Grid Users. Such exchanges shall be governed by the principles of efficiency and proportionality.

(7) Data related to commissioned network installations at the Connection Point to the Transmission System shall be available to Significant Grid Users and DSOs which are connected at that Connection Point.

(8) TSOs and DSOs shall agree on the exact scope of additional information concerning commissioned network installations, to be exchanged in each case. Each TSO shall make this information available to DSOs or Significant Grid Users of its Responsibility Area.

(9) Transmission Connected DSOs shall be entitled to gather the relevant structural, scheduled and real-time information from the neighbouring DSOs. DSOs shall cooperate to define the exact scope of information to be exchanged in each case.

(10) A TSO can entrust the RPCC Administration with some of the tasks that it shall perform in accordance with this Network Code [OS], while retaining the sole responsibility and liability as a TSO. In such a case, the TSO shall inform other TSOs, about this delegation, so that the RPCC Administration can get all the data and information needed to perform the tasks entrusted to them.

3.2 Structural and forecast data exchange between TSOs

(1) Neighbouring TSOs shall exchange the structural information related to the Observability Area including at least:

a) Substations' regular Topology and other relevant data by voltage level;

b) Transmission lines;

c) Transformers connecting the DSOs, Significant Grid Users, which are Demand Facilities and generators' block-transformers of Significant Grid Users, which are Power Generating Facilities;

d) Maximum and minimum active and Reactive Power of Significant Grid Users which are Power Generating Modules;

e) Phase-shifting transformers;

f) High voltage DC lines;

g) Reactors, capacitors and static VAR compensators; and

h) Operational Security Limits defined by each TSO according to paragraph (5) of Section 2.1 of this Network Code [OS].

(2) Neighbouring TSOs shall exchange the protection Set-Points of the lines included as external Contingencies in neighbouring TSOs Contingency Lists to allow protection coordination between the different Transmission Systems.

(3) In order to support coordinated Operational Security Analysis and the establishment of the Common Grid Model, each TSO shall exchange with other TSOs and the RPCC according to the provisions in this Network Code [OS] at least the following data:

a) Topology of the 220 kV and higher voltage Transmission System within its Responsibility Area;

b) A model or an equivalent of the Transmission System with voltage below 220 kV with significant impact to its own Transmission System; and

c) The forecasted aggregate sum by primary energy source of injection and withdrawal in every node of the Transmission System for the different timeframes. This data shall correspond to the best forecast available at the TSO level. The resulting forecast situation in the Transmission System shall be as realistic and accurate as possible.

(4) In order to support coordinated Dynamic Stability Assessment, each TSO shall, when required in accordance with Section 2.8, paragraph (2) of this Network Code [OS], exchange with other TSOs within the relevant part of the Synchronous Area the necessary data for DSA, informing the affected Power Generating Facility Owner. Concerning Significant Grid Users, which are Power Generating Modules, the TSO shall provide the necessary data at least on:

a) Electrical parameters of the alternator suitable for DSA, including total inertia;

b) Protection models;

c) Alternator and prime mover;

d) Step up transformer description;

e) Minimum and maximum Reactive Power;

f) Voltage and speed controller models; and

g) Prime movers and excitation system models suitable for large disturbances.

Concerning tap changers, description of existing on load tap changers, step up and network transformers, the TSO shall provide the necessary data on:

a) Type of regulation; and

b) Voltage regulation range.

Concerning HVDC lines and FACTS devices, the TSO shall provide the necessary data on:

a) Dynamic models of the device and its associated regulation suitable for large disturbances.

3.3 Real-time data exchange between TSOs

(1) In accordance with paragraph (11) (a) of Section 2.1 of this Network Code [OS], each TSO shall exchange with all other TSOs in its Synchronous Area the necessary data on the System State of its Transmission System using the IT tool for real-time data exchange set up at GMS level, including:

a) Frequency;

b) Frequency Restoration Control Error or an equivalent parameter;

c) Measured Active Power exchanges between LFC Areas;

d) Aggregated generation in-feed;

e) System State in accordance with paragraph (1) of Section 2.1 of this Network Code [OS];

f) Set-value of the FR controller; and

g) Power exchange via the Virtual Tie-Lines.

(2) Each TSOs shall exchange with the TSOs from its Observability Area the following data from its own Transmission System:

a) Actual substation Topology;

b) Active and Reactive Power in line bay, including transmission, distribution and lines connecting Significant Grid User;

c) Active and Reactive Power in transformer bay, including transmission, distribution and Significant Grid User connecting transformers;

d) Active and Reactive Power in Power Generating Facility bay;

e) Regulating positions of transformers, including phase-shifting transformers;

f) Measured or estimated busbar voltage;

g) Reactive Power in reactor and capacitor bay or from a static VAR compensator; and

h) Restrictions on Active and Reactive Power supply capabilities with respect to the Observability Area.

3.4 Structural data exchange between TSOs and DSOs within the TSO's Responsibility Area

(1) Each TSO shall define the Observability Area of the Transmission Connected Distribution Networks, which is relevant to accurately and efficiently determine the System State, based on the methodology developed according to the provisions of this Network Code [OS].

(2) In those cases where a Distribution Network is not a Transmission Connected Distribution Network, but whose electrical influence is deemed as significant by the TSO for the proper representation of the system behaviour, such Distribution Networks shall be defined by the TSO as being part of the Observability Area defined according to Section 3.4 paragraph (1) of this Network Code [OS].

(3) Each DSO shall provide to its TSO the structural information related to the Observability Area referred to in Section 3.4 paragraph (1) and (2) of this Network Code [OS] including, but not limited to:

a) Substations by voltage;

b) Lines that connect the substations from a) above;

c) Transformers from the substations from a) above;

d) Significant Grid Users; and

e) Reactors and capacitors connected to the substations from a) above.

(4) Each DSO with the Connection Point to the Transmission System shall provide the TSO with updated structural information about the elements of the Observability Area referred to in Section 3.4 paragraph (1) and (2) of this Network Code [OS], periodically, at least every six months.

(5) Each DSO shall provide to its TSO the total aggregated generating capacity of all new type A Power Generating Modules and best possible estimate of type A Power Generating Modules, by primary energy source, which are not subject to or are derogated from the Connection Code [Section 2 – RfG], connected to its Distribution Network and the related information concerning their frequency behaviour.

3.5 Real-Time data exchange between TSOs and DSOs within the TSO's Responsibility Area

(1) Each DSO shall provide in real-time to its TSO the information related to the Observability Area referred to in Section 3.4 paragraph (1) and (2), comprising:

a) Actual substation Topology;

b) Active and Reactive Power in line bay;

c) Active and Reactive Power in transformer bay;

d) Active and Reactive Power injection in Power Generating Facility bay;

e) Tap positions of transformers connecting to the Transmission System;

f) Busbar voltages;

g) Reactive Power in reactor and capacitor bay;

h) Best available data for aggregated generation in the DSO area; and

i) Best available data for aggregated consumption in the DSO area.

3.6 Structural data exchange between TSOs, owners of Interconnectors or other lines and Power Generating Modules directly connected to the Transmission System

(1) Each Significant Grid User, which is a Power Generating Facility Owner operating a type D Power Generating Modules, shall provide at least the following data to the TSO:

a) General data of the Power Generating Module, including installed capacity and primary energy source;

b) Turbine and Power Generating Facility data including time for cold and warm start;

c) Data for short-circuit calculation;

d) Power Generating Facility transformer data;

e) Frequency Containment Reserve data according to the definition and requirements of the Load Frequency Control and Reserves Code [LFCR] for Power Generating Facilities offering or providing this service;

f) Frequency Restoration Reserve data, according to the definition and requirements of the Load Frequency Control and Reserves Code [LFCR] for Power Generating Modules that participate in this service;

g) Replacement Reserve data for Power Generating Modules that participate in this service;

h) Data necessary for Restoration;

i) Data and models necessary for performing dynamic simulation;

j) Protection data; and

k) Voltage and Reactive Power control capability.

(2) Each Significant Grid User, which is a Power Generating Facility Owner operating a type B and C Power Generating Modules, which is directly connected to the Transmission System, shall provide at least the following data to the TSO:

a) General data of the Power Generating Module, including installed capacity and primary energy source;

b) Data for short-circuit calculation;

c) Frequency Containment Reserve data according to the definition and requirements of the Load Frequency Control and Reserves Code [LFCR] for Power Generating Modules offering or providing this service;

d) Frequency Restoration Reserve data for Power Generating Modules that participate in this service;

e) Replacement Reserve data for Power Generating Modules that participate in this service;

f) Protection data;

g) Reactive Power control capability; and

h) Data necessary for performing DSA according to the provisions in the Connection Code [Section 2 – RfG].

(3) A TSO may request any Power Generating Facility Owner operating a Power Generating Module with Connection Point directly to the Transmission System, to provide further data needed for Operational Security Analysis.

(4) Each HVDC Interconnector or Line owner shall provide at least the following data to the TSO:

a) Name plate data of the installation;

b) Transformers data;

c) Data on filters and filter banks;

d) Reactive compensation data;

e) Active Power control capability;

f) Reactive Power and voltage control capability;

g) Active or reactive operational mode prioritization if exists;

h) Frequency response capability;

i) Dynamic models for dynamic simulation;

j) Protection data; and

k) Fault Ride Through capability.

(5) Each AC Interconnector or Line owner shall provide at least the following data to the TSO:

a) Name plate data of the installation;

b) Electrical parameters; and

c) Associated protections.

3.7 Scheduled data exchange between TSOs, owners of Interconnector or other lines and Power Generating Modules directly connected to the Transmission System

(1) Each Significant Grid User, which is a Power Generating Facility Owner operating a type B, C and D Power Generating Module with Connection Point directly to the Transmission System, shall inform the TSO on a Day-Ahead and Intra-Day basis of its Active Power output and Active Power reserves amount and availability and, without delay, about its scheduled unavailability or Active Power capability restriction.

(2) Each Significant Grid User, which is a Power Generating Facility Owner operating a type B, C and D Power Generating Module with Connection Point directly to the Transmission System, shall provide to the TSO any forecast restriction in the Reactive Power control capability.

(3) In regions with a Central Dispatch System, the Significant Grid User, which is a Power Generating Facility Owner directly connected to the Transmission System, shall submit the data required by the TSO to allow the TSO to construct an Active Power output schedule. This data shall be provided instead of that required in Section 3.7, paragraph (1) of this Network Code [OS].

(4) Each HVDC Interconnector owner or owner other than the TSO, of an internal HVDC line within a single TSO Responsibility Area shall provide the following data to the TSOs:

a) On a Day-Ahead and Intra-Day basis, its Active Power schedule and Active Power reserves and availability;

b) Without delay, its scheduled unavailability or Active Power restriction; and

c) Any forecast restriction in the Reactive Power or voltage control capability.

(5) Each AC Interconnector or Line owner shall provide its scheduled unavailability or Active Power restriction data to the TSOs.

3.8 Real-Time data exchange between TSOs, owners of Interconnector or other lines and Power Generating Modules directly connected to the Transmission System

(1) Each Significant Grid User, which is a Power Generating Facility Owner operating a type B, C and D Power Generating Module, including its own house load, shall provide to the TSO in real-time the following information:

a) Position of the circuit breakers at the Connection Point or another point of interaction agreed with the TSO;

b) Active and Reactive Power at the Connection Point or another point of interaction agreed with the TSO; and

c) In the case of Power Generating Facility with consumption other than auxiliary consumption, net active and Reactive Power.

(2) Each HVDC or AC Interconnector owner or an owner of the HVDC or AC line other than the TSO within the TSO Responsibility Area, shall provide the following data referred to the Connection Point to the TSOs in real-time:

a) Position of the circuit breakers;

b) Operational status; and

c) Active and Reactive Power.

3.9 Structural data exchange between TSOs, DSOs and Significant Grid Users according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) connected to the Distribution Network

(1) Each Significant Grid User according to Section 1.1 - (4)(a) and Section 1.1 – (45)(d) of this Network Code [OS], Power Generating Facility Owner connected to the Distribution Network, shall at least provide the following data to its TSO and/or to its DSO:

a) General data of the Power Generating Module, including installed capacity and primary energy source or fuel type;

b) Frequency Containment Reserve data according to the definition and needs of the Load Frequency Control and Reserves Code [LFCR] for Power Generating Facilities offering or providing this service;

c) Frequency Restoration Reserve data for plants that participate in this service;

d) Replacement Reserve data for Power Generating Modules that participate in this service;

e) Protection data;

f) Reactive Power control capability;

g) Capability of remote access to the circuit breaker;

h) Data necessary for performing dynamic simulation according to the provisions in Connection Code [Section 2 – RfG]; and

i) Voltage level and location of each Power Generating Module.

Organization of the data exchange shall be defined according to the key organisational requirements, roles and responsibilities established in Section 3.1, paragraph (6) and (8) of this Network Code [OS].

(2) Each Significant Grid User affected by the Section 3.9, paragraph (1), shall inform the TSO and/or the DSO to which it has Connection Point, within the agreed time but before first commissioning or before any changes of the existing installation, about any change in the scope and the contents of the data according to Section 3.9, paragraph (1) of this Network Code [OS]. Organization of the data exchange shall be defined according to the key organisational requirements, roles and responsibilities established in Section 3.1, paragraph (5) of this Network Code [OS].

3.10 Scheduled data exchange between TSOs, DSOs and Significant Grid Users according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) connected to the Distribution Network

(1) Each Significant Grid User, which is a Power Generating Facility Owner according to the Section 1.1 - (4)(a) and Section 1.1 – (4)(d) of this Network Code [OS] and with Connection Point to the Distribution Network, shall provide its TSO and/or its DSO with its scheduled unavailability, Active Power restriction and its forecast scheduled Active Power output at the Connection Point. Organization of the data exchange shall be defined according to the key organisational requirements, roles and responsibilities established in Section 3.1, paragraph (6) and (8) of this Network Code [OS].

(2) Each Significant Grid User, which is a Power Generating Facility Owner according to the Section 1.1 - (4)(a) and Section 1.1 – (4)(d) of this Network Code [OS], shall provide to its TSO and/or its DSO any forecasted restriction in the Reactive Power control capability. Organization of the data exchange shall be defined according to the key organisational requirements, roles and responsibilities established in Section 3.1, paragraph (6) and (8) of this Network Code [OS].

(3) In regions with a Central Dispatch System, the Significant Grid User, which is according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) of this Network Code [OS], Power Generating Facility Owner, shall submit the data required by the TSO to allow the TSO to construct an Active Power output schedule. This data shall be provided instead of that required in Section 3.10, paragraph (1) of this Network Code [OS].

3.11 Real-Time Data exchange between TSOs, DSOs and Significant Grid Users according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) connected to the Distribution Network

(1) Each Significant Grid User, which is Power Generating Facility Owner according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) of this Network Code [OS] connected to the Distribution Network, shall provide to its TSO and/or its DSO in real-time the following information:

a) Status of the switching devices and circuit breakers at the Connection Point; and

b) Active and Reactive Power flows, current, and voltage at the Connection Point.

Organization of the data exchange shall be defined according to the key organisational requirements, roles and responsibilities established in Section 3.1, paragraph (6) and (8) of this Network Code [OS].

(2) Each TSO shall define in coordination with the responsible DSOs, whether and which Significant Grid Users might be exempted from providing the real-time data directly to the TSO whereas the real-time data of such Significant Grid Users needs to be delivered by responsible DSOs to the TSO in an aggregated form.

3.12 Data exchange between TSOs, DSOs and Significant Grid User according to Section 1.1 - (4)(a) and Section 1.1 – (4)(d) connected to the Distribution Network

(1) Each DSO shall provide to its TSO the information specified in Sections 3.9, 3.10 and 3.11 of this Network Code [OS] when and to the extent requested by the TSO.

(2) Each TSO shall make available to the DSO to whose Distribution Network SGUs are connected, the information specified in Sections 3.9, 3.10 and 3.11 of this Network Code [OS] as requested by the DSO.

(3) A TSO may request further data from any Significant Grid User according to the Section 1.1 - (4)(a) and Section 1.1 – (4)(d) of this Network Code [OS], which is a Power Generating Facility Owner with Connection point to the Distribution Network, if this is necessary for Operational Security Analysis and validation of models.

3.13 Data exchange between TSOs and Demand Facilities directly connected to the Transmission System

(1) Transmission Connected Demand Facilities shall provide the following structural data to the TSO:

a) Electrical data of the transformers connected to the Transmission System;

b) Characteristics of the load of the Demand Facility; and

c) Characteristics of the Reactive Power control.

(2) Each Transmission Connected Demand Facility shall communicate to the TSO, as a minimum, its scheduled active and forecast reactive consumption on a day-ahead and intraday basis, including any changes of these schedules or forecast.

(3) Each Transmission Connected Demand Facility shall communicate to the TSO any forecast restriction in the Reactive Power control capability.

(4) Each Transmission Connected Demand Facility which participates in Demand Side Response shall inform the TSO about the structural minimum and maximum power to be curtailed.

(5) Each Demand Facility directly connected to the Transmission System shall communicate to the TSO in real-time the following information:

a) Active and Reactive Power at the Connection Point; and

b) Minimum and maximum power to be curtailed.

(6) In regions, with a Central Dispatch System the Transmission Connected Demand Facility is not required to provide the data required by Section 3.13, paragraph (2) of this Network Code [OS].

(7) Each Demand Facility directly connected to the Transmission System shall describe to its TSO its behaviour at the voltage ranges according to the provisions in Section 2.3 of this Network Code [OS].

3.14 Data exchange between TSOs and Demand Facilities connected to the Distribution Network or Aggregators

(1) The following requirements shall be defined by the TSO in coordination with DSO. Each Significant Grid User, which is a Demand Facility connected to the Distribution Network and which participates in Demand Side Response, other than through an Aggregator, shall communicate to its TSO or via its DSO to the TSO the following scheduled and real-time data:

a) Structural minimum and maximum Active Power available for Demand Side Response; and the maximum and minimum duration of any potential usage of this power for Demand Side Response;

b) Forecast of unrestricted Active Power available for and any planned Demand Side Response;

c) Real-time Active and Reactive Power at the Connection Point; and

d) Confirmation that the estimated actual values of demand response are applied.

(2) The following requirements shall be defined by the TSO in coordination with DSO. Each Significant Grid User, which is an Aggregator which participates in Demand Side Response as defined in the Connection Code [Section 4 - DC], shall communicate to its TSO or via its DSO to the TSO at the day ahead and within a day at near real-time on behalf of all of its distribution connected demand sites:

a) Structural minimum and maximum Active Power available for Demand Side Response and the maximum and minimum duration of any potential activation of Demand Side Response in a specific geographical area defined by the TSO and DSO;

b) Forecast of unrestricted Active Power available for and any planned level of Demand Side Response in a specific geographical area defined by the TSO and DSO;

c) Real-time Active and Reactive Power; and

d) Confirmation of the estimated actual values of Demand Side Response applied.

4. Compliance

4.1 Responsibility of the Significant Grid Users

(1) Each Significant Grid User or DSO with Connection Point directly to the Transmission System or Transmission Connected Closed Distribution Network shall ensure that its facilities are compliant with the requirements of this Network Code, which are relevant for their connection and interaction with the Transmission System. This compliance shall be maintained throughout the lifetime of the facility.

(2) Before initiating any modification, each Significant Grid User shall notify the TSO or DSO to which it has Connection Point, about any planned modification of its technical capabilities which could have an impact on its compliance with the requirements of this Network Code [OS].

(3) Each Significant Grid User shall notify the TSO or DSO to which it has Connection Point, about any operational disturbance on its facility which could have an impact on its compliance with the requirements of this Network Code as soon as possible and without any delay after its occurrence.

(4) In order to allow the TSO or DSO to evaluate and mitigate where necessary the risks to the Transmission System or Distribution Network, each Significant Grid User shall inform the TSO or DSO to which it has Connection Point of any foreseen tests or test schedules and procedures to verify compliance of a Significant Grid User's facility with the requirements of this Network Code [OS].

(5) The TSO or DSO to which the Significant Grid User has Connection Point, shall approve the foreseen tests, or test schedules and procedures, prior to their launch.

(6) The Significant Grid Users shall enable the participation of the TSO or DSO to which it has Connection Point in such tests. The TSO or DSO to which the Significant Grid User has Connection Point, shall have the right to record the performance of these facilities of the Significant Grid Users.

(7) When the Significant Grid User has Connection Point to the DSO and interacts, in line with Section 4.1 paragraph (1) to paragraph (6) of this Network Code [OS], only with the DSO, the TSO shall be entitled to request any compliance testing results, if this is relevant for Operational Security of the Transmission System.

(8) Upon request from the TSO or DSO, pursuant to the Connection Code [Section 2 – RfG] and [Section 4 - DC], the Significant Grid User shall carry out compliance tests and simulations at any time throughout the lifetime of the Significant Grid User's facility and in particular after any Fault, modification or replacement of any equipment which could have an impact on the Significant Grid User's facility compliance with the requirements of this Network Code, capability to achieve its Declared Availability or physically contracted provision of Ancillary Services.

(9) The Aggregators according to the Connection Code [Section 4 – DC], providing Demand Side Response directly to the TSO, and Redispatching Aggregators and Providers of Active Power Reserve according to the Load Frequency Control and Reserves Code [LFCR] shall ensure that facilities in their portfolio are compliant with the requirements of this network code.

4.2 Responsibility of the TSOs and DSOs

(1) Each TSO has the sole responsibility for the Operational Security in its Responsibility Area in terms of:

a) utilizing the means within its own Responsibility Area including real-time operation, operational planning, development and deployment of tools and solutions for prevention and remedy of Disturbances;

b) utilizing the means provided through cooperation with other stakeholders including Redispatching or Countertrading and congestion management, operating reserves and other Ancillary Services;

c) identifying, evaluating and implementing necessary enhancements of the means from Section 4.2 paragraph (1)(a) and Section 4.3 paragraph (1)(b), or initiating amendments of this or other Network Codes, which are required in order to maintain Operational Security.

(2) Each TSO shall contribute to the annual reporting pursuant to a common incidents classification scale. The format and contents of this annual report, including geographical scope of the incidents reported, electrical interdependencies between the TSOs' Responsibility Areas and relevant historical information shall be approved by the RPCC. The annual report shall contain the Operational Security Performance Indicators:

a) Number of tripped Transmission System elements per year;

b) Number of tripped Power Generation Facilities per year;

c) Energy of disconnected Demand Facilities per year;

d) Time duration of being in Operational States other than Normal State;

e) time duration and number of events within which there was a lack of reserves identified;

f) Voltage deviation exceeding the voltage thresholds for Emergency State;

g) Frequency deviation per Synchronous Area;

h) Number of system-split separations or local blackouts; and

i) Number of blackouts involving two or more TSOs.

The yearly report shall contain explanation of reasons for incidents.

(3) The Operational Security Ranking in the yearly report shall be based on the following scales:

a) Scale 1 where any primary failure may have high security influence and/or high market influence consequences or cause noticeable violation of standards for at least two Transmission System Operators;

b) Scale 2 where any primary failure may lead to degradation of system adequacy with the necessity to activate at least one measure of the System Defence Plan;

c) Scale 3 where there is Blackout in the Responsibility Area of more than one TSO.

(4) The TSO or DSO with Connection Point directly to the Transmission System shall assess and where necessary request to witness the testing of the compliance of a Significant Grid User's facility with the requirements of this Network Code [OS] at any time throughout the lifetime of the Significant Grid Users' facility.

(5) Each TSO or DSO to which the Significant Grid User has Connection Point retains the right to evaluate a Significant Grid User's compliance with the requirements from this Network Code [OS], expected input or output, and contracted provision of Ancillary Services.

(6) The TSO or DSO to which the Significant Grid User has Connection Point, shall make publicly available the list of information and documents to be provided as well as the requirements to be fulfilled by the Significant Grid User in the framework of the compliance testing. Such list shall at least cover the following information, documents and requirements:

a) All documentation and Equipment Certificates to be provided by the Significant Grid User;

b) Details of the technical data of the Significant Grid User facility with relevance for the system operation;

c) Requirements for models for Dynamic Stability Assessment; and

d) Studies by the Significant Grid Users demonstrating expected outcome of the Dynamic Stability Assessment, where applicable.

(7) Each TSO or DSO where applicable, shall make publicly available the allocation of responsibilities of the Significant Grid Users and of the TSO or DSO for compliance testing and monitoring.

(8) Each TSO shall carry out the necessary analysis and planning using the Common Grid Model or a part of it to ensure that tests in its Responsibility Area are carried out in a manner that minimizes the impact on Operational Security and economic operation of the interconnected Transmission Systems and Significant Grid Users.

(9) Each TSO shall provide to the other TSOs at least that information on the test according to the multi-party agreements concluded in accordance with Section 3.5 of this Network Code [OS]. Each TSO shall provide the same information to the directly connected DSOs in its own Responsibility Area.

(10) Each TSO shall elaborate a list of high priority Significant Grid Users which are Power Generating Facilities or Demand Facilities, in terms of the conditions for their disconnection and re-energizing.

(11) Each DSO is responsible for quality, reliability and security in its Distribution Network.

4.3 Common testing and incident analysis responsibilities

(1) Each TSO, DSO and Significant Grid User with Connection Point directly to the Transmission System shall monitor their areas of responsibility, may perform operational testing when required and shall participate in the analysis of events in order to:

a) Ensure correct functioning of elements of Transmission System, Distribution Network and the Significant Grid Users facilities;

b) Maintain and develop operational procedures;

c) Ensure the fulfilment of Ancillary Services;

d) Train staff;

e) Acquire information about system and equipment performance under any conditions, including:

i. Tests involving the controlled application of frequency or voltage variations aimed at gathering information on Transmission System behaviour; and

ii. Tests of standard procedures in Emergency State and Restoration;

(2) Each TSO shall have Operational Security of its own Transmission System and Responsibility Area as its main concern during testing. Any test may be postponed or interrupted due to unplanned system conditions as assessed by the TSO or due to safety of its personnel and equipment as assessed by the DSO or Significant Grid User.

(3) In the event of System State degradation in the Transmission System in which the testing is being performed, the TSO of this Transmission System shall be entitled to interrupt the testing. If a TSO or a Significant Grid User is conducting a test influencing another TSO and the System State of the affected Transmission System changes to Alert State or Emergency State, if required the TSO or Significant Grid User conducting the test shall, having been informed by its TSO, immediately cease the test.

(4) TSOs, DSOs and Significant Grid Users shall exchange any relevant data, necessary to fully analyse both Local and Wide Area system incidents and facilitate system analysis.

(5) Each TSO shall ensure that the relevant results of tests carried out and the analysis of system incidents are:

a) Incorporated into the training and certification process;

b) Used as inputs for research and development process; and

c) Used to improve operational procedures including also procedures in Emergency State and Restoration.

5. Final Provisions

5.1 Amendments of contracts and general terms and conditions

By [*date – the same as the date in Section 5.2*], each relevant TSO, DSO and each relevant Significant Grid User shall amend all relevant clauses in contracts and relevant clauses in general terms and conditions, regardless of whether the relevant contracts or general terms and conditions contain an amendment process, in order to achieve compliance with the requirements of this Network Code.

5.2 Entry into force

This Network Code shall enter into force on xxxxx.

It shall apply as from [*date - at minimum 18 months after entry into force*].

This Network Code shall be binding in its entirety and directly applicable in all Member States.

ANNEX: Operational Security Code – History of Comments

#	Country	Reference section in the document	Country Comment	Consultants Review and Recommendation	Country Acceptance
1.	PR of China	2.1 c) iv Emergency State	We suggest the time period should be shorter than real-time Contingency Analysis period.	30 minutes is reasonable to declare Emergency situation. GMS Members have to decide, but China can adopt a stricter approach (15 minutes).	
2.	PR of China	Table 2.1 – Voltages ranges for reference voltages defined by TSOs	Considering the transmission distance in GMS scenario may be very long, and the higher transmission voltage level will be good to reduce transmission loss, we consider the voltage range for 230kV above can be changed into 0.9-1.1p.u.	This request needs to review the Performance Standards! +5% introduced in 2016 and confirmed in 2017… Please refer to paragraph Section 2.3 (2) and (12) below. Possibility for China to adopt wider voltage range in its responsibility area (multi-party agreement).	
3.	PR of China	2.4 (2) Short-circuit current management	In section 2.4 (2), could you explain why the deviation is allowed during switching sequences	Higher short-circuit currents can be tolerated during the transitory period of switching sequences.	
4.	PR of China	2.6 (5) Contingency analysis and handling	We suggest the detailed content of the contingency list could be defined more clearly.	Each TSO shall differentiate between Ordinary, Exceptional and Out-of-Range Contingencies, taking into account their probability of occurrence. It is reasonably detailed. The list of contingencies to be analyzed will be included in the multi-party operational agreement.	

#	Country	Reference section in the document	Country Comment	Consultants Review and Recommendation	Country Acceptance
5.	PR of China	Security Analysis	We suggest that some more clear definition on security analysis could be proposed. For example, the reference value for low frequency oscillation damping ratio, the definition of voltage stability/instability and the margin between the calculation transmission limitation and the operational transmission capacity.	These parameters vary with the development of the power system. It is therefore difficult to specify these parameters and consider them in the Code. Nevertheless, these parameters shall be determined in coordination with RPCC and considered by the operators. Due to the influence of uncertainties such as the load and structure variation, and variable component parameters, great gaps may exist between the practical operation condition and the typical operation mode, and therefore big errors between the model parameters used for simulation and the actual data of the system are Inevitable (Refer to “Probabilistic Stability Analysis of Low Frequency Oscillation” - Xuan Gong, Feifei Dong, Chao Dong (PR of China) – Conclusion: “There are numerous factors that would trigger low frequency oscillation in the real power grid. Comprehensive risk assessment system should be established, and probability analysis needs to be performed with the different conditions between the grids”.	
6.	PR of China	2.8 (8) Dynamic stability management	We suggest the analysis should be updated every year, because the load increasing rate is very high in GMS countries.	Acceptable	

#	Country	Reference section in the document	Country Comment	Consultants Review and Recommendation	Country Acceptance
7.	PR of China	3.2 (1) Structural and forecast data exchange between TSOs	The demands of data exchange between TSOs are proposed. What is the original basis of these demands, basing on IEC standards or only ENTSO-E standards?	ENTSO-E requirement but widely accepted.	
8.	PR of China	3.2 (3) b) Structural and forecast data exchange between TSOs	How to verify the validity of the equivalent model of the transmission system?	By simulation on past situations.	
9.	PR of China	3.2 (4) Structural and forecast data exchange between TSOs	We suggest that in calculation related to HVDC system, electro-magnet transient calculation should be added to confirm the commutation process?	This section is dedicated to data exchange for analysis. What type of additional data do you need for electro-magnet transient calculation? It is specified: "Concerning HVDC lines and FACTS devices, the TSO shall provide the necessary data on: a) Dynamic models of the device and its associated regulation suitable for large disturbances". Isn't it enough?	
10.	PR of China	General	We suggest the same simulation and calculation tool/software is necessary in RPCC data environment.	Fully agreed, necessary.	
11.	Thailand	2/2.1/(1)/(d)/i. System States	Loss of ~~more than 50% of~~ load in the TSO Responsibility Area.	Emergency State can be declared in case of 50% partial loss of load in the TSO Responsibility Area (definition of Black-out State). WGPG to decide.	
12.	Thailand	2/2.1/(2) System States	In order to determine the System State, each TSO shall at least every ~~30~~15 minutes perform Contingency Analysis in real-time.	May be difficult to realize! WGPG to decide. The periodicity depends on the frequency of market re-declarations (less than 30 minutes will be difficult in the GMS)!	
13.	Thailand	2/2.1/(3) System States	Please add PMU data.	Done.	

#	Country	Reference section in the document	Country Comment	Consultants Review and Recommendation	Country Acceptance
14.	Vietnam	General	The definition (N-2) criterion and Provisions for interconnection with (N-2) criterion transmission system should be clarified and added.	Done.	
15.	Vietnam	2.2 Frequency control management	Add clear boundary of LFC Area (Load – Frequency Control area): By country's boundary or another criteria.	The definition of LFC Area is given in the Glossary of Terms: Load-Frequency Control Area (LFC Area) is a part of a Synchronous Area or an entire Synchronous Area, physically demarcated by points of measurement of Interconnectors to other LFC Areas, operated by one or more TSOs fulfilling the obligations of a LFC Area. In general, LFC Area corresponds to a TSO responsibility area, but in some countries you can have several TSOs…	
16.	Vietnam	2.7 (1) Protection	Each TSO shall install the necessary protection and backup protection equipment within its Transmission System in order to efficiently and effectively protect Transmission System elements and to coordinate with the protection of the equipment of Significant Grid Users, from effects of Faults in the Transmission System. Add: At the connection point, the related TSOs must cooperate to define the protection schemes for connecting elements.	Done.	
17.	Vietnam	2.7 Protection	Every year, at the connection point, related TSOs will provide the total impedance of each side. TSOs must cooperate with each other to define the exchanged information from WAMs system of each TSO.	Done.	

#	Country	Reference section in the document	Country Comment	Consultants Review and Recommendation	Country Acceptance
18.	Vietnam	2.8 2.8 Dynamic stability management	Each TSO shall monitor the dynamic state of the Transmission System in terms of Voltage, Frequency and Rotor Angle Stability by off-line studies, wide area measurements, or other approaches according to paragraph (5) of Section 2.8 of this Network Code [OPS] including the exchange of relevant data with other TSOs if necessary, in order to be able to take the necessary Remedial Actions when the Transmission System Operational Security is at a risk. Please specify the level of data (equivalent network, completed network…?) to be exchanged.	All necessary data to ensure DSA of high quality. The nature of data exchanged will be analysed jointly by the concerned TSOs and a list of data could be included as well as the list of contingencies to be considered in the multi-party operational agreement.	
19.	Vietnam	4.2.2.a Responsibility of the TSOs and DSOs	Clarify more detail: number of tripped elements of transmission system per year.	Each TSO shall contribute to the annual reporting. Therefore, each TSO shall submit number of incidents, causes, tripped elements, etc…	