ENTSO-E Draft Network Code on Operational Security

14. December 2012

Notice
This document reflects the status of the work of Transmission System Operator experts as of 14. December 2012 in line with the ACER Framework Guidelines on Electricity System Operation published on 2. December 2011. It reflects the comments received by ENTSO-E during the public consultation held between 3. September 2012 and 3. November 2012. Furthermore, it is based on the input received through extensive informal dialogue with stakeholders, as well as bilateral/trilateral meetings with ACER and with the European Commission. **The document does not in any case represent a firm, binding or definitive ENTSO-E position on the content, the structure of the prerogatives of the Network Code on Operational Security.** **Such version of the draft Network Code is released for consultation in view of the stakeholders' workshop organised by ENTSO-E on the 20 December 2012.**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC,

Having regard to Regulation (EC) 714/2009 of the European parliament and of the Council of 13 July 2009 and in particular Article 6,

Having regard to the priority list issued by the European Commission on 19 July 2012,

Having regard to the Framework Guidelines on Electricity System Operation issued by ACER on 2 December 2011,

Having regard to the letter from European Commission of 24. February 2012 by which the ENTSO-E was mandated to develop this Network Code,

Whereas:

(1) Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC and Regulation (EC) N° 714/2009 of the European parliament and of the Council of 13 July 2009 underline the need for an increased cooperation and coordination among Transmission System Operators within a European Network of Transmission System Operators for Electricity (ENTSO-E) to create Network Codes for providing and managing effective and transparent access to the transmission systems across borders, and to ensure coordinated and sufficiently forward-looking planning and sound technical evolution of the transmission system in the European Union, including the creation of interconnection capacities, with due regard to the environment.

(2) Directive 2009/72/EC stresses that a secure supply of electricity is of vital importance for the development of European society, the implementation of a sustainable climate change policy, and the fostering of competitiveness within the internal market.

(3) Transmission System Operators (TSOs) are according to Article 2 and Article 12 of Directive 2009/72/EC responsible for operating, ensuring the maintenance of and, if necessary developing the extra-high and high voltage interconnected system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity. TSOs are also responsible for the Operational Security of their Responsibility Areas and together in the whole Synchronous Areas and the European Union, with a high level of reliability and quality.

(4) Secure transmission system operation can be made possible only if there is an obligation for the TSOs, Distribution System Operators (DSOs), Power Generating Facility Operators and Demand Facilities to cooperate and to meet the relevant minimum technical requirements for the operation of the interconnected transmission systems as one entity.

(5) ENTSO-E has drafted this Network Code for Operational Security aiming at setting out clear and objective requirements for TSOs, DSOs, Power Generating Facility and Demand Facilities in order to contribute to non-discrimination, effective competition and the efficient functioning of the internal electricity market and to ensure system security.

(6) This Network Code has been drafted in accordance with the Article 8(7) of Regulation (EC) No 714/2009 according to which the Network Codes shall be developed for cross-border network issues and market integration issues and shall be without prejudice to the Member States' right to establish national Network Codes which do not affect cross-border trade.

(7) To ensure the Operational Security of the interconnected transmission systems and to provide a common Security Level it is essential that a common set of minimum requirements for European Union-wide Operational Security principles is defined as a basis for both the cross-border cooperation between the TSOs and for utilising where relevant characteristics of the connected generation, consumption and distribution systems.

(8) The distinction between the different types of Power Generating Facility Operators as defined in the Article 3 of the Network Code on Requirements for Grid Connection Applicable to All Generators should be used in this Network Code to address Power Generating Facility Operators in a systematic and consistent manner.

(9) Transmission System Operators should respect the common principles when operating the interconnected transmission systems in order to maintain the Operational Security, quality and stability of the interconnected transmission system and to support the efficient functioning of the European Internal Electricity Market. These principles are the basis for the key elements, structure and provisions of this Network Code.

(10) Measuring and monitoring operational parameters in order to estimate the System State is the first step required for activities and applications to maintain Operational Security. State Estimation throughout the EU in a common and coherent way supports communication between Transmission System Operators and where necessary with Distribution System Operators and system users.

(11) Each Transmission System Operator should operate the frequency control management in its transmission system, in order to actively contribute to maintaining the global balance between generation and demand of all transmission systems interconnected within a Synchronous Area.

(12) Transmission System Operators should apply voltage control and reactive power management, in order to keep voltages within the Operational Security Limits and to minimize reactive power flows.

(13) Transmission System Operators should deploy short-circuit management in order to calculate the short-circuit currents within their Responsibility Areas and thus to ensure adequate treatment of short-circuit Faults.

(14) The goal of the power flows management is twofold: the effective and efficient functioning of the Internal Electricity Market and the maintaining of the Operational Security. These objectives should be attained by an adequate coordination between TSOs in order to get an overview of the power-flows all over the transmission system, to detect the potential constraints, and to set up the Remedial Actions when necessary.

(15) To identify contingencies which would endanger the Operational Security and lead to unplanned outages, the Transmission System Operators should rely on Contingency analysis and handling. The Contingency analysis should be performed during the operational planning and in real-time operation. The results of the Contingency analysis will allow identifying and deploying necessary pre-fault or post-fault Remedial Actions.

(16) Transmission system protection, coordinated with Dynamic Stability Management and short-circuit management, should establish the protection concepts and devices required to manage Faults and disturbances in the operation of the transmission system.

(17) The correct functioning of the transmission system elements, processes and facilities of the system users which are connected to the transmission system should be continuously monitored, tested if required and investigated following disturbances in a coordinated and coherent way throughout Europe. These monitoring, investigating and testing activities should take place before, during and after any changes affecting the Operational Security of the transmission system.

(18) The Operational Security of the transmission system and all the activities which contribute to it require an accurate, timely and adequate exchange of data and information. Data exchange should therefore not encounter any barrier between the different actors involved in ensuring the Operational Security.

(19) Finally, the relevant education, on-the-job training and certification should be obligatory for the employees of the Transmission System Operators who are in charge of the operation of the transmission system and of its Operational Security. All European Transmission System Operators should adopt a coordinated and coherent approach towards training and certification.

HAS ADOPTED THIS NETWORK CODE:

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CHAPTER 1

GENERAL PROVISIONS

Article 1
SUBJECT MATTER AND SCOPE

1. This Network Code defines the minimum Operational Security requirements and principles for transmission systems applicable to all TSOs, DSOs and Significant Grid Users. It is the first Network Code in the field of System Operation, and serves as the 'umbrella' code for all the System Operation Network Codes. It sets the overall principles for System Operation and reflects on the common issues for the Network Codes for Load-Frequency Control and Reserves [LFCR NC], and for Operational Planning and Scheduling [OPS NC].

2. This Network Code aims at:
   a) determining common Operational Security requirements and principles;
   b) ensuring conditions for maintaining Operational Security throughout the EU;
   c) providing for coordination of system operation;

3. The following shall be considered Significant Grid Users within the scope of this Network Code, while respecting the provisions of Article 24(2) and Article 27(2):
   a) New Power Generating Modules type A, B , C and D according to [NC RfG];
   b) Existing Power Generating Modules whose Connection Point or Maximum Capacity is at or above the Thresholds defined in Article 6(3) of [NC RfG]. For the purpose of this Network Code, Existing Power Generating Modules shall be also classified as type A, B, C and D following the same criteria defined in Article 6(3) of [NC RfG] for New Power Generating Modules;
   c) Existing and New Demand Facilities with the Connection Point to the transmission system;
   d) Existing and New Demand Facilities providing Demand Side Response whose Maximum Capacity is equal or above 1 MW.

   While respecting the provisions of Article 3(3), each TSO may define different thresholds of significance for system users depending on the characteristics of the power system.

4. In the Micro Isolated Systems and the Small Isolated Systems and in the Isolated Systems which do not present any cross-border network issues or market integration issues, the provisions of this Network Code shall not apply. DSOs shall nevertheless take fully into account the provisions of this Network Code when adopting their own network codes on Operational Security.

5. TSOs and DSOs shall always respect relevant provisions for human safety and nuclear safety.

Article 2
DEFINITIONS

1. For the purpose of this Network Code, the definitions contained in Article 2 of Directive 2009/72/EC and in Article 2 of Regulation (EC) N°714/2009 apply. The definitions contained in the Article [2] of the [NC RfG], [NC CACM], [NC DCC] shall also apply, to the exception of the definition of "Connection Point" and "Operational Security" which shall be replaced by the following:

   Connection Point means the interface at which the Demand Facility or Power Generating Module is connected to a transmission or distribution network, or at which the distribution network is connected to a transmission 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 reference value and stability limits;

2. 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 exceeding 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 operational 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 cope with;

   Area Control Error (ACE) means the sum of the instantaneous difference between the actual and the set-point value 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 system at the generation node, at the end nodes of the AC lines, High-Voltage DC lines or including actions on automatic voltage and reactive power control of transformers, or other means that contribute to voltage control, 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;

   Business Continuity Plan means the plan detailing TSO's responses to a loss of critical tools and facilities;

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;

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, but also the distribution networks of DSOs if relevant for the transmission network security. Internal Contingency is a Contingency within the TSO's Responsibility Area. External Contingency is a Contingency within the Responsibility Area of neighbouring TSO having effects in the Responsibility Area of the TSO;

Critical Fault Clearing Time means the maximum Fault duration for which the electric power system remains transiently stable;

Declared Availability means declaration and notice prepared in respect of a Significant Grid User Plant, 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 power system to divert from Normal State;

Dynamic Stability Assessment (DSA) means the security assessment in terms of Rotor Angle Stability, Frequency Stability and Voltage Stability;

Emergency State means the situation where Operational Security Limits are not kept at least one of the operational parameters is outside of the respective limits;

Exceptional Contingency means the unusual – as opposed to Ordinary Contingency – loss of one or more elements such as, but not limited to, a double line - two circuits on the same tower over a long distance, where the consideration of distance is left to the determination of the TSO, a single busbar, a common mode Fault with the loss of more than one Power Generating Facility, a common mode Fault with the loss of more than one DC line;

Fault means the event occurring on the primary equipment in the power system that could affect the transmission system such as all kinds 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 Restoration Control Error means the control error for the Frequency Restoration Process which is equal to the Area Control Error of a Load Frequency Control Area or is based on the Frequency Deviation where the area geographically corresponds to the Synchronous Area;

Frequency Restoration Process (FRP) means a process that aims at restoring frequency to the Nominal Frequency and, where applicable, power balance to the scheduled value;

Frequency Stability means the ability of the power system to maintain stable acceptable frequency in N-Situation and after being subjected to a disturbance.

Isolated System means a system which is designed to operate as a stand-alone system for a definite or indefinite time. It includes systems that bear DC or a single AC interconnection to other synchronous areas.

Load Frequency Control Area (LFC Area) means a part of the Synchronous Area physically demarcated by points of measurement of Tie-Lines to other LFC Areas fulfilling the Area Process Obligations of a LFC Area;

Load Frequency Control Block (LFC Block) means a part of the Synchronous Area physically demarcated by points of measurement of Tie-Lines to other LFC Blocks;

Nominal Frequency means the rated value of the System Frequency in a power system;

Normal State means the operational 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 Remedial Actions available;

N-Situation means the situation where no element of the transmission system is unavailable due to a Fault;

Observability Area means the area of the relevant parts of the transmission systems, distribution networks and neighbouring TSOs transmission system, on which TSO shall implement a real-time monitoring and modelling to ensure reliability of the respective Responsibility Area;

Operational Security Limits means the acceptable operating boundaries: thermal, voltage, short-circuit current, frequency and stability limits;

Operational Security Performance Indicators are used for monitoring of the Operational Security; these criteria are based on the definition of Faults, incidents, disturbances and other terms, which influence Operational Security; as specified in the ENTSO-E incidents classification scale according to the Article 8(3)(a) of the Regulation (EC) N°714/2009;

Operational Security Ranking is used for monitoring of the Operational Security on the basis of the Operational Security Performance Indicators, according to the ENTSO-E incidents classification scale according to the Article 8(3)(a) of the Regulation (EC) N°714/2009;

Ordinary Contingency means the loss of a transmission system element such as, but not limited to, a single line, a single Power Generating Facility, a single Demand Facility, a single transformer, a single phase-shifting transformer, a voltage compensation installation of 50 MVAr or more or a DC link;

Out-of-Range Contingency means the very unusual simultaneous loss of several transmission system elements such as, but not limited to two independent lines, a substation of more than one busbar, a tower with more than two circuits or a power swinging or oscillation event leading to the loss of more than one large Power Generating Facility;

Power Generating Facility Operator means the natural or legal person who is the operator of a Power Generating Facility;

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;

Ramping Rate means the rate of change of active power by a Power Generating Module, Demand Facility or DC interconnection;

Reactive Power Reserve means the reactive power which is available for maintaining voltage;

Regional Security Coordination Initiative (RSCI) means regional unified scheme set up by TSOs in order to coordinate Operational Security analysis on a determined geographic area;

Responsibility Area means a coherent part of the interconnected system, including interconnections, operated by a single TSO with physical loads and/or generation units connected within the area, if any;

Restoration means the state where the objective is to re-establish the system 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 means the existing system users and new system users which are deemed by the TSO in accordance with Article 3(3) as being significant on the basis of their impact on the internal or cross border system performances via influence on the Responsibility Area's 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 which might contain faulty and inaccurate values or where some measurement values are missing;

Synchronous Area means an area covered by interconnected TSOs with a common system frequency in a steady operational state. The following Synchronous Areas are covered in this NC: Continental Europe (CE), Cyprus (CY), Great Britain (GB), Iceland (ICE), Ireland (IRE) and Northern Europe (NE);

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 network areas of the synchronous system under the assumption of a coherent value for the system in the time frame of seconds (with minor differences between different measurement locations only);

System Operator Employee means the person in charge of operational control of the transmission system in real-time;

System Protection Schemes (SyPS) means the set of coordinated and automatic measures designed to ensure fast reaction to disturbances and to avoid their propagation in the transmission system. SyPS can include event or measure based and may use telecommunication infrastructure to transmit the activation measures;

System State means the operational state of the transmission system in relation to the Operational Security Limits, namely: Normal, Alert, Emergency, Blackout and Restoration;

Tie Line means a transmission line that connects different areas excluding HVDC interconnectors;

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 elements or secondary equipment as long as the defined duration and thresholds are respected;

Voltage Stability means the ability of a transmission system to maintain acceptable voltages at all buses in the power 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.

Article 3
REGULATORY ASPECTS

1. The requirements established in this Network Code and their applications are based on the principle of non-discrimination and transparency as well as the principle of optimisation 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. NRA shall be involved after the requirements of EU and national legislation. TSO and where required in cooperation with DSO shall establish the terms and conditions or actions necessary to ensure Operational Security in accordance with the principles of transparency, proportionality and non-discrimination. The establishment of these terms and conditions or actions necessary to ensure Operational Security shall be performed in compliance with and respecting the TSO's responsibility to ensure system security according to national legislation. NRA shall be informed about established terms and conditions and executed actions.

4. The OS NC relies on the capabilities required in the [NC RfG] and [NC DCC]. The Power Generating Facilities, Demand Facilities and HVDC links that are not a subject of the provisions in [NC RfG] and [NC DCC] shall continue to be bound by those technical requirements that apply to them pursuant to legislation in force in the respective Member States or contractual arrangements in force.

5. For nuclear power plants, nuclear safety has priority in the case of the conflict between applicable nuclear safety regulations and this Network Code.

Article 4
RECOVERY OF COSTS

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

2. Costs assessed as reasonable, proportionate shall be recovered in a timely manner via network tariffs or appropriate mechanisms as determined by National Regulatory Authorities.

3. If requested by National Regulatory Authorities, regulated Transmission System 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.

4. While respecting the provisions of Article 3(3), TSOs and / or DSOs in cooperation with their National Regulatory Authorities shall develop the methodology for recovering the costs of tests of compliance with this Network Code. Reasonable costs directly associated with the performing of tests, other than compliance tests, will be paid by the test requestor.

Article 5
CONFIDENTIALITY OBLIGATIONS

1. Each TSO, DSO, Power Generating Facility Operator or Demand Facility Operator 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 in compliance with this 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, sufficient information to ensure the secure and efficient operation, coordinated development and interoperability of the interconnected system.

3. In accordance with Article 14.8, each TSO may have to provide confidential information to Regional Security Coordination Initiatives. The regional security coordination initiatives which are taking the form of a legal entity 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, in compliance with this Network Code.

CHAPTER 2
OPERATIONAL SECURITY REQUIREMENTS

Article 6
SYSTEM STATES

1. Each TSO shall differentiate five System States by applying the following criteria:

   a) Normal State:
      i. frequency, voltage, active and reactive power flows are within the Operational Security Limits defined in Articles 7, 8 and 10 in accordance with Articles 6(5) and 6(6);
      ii. active and reactive power reserves are sufficient to withstand Contingencies from the Contingency List; and
      iii. operation is and will remain within Operational Security Limits even after a Contingency from the Contingency List defined in Article 11 and after effects of Remedial Actions.

   b) Alert State:
      i. frequency, voltage, active and reactive power flows are within their Operational Security Limits defined in Articles 7, 8 and 10 in accordance with Articles 6(5) and 6(6),; and
      ii. At least one of the following conditions is fulfilled:
         a. reserve requirements are not fulfilled with lack of more than 20% of the required amount of reserves, defined in the [NC LFC&R] for more than 30 minutes and with no means to replace them; and
         b. at least one Contingency from the Contingency List defined in Article 11 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 in Articles 7(1), 8(2) and 10(2) in accordance with Articles 6(5) and 6(6); and
      ii. at least one measure of the System Defence Plan is activated.

      When Operational Security is endangered because of a major IT problem, the TSO also has to declare an Emergency State.

   d) Blackout State:
      i. loss of more than 50% of load at the time of the incident or total absence of voltage for at least 3 minutes in the system and triggering restoration plans.

   e) Restoration:
      i. frequency, voltage and other operational parameters are brought within the Operational Security Limits defined in Articles 7, 8 and 10 in accordance with Articles 6(5) and 6(6); 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 Power Generating Facility resources.

2. In order to determine the System State, each TSO shall continuously monitor the relevant parameters against a common set of criteria as defined in Article 6(1) while taking into account the effect of potential Remedial Actions or measures of the System Defence Plan.

3. Each TSO shall monitor in real-time the following parameters on its transmission system, taking into account the structural and real-time data required in Chapter 4:
   a) active and reactive power flows;
   b) busbar voltages;
   c) frequency;
   d) active and reactive power reserves; and
   e) actual generation and consumption.

4. Each TSO shall use its best endeavour to operate its transmission system in a Normal State.

5. For each element of its transmission system, each TSO shall define the Operational Security Limits for:
   a) voltage ranges in accordance with Article 8;
   b) short-circuit current ranges in accordance with Article 9; and
   c) current limits in terms of thermal rating .

   When defining these Operational Security Limits, each TSO shall take into account the capabilities required for system users in [NC RfG] and [NC DCC] and national grid codes, in order that voltage and frequency ranges in Normal and Alert States do not lead to their disconnection.

   For each interconnection, each TSO shall coordinate with the interconnected TSO to define the Operational Security Limits.

6. If its transmission system is in Alert State, a TSO shall:
   a) adopt and implement the Remedial Actions which are rendered necessary to restore the Normal State;
   b) adopt and implement the Remedial Actions which are rendered necessary to prevent the propagation of this System State outside of its transmission system; and
   c) prepare with the relevant TSOs, DSOs and Significant Grid Users the coordination needed in case of occurrence of a Contingency which can degrade the state of the system.

7. If its transmission system is in Emergency State, a TSO shall:
   a) adopt and implement the measures of the System Defence Plan which are rendered necessary to restore the Alert or Normal State ;
   b) adopt and implement the measure of the System Defence Plan which are rendered necessary to prevent the propagation of Emergency State outside of its transmission system; and
   c) inform the directly interconnected TSOs, DSOs directly connected to the transmission system and Significant Grid Users involved in the system defence and restoration.

8. If its transmission system is not in a Normal State and that System State is qualified as "Wide Area" in accordance with Article 2, a TSO shall:
   a) inform all TSOs about the System State of its transmission system via a common awareness system;
   b) provide additional information on the elements of its transmission system which are part of the Observability Area of the affected TSOs; and
   c) coordinate the joint Remedial Actions which are taken by the affected TSOs.

9. When preparing and implementing a Remedial Action which has an effect on other TSOs, a TSO shall cooperate with the affected TSOs to assess the impact of its Remedial Action within and outside its Responsibility Area and coordinate with affected TSOs to select the action which is in accordance with the principle of optimisation between the highest overall efficiency and lowest total cost for all involved parties. Each affected TSO shall provide all the information necessary for this cooperation.

10. When preparing a Remedial Action or a measure of the System Defence Plan, a TSO shall in case of mutual implications, cooperate with the Significant Grid Users and DSOs directly connected to the transmission system. When a Remedial Action has significant consequences on the directly connected distribution network, each TSO shall ex-ante cooperate with the affected DSOs to assess the impact of the Remedial Action on the distribution network, and coordinate with affected DSOs to select the action which enhances system security for all involved parties. Each affected DSO shall ex-ante provide all the information necessary for this cooperation.

11. When implementing a Remedial Action or a measure of the System Defence Plan, each Significant Grid User or DSO directly connected to the Transmission System shall execute the instructions given by the TSO to support maintaining Operational Security of the transmission system, without undue delay. Unless decided otherwise by the TSO and while respecting provisions of Article 3(3), DSOs shall communicate the instructions of the TSO to the Significant Grid Users if the latter is connected to the distribution network.

12. Each TSO shall prepare Remedial Actions to maintain voltages in the ranges according to Tables 8.1 and 8.2. in Article 8 of this Network Code. The effectiveness of Remedial

Actions shall be evaluated by the TSO and where there are directly connected DSOs in coordination with those DSOs.

13. Each TSO shall adopt and implement Remedial Actions to cope with the potential or identified deviation from the power flow Operational Security Limits in N-Situation and be prepared to set-up the necessary Remedial Actions for coping with (N-1)-Situation
14. If after a Contingency when the steady-state operation is re-established, 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 neighbouring TSOs or enhanced probability of further Faults, the TSO shall initiate Remedial Actions as soon as possible.

15. Each TSO shall 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 between control centres of TSOs;
    d) tools for Operational Security analysis.

    Moreover, where the above tools and facilities involve the DSOs directly connected to the transmission system or Significant Grid Users involved in balancing, ancillary services, transmission system defence, Restoration and delivery of real-time operational data, the TSO and involved DSOs and Significant Grid Users shall, in accordance with Article 3(3) cooperate and coordinate in ensuring their availability, reliability and redundancy.

16. While respecting the provisions of Article 3(3), each TSO shall adopt a Business Continuity Plan which shall be reviewed at least annually and updated as required or following any significant change of critical tools and facilities or relevant system operation conditions. Parts of the Business Continuity Plan shall be shared with DSOs and Significant Grid Users to the extent to which they are affected.

17. While respecting the provisions of Article 3(3), 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 European interconnected transmission systems. These reviews can lead to set up intruder detection, access control, procedures, training, alert processes, preventive procedures, restoration plans and other counter-measures as deemed appropriate by the TSO.

18. Each TSO shall perform Operational Security analysis based on the forecast and real-time system operation parameters, in line with Chapter 3 of [NC OP&S].

19. For Operational Security analysis in operational planning:
    a) each TSO shall use information on network, load and generation based upon a Common Grid Model as described in [NC OP&S]; and
    b) each TSO shall apply the coordination methodology described the [NC OP&S].

20. Each TSO shall perform Operational Security analysis in real-time, based on real-time measurements of voltages, currents, power flows, injections and withdrawals in its own Observability Area, of:
    a) transmission system and distribution networks elements;
    b) Power Generating Facilities and Demand Facilities connected to transmission system and the observable part of distribution network;
    c) aggregated values of Power Generating Facilities and Demand Facilities connected to the non-observable distribution network.

Article 7
FREQUENCY CONTROL MANAGEMENT

1. In accordance with Article 6(4) and Article 6(6), each TSO shall contribute to the Load-Frequency Control Structure according to the requirements in [NC LFC&R]. While doing so, all TSO shall comply with the frequency quality parameters as specified in the Table 7.1.

	Baltic	**Continen-tal Europe**	**Great Britain**	**Ireland**	**Nordic**
Nominal frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Standard Frequency Range	±50 mHz	±50 mHz	±200 mHz	±200 mHz	±100 mHz
Maximum Instantaneous Frequency Deviation	800 mHz	800 mHz	800 mHz	1000 mHz	1000 mHz
Maximum Steady-state Frequency Deviation	200 mHz	200 mHz	500 mHz	500 mHz	500 mHz

Time To Restore Frequency	15 min	15 min	60 s	60 s	15 min
Range Within Time To Restore Frequency	±0 mHz	±0 mHz	±500 mHz	±500 mHz	±0 mHz

Table 7.1: Frequency ranges to be complied with by all TSOs

2. In case the frequency is beyond the Maximum Steady-state Frequency Deviation but within the range 49 – 51 Hz, each TSO shall increase or decrease active power generation based on coordinated procedures defined for each Synchronous Area, in order to restore frequency back into the range of maximum steady-state frequency deviation.

3. In case the frequency is outside of the range 49 – 51 Hz, each TSO shall use its best endeavour applying system defence measures based on coordinated procedures defined for each Synchronous Area, in order to restore frequency within the time ranges specified in Article 8 of [NC RfG] and Article 13 of [NC DCC].

4. Power Generating Modules subject to the requirements of the [NC RfG] shall remain connected at least within the frequency and time ranges defined in the Article 8 of [NC RfG] when generating electrical power. All other existing Power Generating Modules of Type A, B, C and D shall inform their TSOs and DSOs if connected to the distribution network, about their compliance with the frequency requirements in [NC RfG] and in case they are not compliant they shall declare the frequencies and time ranges they can withstand without disconnection while respecting Article 3(3).

   In Emergency State, frequencies can exceed the range of 49 – 51 Hz described in Article 7(1) and 7(2). TSOs shall be aware that system users who are affected by [NC RfG] and [NC DCC] can disconnect after the time periods required in Article 8 of [NC RfG] or Article 13 of [NC DCC] and take this into account in their Operational Security Analysis.

   For system users for which the [NC RfG] does not apply, the TSOs shall take into account in their Operational Security Analysis the frequency values at which each of these system users may disconnect.

5. All TSOs at the level of Synchronous Area, shall implement the provisions from the Article 7(1) - 7(4) in a harmonized way.

6. Each Significant Grid User connected to the transmission system shall, while complying with Article 3(3), agree with the TSO the criteria and conditions for manual or automatic re-synchronization. In case of manual re-synchronization, each Significant Grid User connected to the transmission system shall obtain the permission from its TSO to re-synchronise. The TSO shall inform the Significant Grid User before re-

energization of a transmission system element which the Significant Grid User is connected to.

7. Each DSO directly connected to the transmission system shall, while complying with Article 3(3), agree with the TSO the criteria and conditions for manual or automatic re-synchronization of the Significant Grid Users connected to its distribution network. Each DSO shall in turn ensure that those criteria and conditions are agreed upon with the Significant Grid Users Connected to its distribution network. In case of manual re-synchronization, each Significant Grid User shall obtain the permission to re-synchronize from its DSO and from its TSO via its DSO prior to its re-synchronization. The DSO shall inform the Significant Grid User before its re-energization.

8. Notwithstanding the provisions of Article 7, a DSO directly connected to the transmission system, Power Generating Facility or Demand Facility shall automatically disconnect at specified frequencies if required by the TSO or DSO, while respecting the provisions of Article 3(3).

9. Each TSO making use of the provisions from Article 7(6), 7(7) or 7(8) shall, while respecting the provisions of Article 3(3), coordinate with all other affected TSOs a common decision process, 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 unbalances of demand and supply within its LFC Area. Each TSO shall control the Frequency Restoration Control Error or an equivalent parameter at the set-point as defined in the [NC LFC&R] in order to reach the required frequency quality within the Synchronous Area in cooperation with the TSOs in the same Synchronous Area. Each TSO shall coordinate with the other TSOs of its Synchronous Area to establish the methodology used within this Synchronous Area to determine the sufficient upward and downward active power reserve in accordance with the provisions of the [NC LFC&R].

11. Each TSO shall monitor in real-time the frequency and the Frequency Restoration Control Error or an equivalent parameter.

12. Each TSO shall monitor generation and exchange schedules, power flows, node injections and withdrawals and other parameters relevant for detecting in advance a risk of a frequency deviation and when needed take joint measures to limit their effects on the transmission system balance in co-ordination with other TSOs of its Synchronous Area.

13. Each TSO shall activate, or set up conditions necessary to ensure the activation of active power reserves at different time-frames according to the provisions of the [NC LFC&R], in order to maintain:

    a) the balance of its LFC Area;

b) its Frequency Restoration Control Error, or an equivalent parameter at the set-point value;

c) the frequency within the range defined for its Synchronous Area.

14. Before proceeding to an exchange or sharing of reserves, the reserves connecting TSO and the reserves receiving TSO, together with transiting TSOs, shall carry out a common Operational Security analysis and adopt the necessary measures to ensure that the resulting cross-border flows do not endanger the Operational Security Limits during the exchange of reserves or activation of shared reserve.

15. While respecting the provisions of Article 3(3) and [NC LFC&R], each TSO shall define the restrictions on for the active power Ramping Rates of the Significant Grid Users for all kinds of operating conditions and applications

Article 8
VOLTAGE CONTROL AND REACTIVE POWER MANAGEMENT

1. In accordance with Article 6(4), each TSO shall use its best endeavour to maintain the transmission system steady state voltage at the Connection Point within the ranges specified in the Tables 8.1 and 8.2:

Synchronous Area	Voltage range	Time duration
Continental Europe	0.90 pu – 1.118 pu	Unlimited
Nordic	0.90 pu – 1.05 pu	Unlimited
Great Britain	0.90 pu – 1.10 pu	Unlimited
Ireland	0.90 pu – 1.118 pu	Unlimited
Baltic	0.90 pu – 1.12 pu	Unlimited

Table 8.1: Voltages ranges for reference voltages defined by TSOs according to provisions of Article 3(3), between 110 kV to 300 kV (excluding)

Synchronous Area	Voltage range	Time duration
Continental Europe	0.90 pu – 1.05 pu	unlimited
Nordic	0.90 pu – 1.05 pu	unlimited
Great Britain	0.90 pu – 1.05 pu	unlimited
Ireland	0.90 pu – 1.05 pu	unlimited
Baltic	0.90 pu – 1.10 pu	unlimited

Table 8.2: Voltages ranges for reference voltages defined by TSOs according to provisions of Article 3(3), between 300 kV and 400 kV

In the Responsibility Area of those TSO that decide in accordance with [NC RfG] that Power Generating Modules connected to nominal voltages between 300 and 400 kV

shall stay connected for an unlimited time in the voltage range from 1,05 to 1,0875, this voltage range shall be added to the table 8.2.

2. Each TSO can define wider voltage ranges or limited times for operation while respecting the provisions of Article 3(3) if this deviation does not lead to voltage constraints and no other TSO, DSO or Significant Grid Users are affected thereby.

3. Power Generating Modules subject to the requirements of the [NC RfG] shall remain connected at least within the voltage and time ranges defined in the Article 11 of [NC RfG]. All other pre-existing Power Generating Modules connected to the transmission system shall inform their TSO about their compliance with the voltage requirements in [NC RfG] and in case they are not compliant they shall declare the voltages and time they can withstand without disconnection while respecting the provisions of Article 3(3).

4. If voltages at Connection Point are outside the ranges from Tables 8.1 and 8.2, each TSO shall apply voltage control and reactive power management measures, in order to restore voltages within the ranges from Tables 8.1 and 8.2 and within the time ranges specified in Article 11 of [NC RfG] and Article 14 of [NC DCC].

5. In Emergency State, voltages at Connection Points can exceed the ranges from Tables 8.1 and 8.2. TSOs shall be aware that Significant Grid Users connected to the transmission system and who are affected by [NC RfG] and [NC DCC] might disconnect after the time periods required in Article 11 of [NC RfG] or Article 14 of [NC DCC] and take this into account in their Operational Security Analysis.

6. For Significant Grid Users connected to the transmission system and for which the [NC RfG] does not apply, the TSOs shall take into account in their Operational Security Analysis the voltage values at which each of these Significant Grid Users may disconnect.

7. Each TSO shall use its best endeavour to implement the provisions from the Articles 8(1) – 8(5) in a coordinated way at the level of Synchronous Area, while respecting the provisions from the Article 8(1) of this NC, Article 11 of [NC RfG] and Article 14 of [NC DCC].

8. Each TSO shall monitor, control and use its best endeavour to maintain in real-time voltage levels and reactive power flows of its transmission system according to Articles 8(1) and 8(2) to protect equipment and maintain Voltage Stability of the transmission system.

   Each TSO shall ensure reactive power reserve, with adequate volume and time response, in order to secure the technical functioning of the transmission system and to keep a Normal State following a Contingency from the Contingency List.

9. Notwithstanding the provisions of the Article 8, a Demand Facility shall automatically or manually, disconnect at specified voltages in the specified timeframe if required by the TSO or DSO, according to the provisions of Article 3(3).

10. Each TSO making use of the provisions from Article 8(9) shall, while respecting the provisions of Article 3(3), coordinate with all other affected TSOs according to the common decision process and shall ensure the necessary coordination with involved DSOs.

11. In accordance with Article 6(5), directly connected TSOs with AC interconnection shall define the voltage and/or reactive power flow limits on the interconnections between their networks in a coordinated and coherent way, in order to use the reactive power resources in the most effective way and ensure adequate voltage control. In order to reach an agreement, the directly connected TSOs shall follow the common TSOs decision process.

12. Each TSO shall coordinate Operational Security analysis with all affected TSOs in order to ensure respecting of the Operational Security Limits of voltages in its Responsibility Area and within the Responsibility Areas of these affected TSOs.

13. Each TSO shall perform Operational Security analysis according to Article 8(10) based on the forecast and real-time operational parameters.

14. While respecting provisions of Article 3(3), each TSO shall define the reactive power set-points, power factor ranges or voltage set-poins for voltage control in accordance with Article 6(5) and [NC DCC], which shall be maintained by the Significant Grid Users or DSOs who's Connection Point is to the transmission system.

15. Each TSO shall be entitled to use all available reactive power resources within its Responsibility Area to ensure effective reactive power management and maintaining the voltage and reactive power Operational Security Limits defined in this Network Code.

16. 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 load-shedding measures, in order to maintain Operational Security Limits, to prevent out-of-limit voltage variations and to prevent voltage collapse of the transmission system.

17. While respecting the provisions of Article 3(3), each TSO shall coordinate and define the voltage control actions with the Significant Grid Users, DSOs directly connected to the transmission system and with neighbouring TSOs. TSOs and DSOs shall be entitled to direct their Significant Grid Users in a coordinated way to follow voltage control instructions if and where this is relevant for the voltage and reactive power management of the transmission system, providing that these instructions are in accordance with the Operational Security needs.

18. Each TSO shall maintain voltage ranges and each DSO directly connected to the transmission system shall maintain reactive power flows at Connection Points within the ranges specified in Article 16 of [NC DCC], unless an agreement is defined between the TSO and the DSO foreseeing the active voltage control by the DSO in accordance with Article 16(1)(c) of [NC DCC], or unless another value is defined in accordance with national legislation for existing Connection Points. If voltage deterioration jeopardizes Operational Security or threatens to develop into a voltage collapse either in N or (N-1)-Situation, the TSO may direct DSOs and Significant Grid Users to block automatic voltage/reactive power control of transformers and/or to follow other voltage control instructions. As a consequence of these measures directed by the TSO, the DSO may have to disconnect Demand Facilities in order to avoid jeopardising the transmission system.

Article 9
SHORT-CIRCUIT CURRENT MANAGEMENT

1. In accordance with Article 6(4), Article 6(5) and Article 3(3), each TSO shall define the maximum short-circuit current which does not exceed the capability of circuit breakers and other equipment and the minimum short circuit current for correct operation of protection equipment at any time.

2. In accordance with Article 6(4) and while respecting provisions of Article 30(9), each TSO shall maintain the short-circuit current within maximum and minimum limits defined in Article 9(1), for the contingencies of the Contingency List, at any time and for all protection equipment. A deviation from these conditions is allowed only during switching sequences.

3. Each TSO shall perform the short-circuit current and power calculation according to the best available data and its own practice approaches, according to IEC 60909 or a comparable standard.

4. When assessing the compliance with the limits according to Article 9(1), 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 and Distribution Networks.

5. Each TSO shall perform short-circuit calculations in order to evaluate the impact of neighbouring transmission systems and connected Distribution Networks on the short-circuit current level. If the impact of a connected Distribution Network is significant, the Distribution Network has to be modelled in the transmission short-circuit calculations with the level of detail which is needed for successful calculations, using where applicable the equivalents with sufficient degree of detail and accuracy.

6. Each TSO shall apply operational measures to prevent or relieve a deviation from short-circuit limits in the transmission system according to Article 9(1).

Article 10
POWER FLOWS MANAGEMENT

1. While respecting the provisions of Article 3(3) each TSO shall define Operational Security Limits for power flows on each transmission system element within its own Responsibility Area in accordance with Article 6(5). While respecting the provisions of Article 3(3), directly connected TSOs shall define together the Operational Security Limits for power flows on their interconnections in a coordinated and coherent way, throughout the Synchronous Area and between the Synchronous Areas where the connected TSOs are located in different Synchronous Areas.

2. Each TSO shall maintain the active power flows within Operational Security Limits in accordance with Article 6(5) in Normal State and after the occurrence of a Contingency from the Contingency List defined in Article 11(4).

3. Each TSO shall coordinate Operational Security analysis with all affected TSOs, in order to ensure the respecting of the Operational Security Limits of power flows in its Responsibility Area. Each TSO shall perform Operational Security analysis based on the forecast and real-time operational parameters.

4. In accordance with Article 10(8) and 10(9), each TSO shall be entitled to redispatching available Significant Grid Users connected to the transmission system or to the distribution networks.

5. While respecting the provisions of Article 3(3), each TSO shall, when there is an impact on cross-border flows, define Redispatch measures in coordination with other affected TSOs in order to find the most efficient solution to maintain Operational Security Level.

6. While respecting the provisions of Article 3(3), each TSO shall define Redispatching measures in coordination with DSOs before real-time to identify those Significant Grid Users connected to distribution networks which may be re-dispatched. Each TSO shall inform the affected DSO of Redispatching measures affecting Power Generating or Demand Facilities connected to its distribution networks.

7. Unless market based pricing for Redispatching exists, affected Significant Grid Users shall, while respecting the provisions of Article 3(3), ex-ante provide Redispatch costs. This information shall be treated as confidential and be shared only between the TSOs and relevant NRAs.

8. Each TSO shall monitor power flows within its Responsibility Area based on the real-time telemetry and measurements from its Observability Area.

9. In the (N-1)-Situation each TSO shall keep power flows within the Transitory Admissible Overloads and prepare Remedial Actions to be applied within the time allowed for Transitory Admissible Overloads.

Article 11
CONTINGENCY ANALYSIS AND HANDLING

1. While respecting the provisions of Article 3(3) each TSO shall define the Contingency List within its Observability Area, for which it shall be regularly checked whether it endangers the Operational Security of its Responsibility Area. The Contingency List shall at least include Ordinary Contingencies and may include Exceptional Contingencies.

2. In order to identify the Contingencies which would endanger the Operational Security of the transmission system and to identify the appropriate Remedial Actions, each TSO shall perform a Contingency analysis to monitor impacts of Contingencies from its Contingency List on its Responsibility Area in real-time and during operational planning.

3. Each TSO shall perform Contingency analysis on the basis of the forecast and real-time system operation parameters. Each TSO shall ensure that potential deviations from the Operational Security Limits in its Responsibility Area which are identified by the Contingency analysis of Internal and External Contingencies 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 potential Disturbances are local and they do not impact Operational Security of the interconnected transmission systems.

4. Each TSO shall assess the risks associated with potential Disturbances and prepare the relevant 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 forecast or actual topology of the transmission system, including planned outages. In case of an (N-1)-Situation caused by an unplanned outage, each TSO shall use the prepared Remedial Actions in order to ensure that the Operational Security Limits are restored as soon as reasonably practicable and that this (N-1)-Situation becomes the new N-Situation.

5. Each TSO shall include Internal and relevant External Contingencies in the Contingency List. Each TSO shall further differentiate between Ordinary, Exceptional and Out-of-Range Contingencies, taking into account their probability of occurrence. In treatment of so classified Contingencies, each TSO shall rely on the following principles:
   a) each TSO shall classify Contingencies for its own Responsibility Area.
   b) Ordinary Contingencies shall include, but not be limited to, the loss of any single transmission circuit, transformer, phase-shifting transformer, Power Generation Facility, loss of Demand Facility or HVDC link and reactive power compensation facilities;
   c) when and as long as unusual conditions, such as severe weather 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 pre-fault or post-fault Remedial Actions necessary to maintain its transmission system within Operational Security Limits or to mitigate the impact of this Exceptional Contingency as far as reasonably practical;

d) when and as long as very unusual conditions, such as very severe weather conditions, significantly increases the probability of an Out-of-Range Contingency, the TSO shall use its best endeavour to prepare the conditions to mitigate the impact of these severe conditions;

e) each TSO shall determine the Ordinary and Exceptional Contingencies based on the current topology. Each TSO shall take all Internal and External Ordinary Contingencies into account in Contingency analysis in a Normal State;

f) in order to account for Exceptional Contingencies with high impact on its own or neighbouring transmission systems or with 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 case of significantly changed operational conditions.

g) each TSO shall contribute to the coordination and, as far as reasonably and practically possible and economically efficient also harmonization, of the above key principles for establishment of Contingency list across the Synchronous Areas.

6. Each TSO shall prepare Remedial Actions to cope with any Contingency from its Contingency List, for which potential deviation from Operational Security Limits is identified, in accordance with Article 6(7). Each TSO shall assess the effectiveness of Remedial Actions in advance.

7. Each TSO shall if necessary reassess the Contingencies from its Contingency List to be taken into account according to Article 11(5) in a Normal State and adjust the prepared Remedial Actions.

8. Each TSO shall apply pre-fault Remedial Actions when there is a danger of not being able to cope efficiently and in a timely manner with the conditions occurring after a Contingency.

9. Each TSO shall apply post-fault Remedial Actions to cope with and to relieve the conditions occurring after a Contingency, within the time allowed for Transitory Admissible Overloads of the transmission system elements.

10. Non-compliance with the (N-1)-Criterion is acceptable:

a) during switching sequences;

b) if it only has local consequences within the TSO Responsibility Area; and

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

Each TSO shall inform its responsible national authority about the situations where structural non-compliance according to Article 11(10)(b) can have potential adverse impact on system users.

11. Each TSO shall ensure that the model of its Observability Area used for Contingency analysis is based upon a sufficient amount of accurate real-time data.

12. Each DSO directly connected to the Transmission System and Significant Grid User which is a type B, C or D Power Generating Facility according to Article 3 of the [NC RfG] shall cooperate and deliver all information for Contingency analysis as requested by the TSO, including forecast and real-time data, with possible data aggregation in line with Article 25(2).

13. Each TSO is responsible for Operational Security within its Responsibility Area. Each TSO shall coordinate its Operational Security analysis with other affected TSOs. Each neighbouring TSO shall cooperate and deliver all necessary information for Contingency Analysis including forecast and real-time data.

14. Each TSO shall contribute to establishing the Common Grid Model. This contribution shall include the data for the Common Grid Model according to the defined details and timeframes specified in the [NC OPS] and in consistency with [NC CACM].

15. Each TSO shall inform the neighbouring TSOs about its External Contingencies taken into account in its Contingency list.

16. For each interconnection, each TSO shall inform the connected TSO about the Operational Security Limits of its transmission system. While respecting the provisions of Article 3(3), the applicable Operational Security Limits for the interconnection shall be coordinated and agreed as the most restrictive one defined by both TSOs.

17. Each TSO shall inform the neighbouring TSOs when it operates a transmission system element which is taken into account as an External Contingency of these neighbouring TSOs, outside the Operational Security Limits.

18. Neighbouring TSOs shall coordinate and agree any significant changes of the topology in their Observability Area if this is necessary for maintaining Operational Security of the interconnected system.

Article 12
PROTECTION

1. Each TSO shall install the necessary protection and backup protection equipment within its transmission system in order to efficiently and effectively protect own equipment and to coordinate with protection of the equipment of system users, from Faults in transmission system.

2. Each TSO shall regularly review and analyse the protection concepts and when necessary adapt the protection functions to ensure the correct functioning of the protection and Operational Security.

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 or primary equipment.

4. Each TSO shall ensure that the Fault clearing times for Faults that impact system stability are less than the Critical Fault Clearing Time defined by the TSO.

5. Each TSO shall coordinate with neighbouring TSOs, DSOs and Significant Grid Users the relevant protection concepts and set-points for the interconnections and inform other 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 as the protection system used for the protection of primary equipment;
   c) operate the transmission system affected by the SyPS within the Operational Security Limits determined in accordance with Article 6(5) and Article 6(6); and
   d) coordinate SyPS functions, activation principles and set-points with affected TSOs and affected system users and DSOs directly connected to transmission system;

7. While respecting the provisions of Article 3(3) of this Network Code and the provisions of the [NC DCC], each TSO shall define a Low Frequency Demand Disconnection Scheme 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 case of change of the conditions and settings.
   While respecting the provisions of article 3(3) of this Network Code and the provisions of the [NC RfG], each TSO shall define and implement actions for over-frequency in cooperation with Power Generating Facility Operators and in coordination with the TSOs of its Synchronous Area.

Article 13
DYNAMIC STABILITY MANAGEMENT

1. Each TSO shall perform Dynamic Stability Assessment studies in order to identify the Stability Limits and potential stability problems in its transmission system. These studies can be offline.

2. 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 coordination of approaches to the DSA, including provision of data needed for DSA and preparation of joint Remedial Actions.

3. In deciding the approach for DSA, each TSO shall apply the following rules:
   a) if with respect to the Contingency List, steady state Operational Security 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 short term 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 network is under N-Situation with respect to the Contingency List, 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 within a day.

4. If the DSA indicates violation of dynamic Stability Limits, the affected TSOs shall implement measures to keep transmission system stable. While respecting the provisions of Article 3(3), these measures may involve Power Generating Modules which are Significant Grid Users.

5. Each TSO shall, while respecting the provisions of Article 3(3), in coordination with the other TSOs of its Synchronous Area be entitled to define the minimum inertia of the Synchronous Area for maintaining dynamic stability and Operational Security. Each TSO shall be entitled to define this minimum inertia. The required minimum inertia shall be procured in a market based way.

CHAPTER 3
DATA EXCHANGE

Article 14
GENERAL REQUIREMENTS

1. Each TSO shall use its best endeavor to use accurate data and information which reflect as closely as possible the real situation in the transmission system.

2. Each TSO shall use its best endeavor to resolve inaccuracies and uncertainties and continuously ensure high quality of the data and information used.

3. Each TSO shall be entitled to gather the following information required for the Operational Security analysis, as further described in Article 16 - Article 28:
   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 nodal injections and withdrawals on its own Transmission System model and shall respect requirements described in [NC OP&S] to be gathered in a CGM.

4. While respecting provisions of Article 3(3), each TSO shall adjust the scope of the data exchange with the Significant Grids Users defined in this Chapter 3, according to the following categories:
   a) structural data;
   b) scheduling and forecast data;
   c) real-time data;
   d) individual instructions by TSOs or DSOs.

5. Each TSO shall adhere to the organisational requirements, roles and responsibilities in relation to the data exchange, which are agreed upon and implemented at European level for all TSOs. This 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 interconnections 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 Chapter 3 of this Network Code;

c) obligations of the Significant Grid Users to inform within the agreed timescales their TSO about any relevant change in the scope and contents of the relevant data from Chapter 4 of this Network Code.

6. Data related to in-service installations at the Connection Point of the transmission system shall be available to Significant Grid Users and DSOs which are connected at that Connection Point.

7. Each TSO shall define and implement in a common and coherent way in coordination with the other TSOs, the detailed contents and reporting formats of the data and information referred to in this Chapter and in a coherent way with the data exchange provisions in other Network Codes. Each TSO shall define the detailed contents respecting the provisions of Article 3(3).

8. While respecting the provisions of Article 3(3), TSO or DSO shall define the time stamping and periodicity for the data and information to be provided by Significant Grid Users, to be used by the TSO's energy management systems at the different timescales.

9. While remaining the sole entity responsible and liable, a TSO can entrust a Regional Security Coordination Initiative with some of the tasks that it shall perform in accordance with this Network Code. In such a case, the TSO shall inform other TSOs, about this delegation, so that these Regional Security Coordination Initiatives can get all the data and information needed to perform the tasks entrusted to them.

Article 15
STRUCTURAL AND FORECAST DATA EXCHANGED BETWEEN TSOs

1. Neighbouring TSOs shall exchange the structural information related to the Observability Area including at least:
   a) substations' regular topologies and other relevant data by voltage level;
   b) transmission lines;
   c) transformers connecting the DSOs, Demand Facilities and generators' block-transformers of Power Generating Facilities;
   d) phase-shifting transformers;
   e) high voltage DC lines;
   f) reactors, capacitors and Static VAR Compensators; and
   g) Operational Limits, including Transitory Admissible Overloads and time associated to these transitory thresholds.

2. Neighbouring TSOs shall exchange the Protection set-points 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 all other relevant TSOs at least the following data:
   a) topology of the 220 kV and higher voltage transmission system within its Responsibility Area;
   b) an equivalent of the transmission systems of significant impact to its own transmission system;
   c) the forecast injection and the forecast 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 and the resulting situation in the transmission system shall be as realistic and accurate as possible;
   d) if the impact of a connected distribution network is significant, the distribution network model for transmission short-circuit calculations with the level of detail which is needed for successful calculations, using where applicable the distribution network equivalents with sufficient degree of detail and accuracy. Each TSO shall determine the significance of the distribution networks connected to it for short-circuit calculations.

4. In order to support coordinated Dynamic Stability Assessment, each TSO shall, when required in accordance with article 13(2), exchange with other relevant TSOs the necessary data for DSA, informing the affected Power Generating Facility Owner. Concerning Power Generating Module, the TSO shall provide the necessary data on:
   a) electrical parameters of the alternator suitable for transient stability studies program, 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 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 links and FACTS devices, the TSO shall provide the necessary data on:

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

Article 16
REAL-TIME DATA EXCHANGED BETWEEN TSOs

1. In accordance with Article 6(8)(a), each TSO shall exchange with all other TSOs in its Synchronous Area the necessary data on the System State of its transmission system using a common awareness system, including:
   a) frequency;
   b) Frequency Restoration Control Error or an equivalent parameter;
   c) measured active power exchanges between LFC Areas;
   d) aggregated generation infeed;
   e) System State in accordance with Article 6(1);
   f) set-value of the FR controller; and
   g) energy exchange via the Virtual Tie-Lines.

2. Each TSOs shall exchange with its neighbouring TSOs the following data related to the Observability Area referred:
   a) actual topology;
   b) active and reactive power in line bay, including transmission, distribution and Significant Grid User connecting lines;
   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.

Article 17
STRUCTURAL AND FORECAST DATA EXCHANGED BETWEEN TSOs AND DSOs WITHIN THE TSO's RESPONSIBILITY AREA

1. While respecting the provisions of Article 3(3), each TSO shall define the Observability Area of the distribution networks connected to its transmission system which are relevant to accurately and efficiently determine the System State of the system.

2. While respecting the provisions of Article 3(3), in those cases where a distribution network is not directly connected to the transmission system but whose electrical influence is deemed as significant for the proper representation of the system behaviour by its TSO, those distribution networks may be part of the Observability Area defined in Article 18(1).

3. Each DSO directly connected to the transmission system shall provide to its TSO the structural information related to the Observability Area referred to in Article 17(1) 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 directly connected to the transmission system shall provide the TSO with updated structural information of the elements of the Observability Area in the agreed timescales at least every six months.

5. Each DSO shall provide to its TSO the total aggregated generating capacity of all pre-existing and new Power Generating Facilities of type A connected to its network and the related information concerning their frequency and voltage behaviour, while respecting the provisions of Article 7 and Article 8.

Article 18
REAL-TIME DATA EXCHANGED BETWEEN TSOs AND DSOs DIRECTLY CONNECTED TO THE TRANSMISSION SYSTEM WITHIN THE TSO's RESPONSIBILITY AREA

1. Each DSO directly connected to the transmission system shall provide in real-time to its TSO the information related to the Observability Area referred to in Article 17(1), comprising:
   a) actual topology of the substations: position of circuit breakers and disconnectors;
   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) aggregated generation in the DSO area; and
   i) aggregated consumption in the DSO area.

2. While respecting the provisions of Article 3(3), in those cases where a distribution network is not directly connected to the transmission system but whose electrical influence is deemed as significant for the proper representation of the system behaviour by its TSO, those distribution networks may be part of the Observability Area defined in Article 18(1).

Article 19
STRUCTURAL DATA EXCHANGED BETWEEN TSOs, OWNERS OF INTERCONNECTION OR OTHER LINES AND GENERATORS DIRECTLY CONNECTED TO THE TRANSMISSION SYSTEM

1. Each type D Power Generating Facility Operator according to Article 3 of the [NC RfG] 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 [NC LFC&R] for Power Generating Facilities offering or providing this service;
   f) Frequency Restoration Reserve data, according to the definition and requirements of the [NC LFC&R] for plants 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 model necessary for performing dynamic simulation as stated in [NC RfG];
   j) protection data; and
   k) reactive power control capability;

2. Each type B and C Power Generating Facility Operator according to Article 3 of the [NC RfG] which is directly connected to the transmission system shall at least provide 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 [NC LFC&R] 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 dynamic simulation as stated in [NC RfG].

3. While respecting the provisions of Article 3(3), a TSO may request any Power Generating Facility Operator directly connected to the transmission system to provide further data needed for Operational Security analysis.

4. Each HVDC interconnection 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) reactive power control capability;

f) data necessary for performing dynamic simulation; and

g) protection data; and

h) FR capability.

5. Each AC interconnection or Line owner shall provide at least the following data to the TSO:

a) name plate data of the installation ;

b) electrical parameters.

Article 20

SCHEDULED DATA EXCHANGED BETWEEN TSOs, OWNERS OF INTERCONNECTION OR OTHER LINES AND GENERATORS DIRECTLY CONNECTED TO THE TRANSMISSION SYSTEM

1. Each type B, C and D Power Generating Facility Operator according to Article 3 of the [NC RfG] shall inform the TSO on a Day-Ahead and Intra-Day basis its active power output and active power reserves amount and availability and without delay about its scheduled unavailability or active power restriction.

2. Each type B, C and D Power Generating Facility Operator according to Article 3 of the [NC RfG] shall provide to the TSO any forecast restriction in the reactive power control capability.

3. In regions, with central dispatching of generation, the Power Generating Facility Operator shall submit the data required by the TSO to allow the TSO to construct an active power output schedule.

4. Each HVDC interconnection 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 control capability.

5. Each AC interconnection or Line owner shall provide without delay its scheduled unavailability or active power restriction data to the TSOs.

Article 21

REAL-TIME DATA EXCHANGED BETWEEN TSOs, OWNERS OF INTERCONNECTION OR OTHER LINES AND GENERATORS DIRECTLY CONNECTED TO THE TRANSMISSION SYSTEM

1. Each type B,C and D Power Generating Facility Operator according to Article 3 of the [NC RfG], including Power Generating Facilities own consumption, shall provide 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 interconnection 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; and
   b) active and reactive power.

Article 22

STRUCTURAL DATA EXCHANGED BETWEEN DSOs AND POWER GENERATING FACILITIES CONNECTED TO THE DISTRIBUTION NETWORK

1. Each type B, C and D Power Generating Facility Operator according to Article 3 of the [NC RfG] which is connected to the Distribution Network shall at least provide the following data 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 [NC LFC&R] 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 as stated in [NC RfG]; and

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

2. While respecting the provisions of Article 3(3), each DSO shall define and implement in a common and coherent way, the detailed contents of the data and information referred to in this Article. Each DSO shall consult its NRA, its TSO and the Significant Grid Users connected to a DSO about the detailed content.

3. Each Power Generating Facility Operator affected by the article 22(1), shall inform the DSO where it is connected 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 Article 22(1).

Article 23

SCHEDULED DATA EXCHANGED BETWEEN DSOs AND POWER GENERATING FACILITIES CONNECTED TO THE DISTRIBUTION NETWORK

1. While respecting the provisions of article 3(3), each Significant Grid User which is a type B, C or D Power Generating Facility according to Article 3 of the [NC RfG] connected to the Distribution Network shall provide the DSO with its scheduled unavailability, active power restriction and its forecast scheduled active power output at the Connection Point.

2. While respecting the provisions of article 3(3), each Significant Grid User which is a type B, C or D Power Generating Facility according to Article 3 of the [NC RfG] shall provide to the DSO any forecasted restriction in the reactive power control capability.

3. In regions with central dispatching of generation, the Power Generating Facility Operator shall submit the data required by the TSO according to Article 23(1) to allow the TSO to construct an active power output schedule.

Article 24

REAL-TIME DATA EXCHANGED BETWEEN DSOs AND SIGNIFICANT GRID USERS CONNECTED TO THE DISTRIBUTION NETWORK

1. While respecting the provisions of Article 3(3), each Significant Grid User which is a type B, C or D Power Generating Facility according to Article 3 of the [NC RfG]

connected to the Distribution Network, shall provide to 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.

2. Each TSO shall decide while respecting the provisions of Article 3(3), together with the responsible DSOs, whether and which Significant Grid Users might be exempted from providing the real-time information and if the data of such Significant Grid Users need to be delivered by responsible DSOs in an aggregated form.

Article 25

DATA EXCHANGED BETWEEN TSOs AND POWER GENERATING FACILITIES CONNECTED TO THE DISTRIBUTION NETWORK

1. Power Generating Facility Operators and DSOs shall provide to the TSO all the information described in Article 22 - Article 24 if requested by the TSO, while respecting the provisions of Article 3(3).

2. While respecting the provisions of Article 3(3), a TSO may request further relevant and reasonable data from any Power Generating Facility type B, C or D according to [NC RfG] connected to the Distribution Network, if this is necessary for Operational Security analysis, validation of models, or if, after aggregation of data, the significance of a particular Power Generating Facility is raised in terms of Operational Security.

Article 26

DATA EXCHANGED BETWEEN TSOs AND DEMAND FACILITIES DIRECTLY CONNECTED TO THE TRANSMISSION SYSTEM

1. Demand Facilities which are directly connected to the transmission system 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 Demand Facility directly connected to the transmission system 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 Demand Facility directly connected to the transmission system shall communicate to the TSO any forecast restriction in the reactive power control capability.

4. Each Demand Facility directly connected to the transmission system 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 central dispatching of generation the Demand Facility is not required to provide this data.

7. Each Demand Facility connected to the transmission system shall describe to its TSO its behaviour at the voltage ranges defined in the Article 8 of this NC.

Article 27
DATA EXCHANGED BETWEEN TSOs AND DEMAND FACILITIES CONNECTED TO THE DISTRIBUTION NETWORK

1. While respecting the provisions of Article 3(3), each Significant Grid User that is a Demand Facility connected to the distribution network and which participates in Demand Side Response shall communicate to its DSO and TSO in real-time or near real-time:
   a) forecast of unrestricted active power from which demand can be curtailed and any planned level of Demand Side Response;
   b) minimum and maximum active power that could be curtailed and the maximum and minimum duration of any potential curtailment; and
   c) real-time active and reactive power at the Connection Point.

2. In cases where the real-time information according to Article 27(1) includes large numbers of small Demand Facilities, each TSO shall decide while respecting the provisions of Article 3(3) and together with the responsible DSOs, whether and which Significant Grid Users might be exempted from providing the real-time information and if the data of such Demand Facilities needs to be delivered by responsible DSOs in an aggregated form.

CHAPTER 4
TRAINING

Article 28
OPERATIONAL TRAINING AND CERTIFICATION

1. Each TSO shall adopt and develop a training program for its System Operator Employees in charge of real-time operation of the transmission system. Each TSO shall provide upon request to its relevant national authority the scope and details of its training and certification processes as established under the Article 28(6).

2. Each TSO shall include in its training programs the knowledge of the transmission equipment, the operation of the transmission system, use of the on-the-job systems and processes, inter-TSO operations and market arrangements. Each TSO shall also include in its training programmes training on recognizing of and responding to exceptional situations as defined by the TSO.

3. To maintain and extend the System Operator Employees' skills, each TSO shall carry out training. The detailed contents and frequency of the training for all relevant roles shall be defined in the training programme of each TSO. The training shall include but not be limited to:
   a) relevant areas of electrical power engineering;
   b) relevant aspects of the European Internal Electricity Market;
   c) safety and security for persons, nuclear and other equipment in transmission system operation;
   d) transmission system operation in a Normal and all other states;
   e) inter-TSO cooperation and coordination in real-time and in operational planning at the level of main control centres; this part of the training shall, if not otherwise specified and agreed, be in English; and
   f) exchange and training in conjunction with directly connected DSOs and Significant Grid Users where deemed appropriate.

4. Each TSO shall prepare and carry out training plans, in accordance with article 28(1), for all new System Operator Employees in training - trainees. They shall be structured and detailed and take account of the trainees background and experience relative to the position they are being trained for. Adequate records of System Operators Employees' training plans shall be retained by the TSO for the period of employment as a System Operator Employee.

5. The training plans shall comprise:
   a) an initial program, to be followed by a trainee System Operator Employee before certification;
   b) a program for the continuous development and prolongation of a System Operators Employees' certification, at least every four years; and

6. Each TSO shall appoint an experienced training coordinator, who is responsible for designing, monitoring and updating the complete training process in accordance with Article 28(1). The training coordinator shall be responsible for defining:
   a) qualifications for System Operator Employees;
   b) training required for certification;
   c) processes with documentation for initial and continuous training;
   d) process for certification of System Operator Employees;
   e) process for prolongation of a certification; and
   f) competences for on-the-job trainers and training of trainers in teaching and mentoring skills.

7. Each TSO shall define the skills and the level of competence of the on-the-job trainers. This shall include the necessary practical experience. System Operator Employees acting as trainers shall be registered by each TSO and their on-the-job trainer status reviewed at the same time as their certification prolongation is assessed.

8. Each TSO shall review training programmes at least annually or following any significant system changes and update them to reflect changing operational circumstances, market rules, network configuration and system characteristics, with particular focus on new transmission and generation technologies, changing generation patterns and market evolution.

9. Each TSO shall ensure the training includes on-the-job training and training offline. On-the-job training shall be carried out under the supervision of an experienced System Operator Employee. Offline training shall, as far as practicable, resemble the actual control room equipment with network modelling details appropriate to the role being trained for.

10. Each TSO shall ensure that training is based on a comprehensive database model with respective data also from neighbouring networks at a sufficient level to replicate inter-TSO operational issues. Where relevant, the role of neighbouring TSOs, directly connected DSOs and Power Generating Facility Operators and directly connected Demand Facilities shall also be simulated or directly involved in the offline training.

11. TSO shall co-ordinate regularly with DSOs directly connected to the transmission system, Power Generating Facility Operators and directly connected Demand Facilities to ensure TSO offline training regarding the impact of users' systems is as comprehensive as reasonably practical and reflects the latest developments in systems and equipment. TSOs, DSOs directly connected to the transmission system and Significant Grid Users may run joint offline training simulations or training workshops for their System Operator Employees to enhance co-operation and understanding.

12. Each TSO shall ensure that System Operator Employees have a certification, issued by a nominated representative from their TSO, for the role they are to perform before they can work unsupervised in the control room.

13. Each TSO shall participate in the inter-TSO training at a defined frequency, taking into account the level of mutual influence with neighbouring systems.

14. Each TSO shall define the level of competence and process to gain a certification for each relevant role for System Operator Employee within the control room. The certification shall only be awarded to the System Operator Employees following the passing of a formal assessment.

15. Each TSO shall record the period of validity of the certification issued to any System Operator Employee. The maximum period of any certification shall be defined by each TSO and shall not exceed four years. The prolongation of the certification before expiry shall be based on criteria defined by each TSO, including the System Operator Employees' participation in a continuous training programme with sufficient practical experience.

16. Each TSO shall collaborate with each neighbouring TSO to determine a common language for contacts between their System Operator Employees. If not otherwise agreed, the language shall be English. Each TSO shall train the relevant System Operator Employees to achieve a sufficient skill in this language to carry out their tasks.

17. Each TSO shall exchange operational experiences with their neighbouring TSOs, and delegated entities defined in respective TSOs' agreements on RCSIs in the region where they have a role in operational planning coordination between TSOs, including facilitating visits and exchange of experiences between System Operator Employees. There shall be regular training between neighbouring TSOs to improve the knowledge of the characteristics of neighbouring transmission systems and communication and coordination between System Operator Employees of neighbouring TSOs. The inter-TSO training shall include awareness of co-ordinated actions required under Normal and all other states.

18. Each TSO shall collaborate with each neighbouring TSO to determine the need and frequency for holding joint training sessions and the minimum content and scope of those sessions, taking into account the level of mutual influence and operational cooperation needed. This inter-TSO training may include, but should not be limited to, joint training workshops and joint training simulator sessions.

19. Each TSO shall ensure that each System Operator Employee as a part of their initial training undergoes training in interoperability issues between neighbouring systems based upon operational experiences and feedback from the joint training carried out with their neighbouring TSOs. This part of the initial training regarding interoperability

issues shall include awareness of co-ordinated actions required under Normal and all other states.

20. In regions where RSCI have a role in terms of operational planning coordination between the TSOs, the operators of the RCSIs' delegated entities defined in respective TSOs' agreements, shall be trained as well in common training with the System Operator Employees.

CHAPTER 5
COMPLIANCE

Article 29
RESPONSIBILITY OF THE SIGNIFICANT GRID USERS

1. Each Significant Grid User or DSO directly connected to the transmission system 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 to the TSO or DSO any planned modification of its technical capabilities which could have an impact on its compliance with the requirements of this Network Code.

3. Each Significant Grid User shall notify to the TSO or DSO 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 networks, each Significant Grid User shall notify to the TSO or DSO 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.

5. The TSO or DSO shall approve the foreseen tests or test schedules and procedures, in Article 29(4), prior to their launch.

6. The Significant Grid User shall enable the participation of the TSO or DSO in such tests. The relevant TSO or DSO shall have the right to record the performance of the facilities of the Significant Grid Users.

Article 30
RESPONSIBILITIES OF THE TSOs and DSOs

1. Each TSO has the sole responsibility for the Operational Security of its Responsibility Area in terms of:
   a. utilizing the means within the 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 and congestion management, operating reserves and other ancillary services;

c. identifying, evaluating and implementing necessary enhancements of the means from Article 30(1)(a) of this Network Code and, while respecting the provisions of Article 3(3) of this Network Code, enhancements of the means from article 31(1)(b) of this Network Code, which are required in order to maintain Operational Security; for identification of those enhancements, each TSO shall rely on the results of the yearly report based on the ENTSO-E incidents classification scale according to the Article 8(3)(a) of the Regulation (EC) N°714/2009; and

d. identifying, evaluating and, while respecting provisions of Article 3(3) of this Network Code, implementing of necessary additional means to those from Article 30(1)(b) of this Network Code, including development and implementation of new ancillary services and definition and implementation of new frameworks for data and information exchange, where cooperation with other stakeholders is needed and which are required in order to maintain Operational Security; for identification of those additional means each TSO shall rely on the results of the yearly report based on the ENTSO-E incidents classification scale according to the Article 8(3)(a) of the Regulation (EC) N°714/2009;

2. The annual reporting according to Article 30(1)(c) and Article 30(1)(d) shall contain the following Operational Security Performance Indicators:

   a. number of tripped transmission system elements;

   b. energy [MWh] of disconnected Generation Facilities per year;

   c. energy [MWh] of disconnected Demand Facilities per year;

   d. time of being in Operational States other than Normal State (Alert, Emergency, Blackout);

   e. time duration within which there was a lack of reserves identified;

   f. voltage deviation;

   g. frequency deviation per Synchronous Area;

   h. number of system-split separations and / or local blackouts;

   i. number of regional blackouts involving two or more TSOs;

   j. explanation of reasons of incidents at the Operational Security Ranking levels 2 and 3 according to Article 30(3);

3. The Operational Security Ranking in the annual reporting according to Article 30(1)(c) and Article 30(1)(d) shall be based on the following levels:

   a) Level 0: normal operation of the transmission system, where any incident does not lead to a deviation of security and quality, with the common criteria identified being events on transmission system equipment, events on Generation Facilities and events on Demand facilities; in Level 0 some trends with increasing number of incidents might show degradation of Operational Security but no thresholds of Operational Security Performance Indicators are reached; events of Level 0 are not reported in the yearly report according to the ENTSO-E incidents

classification scale according to the Article 8(3)(a) of the Regulation (EC) N°714/2009;

b) Level 1: alert operation of the transmission system, where any incident could lead to a deviation of security and quality, with the common criteria identified being events on transmission system equipment, events on Generation Facilities, events on Demand Facilities, degradation of Operational Security in terms of reserves, voltage, frequency;

c) Level 2: emergency operation of the transmission system where any incident could lead to any deviation of security, quality or stability, with the common criteria identified being events on transmission system equipment, events on Generation Facilities, events on Demand Facilities, degradation of Operational Security in terms of frequency, system separation, regional collapse with more than 1 TSO affected;

d) Level 3: blackout of the transmission system;

4. The TSO or DSO directly connected 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 at any time throughout the lifetime of the Significant Grid Users' facility.

5. Upon request from the TSO or DSO, 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 contracted provision of ancillary services.

6. Each TSO or DSO retains the right to evaluate a Significant Grid User's compliance with the requirements from this Network Code, expected input or output, and contracted provision of ancillary services.

7. The TSO or DSO 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 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 steady-state and Dynamic Stability Assessment; and

d) studies by the Significant Grid Users demonstrating expected steady-state performance and Dynamic Stability Assessment outcome.

8. The TSO or DSO shall make publicly available the allocation of responsibilities of the Significant Grid User and of the TSO or DSO for compliance testing and monitoring.

9. 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, economic operation of the interconnected transmission systems and Significant Grid Users.

10. Each TSO shall provide to affected TSOs and DSOs at least the following information on the test:
    a) all the details provided by the test requestor;
    b) the TSO's analysis of and planning for the test; and
    c) risk mitigation measures and planned remedial actions.

11. While respecting provisions of the Article 3(3), each TSO shall elaborate a list of high priority system users in terms of defining the terms for disconnection and re-energizing of such system users in any System State, including Restoration.

Article 31
COMMON TESTING AND INCIDENT ANALYSIS RESPONSIBILITIES

1. Each TSO, DSO directly connected to the Transmission System and Significant Grid User 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. test involving the controlled application of frequency or voltage variations aimed at gathering information on transmission system behaviour; and
        ii. test standard procedures for Alert and Emergency States.

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 and / or due to safety of its personnel and plant 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 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. Each TSO shall analyse and classify system incidents according to the common incidents classification scale and the ranking of Operational Security, see Annex I adopted by ENTSO-E in accordance with Article 8(3)(a) of Regulation (EC) N°714/2009. While respecting confidentiality obligations the analysis and classification of system incidents will be published in the annual report at the ENTSO-E webpage. The NRA shall be involved in the process on their request, while respecting the provisions of Article 3(3).

5. TSOs, DSOs and Significant Grid Users shall provide any relevant and reasonable data, necessary to fully analyse both Local and Wide Area system incidents and facilitate system analysis.

CHAPTER 6
FINAL PROVISIONS

Article 32
AMENDMENT OF CONTRACTS AND GENERAL TERMS AND CONDITIONS

Within three years after the entry into force of this Network Code, each relevant TSO, DSO and each relevant Significant Grid User shall amend all relevant clauses in contracts and/or relevant clauses in general terms and conditions relating to the grid connection of New Power Generating Modules, 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.

Article 33
ENTRY INTO FORCE

This Network Code shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

It shall apply as from the day of expiration of a two years period following its publication.

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

ANNEX I

INCIDENTS CLASSIFICATION SCALE

ENTSO-E incidents classification scale in accordance with Article 8(3)(a) of Regulation (EC) N°714/2009, in its current version.