SUPPORTING PAPER FOR THE OPERATIONAL SECURITY NETWORK CODE

31.08.2012

FOR PUBLIC CONSULTATION

1 PURPOSE AND OBJECTIVES OF THIS DOCUMENT

1.1 PURPOSE OF THE DOCUMENT

This document has been developed by the European Network of Transmission System Operators for Electricity (ENTSO-E) to accompany the Operational Security Network Code (OS NC) and should be read in conjunction with that document.

It aims to provide interested parties with information about the rationale for the approach set out in the OS NC, outlining the reasons that led to the requirements specified in it. The document has been developed in recognition of the fact that the OS NC, which will become a legally binding document after comitology, inevitably cannot provide the level of detailed explanation which some parties may desire.

1.2 STRUCTURE OF THE DOCUMENT

This document is structured as follows:

- Section 2 introduces the legal framework within which the OS NC has been developed.
- Section 3 explains the approach which ENTSO-E has taken to develop the OS NC, outlining the challenges and opportunities ahead for System Operation.
- Section 4 describes how this Network Code complies with the requirements of the Framework Guidelines on System Operation (SO FG) developed by the Agency for the Cooperation of Energy Regulators (ACER).
- Section 5 focuses on the objectives of the OS NC by topic.
- Section 6 describes the added values of implementing the operational principles set by the OS NC.
- Section 7 summarises the next steps.

1.3 LEGAL STATUS OF THE DOCUMENT

This document accompanies the OS NC and is provided for information purposes. Consequently, this document has no legally binding status.

2 PROCEDURAL ASPECTS

2.1 INTRODUCTION

This section provides an overview of the procedural aspects of network codes' development. It explains the legal framework within which network codes are developed and focuses on ENTSO-E's legally defined roles and responsibilities. It also explains the next steps in the process of developing the OS NC.

2.2 THE FRAMEWORK FOR DEVELOPING NETWORK CODES

This OS NC has been developed in accordance with the process established within the Third Package, in particular in Regulation (EC) 714/2009. The Third Package establishes ENTSO-E and ACER and gives them clear obligations in developing network codes. This is shown in Figure1.

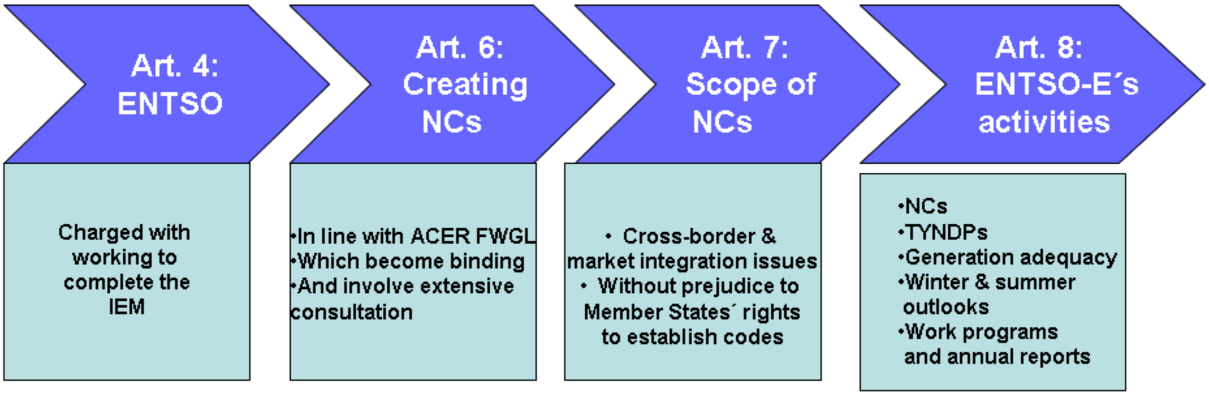

Figure 1: ENTSO-E's legal role in network code development according to Regulation (EC) 714/ 2009.

Moreover, this framework defines the process for developing network codes involving ACER, ENTSO-E and the European Commission, as shown in Figure 2:

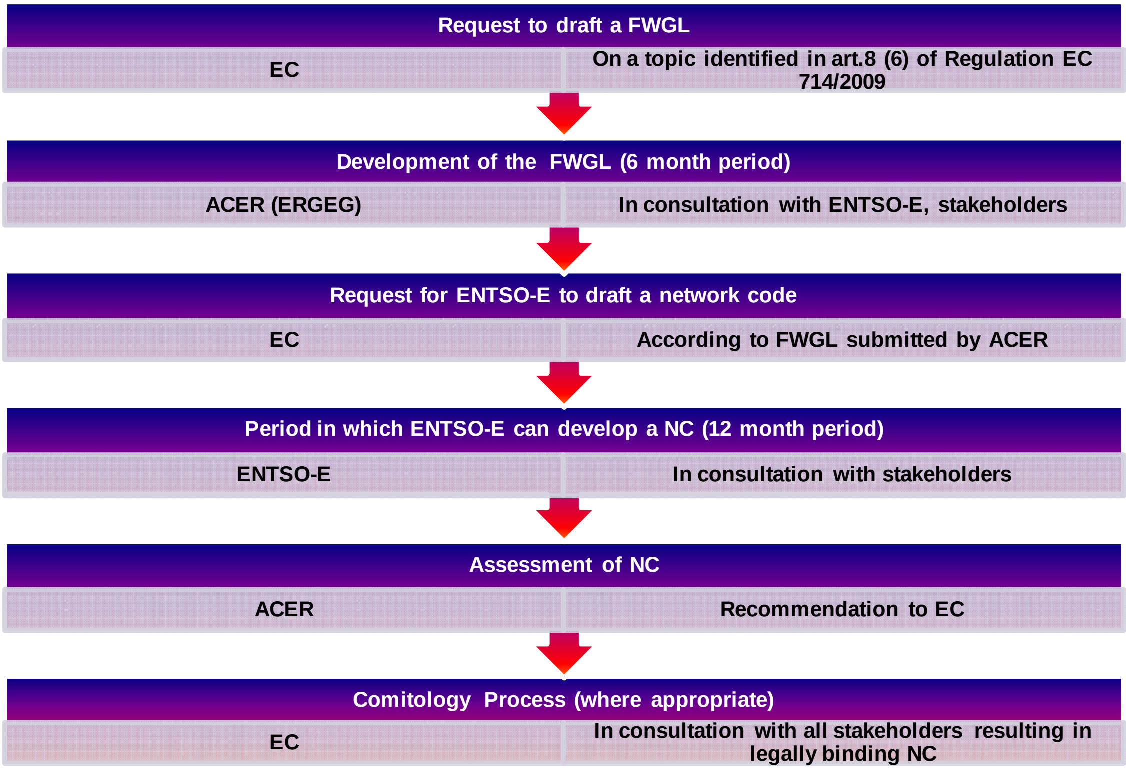

Figure 2: Network codes' development process *(Source: ENTSO-E).*

The OS NC has been developed by ENTSO-E to meet the requirements of the SO FG [1] published by ACER in December 2011. ACER has also conducted an Initial Impact Assessment associated with its consultation on its draft FG SO in June 2011 [2].

ENTSO-E was formally requested by European Commission to begin the development of the OS NC on 1st March 2012. The deadline for the delivery of the code to ACER is the 1st March 2013.

2.3 NEXT STEPS IN THE PROCESS

ENTSO-E is now consulting on the OS NC. We encourage stakeholders and involved parties to submit comments and to provide proposals for addressing any concerns they have with the current draft. ENTSO-E will consider all comments which are provided and will update the network code in light of them. The final amendments of the code will be outlined in the fourth Workshop on the OS NC planned for the 20thDecember 2012. Following agreement and approval within ENTSO-E, the network code will be submitted to ACER in line with the defined deadline of March 2013.

ACER is then expected to evaluate the OS NC compliance with the SO FG and make a recommendation to the European Commission. When the European Commission agrees with the ACER recommendation, the European Commission can conduct the Comitology process which will eventually transform the OS NC into a legally binding integral component of the Regulation (EC) 714/2009.

3 SCOPE, STRUCTURE & APPROACH TO DRAFTING THE OS NC

3.1 BACKGROUND

ENTSO-E has drafted the OS NC to set out clear and objective minimum requirements for real-time Operational Security and achieving the main goal of keeping the European interconnected Transmission Systems in continuous operation, in order to contribute to a harmonised framework for completion of the EU Internal Electricity Market (IEM) and to ensure non-discrimination, effective competition and the efficient functioning of the IEM.

Based on the SO FG and on the Initial Impact Assessment provided by ACER, the OS NC states the Operational Security principles in terms of technical needs, considering market solutions compatible with and supporting security of supply.

3.2 GUIDING PRINCIPLES

The guiding principles of the OS NC are to determine common Operational Security principles, to ensure the conditions for maintaining Operational Security throughout the EU, to promote the coordination of System Operation, as well as to determine common requirements for DSOs, Generating Facilities and Demand Facilities connected to Transmission and Distribution Systems, which are relevant for Operational Security. These Operational Security principles are essential for the TSOs to manage their responsibilities for operating the interconnected Transmission Systems with a high level of coordination, reliability, quality and stability.

A key goal of the OS NC is to achieve a harmonised and solid technical framework - including the implementation of all necessary processes required for Operational Security, taking into account the rapid growth of Renewable Energy Sources (RES) generation and their impact on System Operation. Consequently, the requirements have been designed in order to ensure secure System Operation, taking into account the integration of RES and the effective development of the IEM.

The requirements set out in OS NC on TSOs, DSOs and Grid Users are building upon a long history of existing common and best practices, lessons learned and operational needs throughout the European Transmission Systems. This, together with the fact that the European experience of interconnected Transmission Systems operation dates back to the 1950-ies (Union for Coordination of (Production) and Transmission of Electricity (UC (P) TE)), 1960-ies (Nordel), and 1970-ies (TSO Associations of

Great Britain and Republic of Ireland, UKTSOA and ITSOA), distinguishes the OS NC and all other System Operation Network Codes (SO NCs) from other Network Codes in the following terms:

- The work on the (SO) NCs has not started from “scratch” but builds upon a wide and deep range of requirements, policies and standards of the previous European transmission system organisations, adapting and further developing these requirements in order to satisfy the requirements of the SO FG, to meet the challenges of transformations in the energy sector including RES and increasing volatility and dynamics of market operations and to support effective and efficient completion of the IEM.

- The subject matter – Operational Security of the interconnected Transmission Systems of Europe – is vital not just for the continuous and secure supply of European citizens with electricity but also for the electricity market to function at all; therefore, any changes, adjustments and developments based on the new (legally binding after Comitology) SO NC’s framework must acknowledge and respect the fact that System Operation cannot be interrupted and “restarted” – we are working on a “living grid”.

- By their nature and because of the level of technical detail involving all aspects of Transmission System operations, the SO NCs are mainly addressing the TSOs and ENTSO-E; nevertheless, links and cross-references, as well as practical dependencies and explanations are established in relation to other NCs, most notably those addressing grid connection, market and balancing / regulating power.

3.3 STRUCTURE

Ensuring Operational Security, reliability and quality implies providing a common Security Level within the interconnected Transmission Systems of Europe, requiring the close cooperation of TSOs, DSOs, Generating Facilities and Demand Facilities.

In order to set out clear and objective requirements, the following categories of requirements have been established in the OS NC:

- System states
- Frequency control management
- Voltage control and reactive power management
- Short-circuit current management
- Congestion and power flows management
- Contingency analysis and handling
- Protection
- Dynamic stability management
- Operational testing, monitoring and investigation
- Data Exchange
- Operational training and certification

3.4 LEVEL OF DETAIL

In order to achieve the necessary level of European harmonisation, allowing at the same time more detailed provisions at the regional/national level where necessary, and with the view of drafting an OS NC open for future developments and new applications, an approach focusing on a pan-European view and the most widely applicable Operational Security requirements has been pursued throughout the development of the OS NC. The SO FG[1] provided further clarification concerning the issue of European-wide applicability, while pointing out that *"… ENTSO-E shall, where possible, ensure that the rules are sufficiently generic to facilitate incremental innovation in technologies and approaches to system operation being covered without requiring code amendments"*.

Thus, the requirements have been drafted considering a period of approximately 5 years as a reasonable cycle within which changes to the OS NC will have to be implemented, building up a coherent legal mechanism with the appropriate balance between level of detail and flexibility.

Whereas this first OS NC picks up as much input from involved parties as possible in order to enable a high level of system security, regional requirements concerning the different Synchronous Areas, regions or even single TSOs may lead to further and more detailed provisions. In any case, compatibility and coherence must be ensured for all provisions defined at the level of Synchronous Area, region or a single TSO.

3.5 FIELD OF APPLICABILITY OF THE OS NC

Whereas the requirements of the OS NC are directly applicable in all Member States, it should be noticed that the provisions set in the OS NC should not apply in the following cases:

- In the small isolated systems for which a derogation has been granted in application of Article 44 of Directive 2009/72/EC;
- In the isolated systems which do not present any cross-border network issues nor market integration issues, in the absence of transmission system.

The references to market rules in the OS NC do not apply in the Spanish isolated systems, where the SEIE rules apply.

Nevertheless, DSOs shall fully take into account the provisions of the OS NC when adopting their own Network Code on Operational Security.

3.6 CHALLENGES AND OPPORTUNITIES AHEAD FOR SYSTEM OPERATION

Nowadays, in line with the challenging objectives set out in the SO FG, System Operation goes beyond just operating the electric power system in a safe, secure, effective and efficient manner. Aspects such as enabling the integration of innovative technologies and making use of information and communication technologies must be fully integrated, while applying the same principles for the different Transmission Systems of Europe.

[1]Article 1.5 Application, Framework Guidelines on System Operation, ACER, December 2011.

Challenges

In this context, the future challenges for System Operation, which are addressed in particular, include:

- Effects resulting from the fast growth of intermittent generation from RES.
- Needs resulting from the evolution (and completion) of the IEM.

Generation from RES

The transmission tasks and challenges within the Transmission Systems of the European TSOs are ever more driven and influenced by the effects of the growing generation from RES. RES generation predominately varies with weather conditions. The characteristic of variability and also uncertainty of RES generation, being difficult to forecast accurately, until close to real time, causes the following consequences for System Operation:

- Renewable energy increasingly replaces the feed-in from large power plants directly connected to the Transmission System;
- During the past several years RES generation has contributed significantly to the increase in and volatility of planned and unplanned cross-border power flows, therefore posing new challenges to maintaining the required balance between production and consumption, and to the management of physical flows over the borders;
- The influence of underlying production leads to a high forecast complexity for the balance of transfers into the Distribution Network and thus also for the prediction of load flows in the Transmission System.

This leads to concerns about how to maintain stable System Operation in an electricity network with high penetration of RES. The general answer to this is to increase the controllability and the flexibility of all elements of the Transmission System. This can in turn lead to a Transmission System which can react and cope better with the intermittency of RES.

Internal Electricity Market (IEM)

Cross border trades and intraday markets have significantly increased in recent years, with the corresponding introduction of intraday capacity allocation and the resulting short-term adjustments to the generating capacity of power plants. Due to this fact and in order to comply with the obligations under Regulation (EC) 714/2009, a short-term update of generation forecasts has become indispensable and reliable System Operation can only be established on the basis of reliable input values.

In addition to the consequences for power flows, large changes on generation programs with different ramp rates (especially non-synchronous ramps) lead to temporary imbalances and can create a frequency deviation; this phenomenon is observed throughout ENTSO-E Regional Group Continental Europe (former UCTE), with an increasing trend in the number, duration, and the amplitudes of these frequency deviations, especially during the ramping periods in the morning and in the evening[2]. Another observed reason for longer periods with large frequency deviations is the persistent imbalance in one or more Control Areas which cannot be restored due to insufficient secondary

[2] „Deterministic frequency deviations – root causes and proposals for potential solutions", a joint EURELECTRIC – ENTSO-E response paper (https://www.entsoe.eu/news/announcements/newssingleview/article/the-report-on-deterministic-frequency-deviations-root-causes-and-proposals-for-potential-solu/)

(Frequency Restoration Reserve) and/or tertiary (Replacement Reserve) control reserve (in these cases the Control Areas concerned experience a large ACE (Area Control Error) or an equivalent parameter).

These frequency deviations activate a significant share of the primary control reserve (Frequency Containment Reserve) in the system, which is intended and dimensioned for coping with predictable (in terms of quantity and risk) sudden generation or load outages. Consequently these frequency deviations endanger secure System Operation by depleting the required containment reserves for significant periods.

Another factor has accentuated these frequency deviations: the rapid growth in generation from RES, where the generators used (mainly asynchronous by technology) provide no natural inertia, for frequency response, to the system, compared to the conventional synchronous generators used in the traditional power plants.

Opportunities and Challenges

In view of achieving the integration of RES in the system and implementation of the IEM, the following opportunities and challenges (with their associated risks) have been identified as relevant for System Operation. These changes create a scenario with increasing complexity, where further challenges can be foreseen in the near future due to the new applications and developments on system operation, such as:

- High Voltage DC (HVDC) Links
- Demand Side Response (DSR)
- Smart Grids
- Super Grids

HVDC Links

The operation of HVDC links has to be ensured by TSOs. This requires a systematic approach to their reliability when connected to the continental European AC grid and the consideration of the effects of connecting such large amounts of bi-directional power, in-feed/out-feed to single points, on the operation of the pan-European Transmission System. In addition, the operational impacts of HVDC also need to be accounted for, with their filter banks, zero fault level in-feed and very fast ramping rates.

The common features of devices such as PST (Phase-Shifting Transformers) or FACTS (Flexible Alternating Current Transmission Systems) are their controllability and the large impact they can have on cross-border power flows, including in conjunction with HVDC.

Nevertheless, these also provide opportunities for TSOs to optimise flows and voltages and have to be considered as such. It follows that TSOs have to coordinate the application and operation of PSTs and HVDC lines for coherent and coordinated power flows' control.

Demand Side Response

Demand Side Response is already becoming a reality, increasing the complexity of system operation due to its corrective control approach. Technical requirements, information provision and co-ordination are therefore needed in order to facilitate DSR resources to support transmission system security and to give demand users access to markets for ancillary services acquired by TSOs.

Smart Grids

Whereas Smart Grids will provide a competitive edge for the IEM, focusing particularly on the Distribution Grids, leading to new products, processes and services. At the same time they will require a transformation of the functionality of the current Transmission and Distribution Systems to achieve the energy policy targets and to guarantee high security, quality and economic efficiency of electricity supply. Moreover, new developments related to aspects such as communication, especially between DSOs and TSOs, IT-infrastructure and new power system applications must be foreseen.

Super Grids

Contrary to the Smart Grids, the term Super Grids stands for the developments almost exclusively affecting the TSOs and Transmission Systems. Whereas the first ideas on a pan-European Super Grid date back to the early 1950-ies, the real needs (i.e. “collecting” and delivering wind power from the North and solar power from the South, while fostering evolution of the IEM at the same time) emerge only with the current evolution of the power systems, as a consequence of the energy turnaround. While initially perceived as a future prospect, Super Grids – building upon additional and substantial AC-lines re-enforcements, as well as greater integration of HV DC technology – are already becoming a reality today.

The OS NC provisions must therefore also account for the relevant aspects of the Super Grids, which are additionally determining the System Operation and Operational Security of the European Transmission Systems:

- Establishment and usage of the Common Grid Models for all phases of operational planning and real-time System Operation;
- Exchange and coordination of all relevant information and data, both between the TSOs and also between the TSOs and DSOs / System Users. This is an issue which is addressed in detail in Chapter 4 of the OS NC;
- Ensuring the provisions and a firm basis for coordinated control actions of all relevant TSOs , DSOs and System Users, in order to maintain the global and overall view, while at the same time acting locally or regionally to achieve the most efficient and effective results – maintaining Operational Security and maximizing the welfare from well utilised Transmission System capacities.

Taking into consideration the new developments described in this section and the associated opportunities and challenges for System Operation, the OS NC principles set the base for operational rules and for a technical-operational coordination between TSOs, DSOs and Grid Users in order to deal with issues such as the intermittent generation, with low predictability until closer to real-time, the massive growth of cross-border trade and transits, generation allocation close to real-time and continuously changing or high forecast complexities.

3.7 INTERACTION WITH OTHER NETWORK CODES

The network codes development process carried out by ENTSO-E addresses the interaction during drafting of several network codes in parallel. That these codes are at the same time both interfacing and influencing each other is a significant issue. Recognising this issue in the early drafting phases of the OS NC, internal coordination has been held between the convenors and drafting teams (regular conveners meetings, workshops between different drafting teams, etc.) to treat the key cross-issues and therefore reach the required close cooperation between the different network codes drafts.

The major cross-issues have been dealt among the different network codes in the following way:

- The Network Codes on *System Operation* - The OS NC can be viewed as the 'umbrella' code for all the System Operation Network Codes. It therefore sets the overall principles for System Operation and reflects on the common high level issues for the Network Codes for Load-Frequency Control and Reserves (LFCR NC), and for Operational Planning and Scheduling (OPS NC). The LFCR and OPS codes will describe their specific processes in greater detail. Moreover, issues to be covered in the future Emergency Code are referred to where necessary.

- The Network Code on *Capacity Calculation and Congestion Management* (CACM NC) –was developed in advance of the OS NC, enabling the interfaces between the capacity calculation process and system operation to be identified in the early drafting phase of this code.

  The common work between the Capacity Calculation Drafting Team and the Operational Security Drafting Team led to the classification of topics treated among both codes based on the following reasoning: while topics related to the physical operation of the power system - where physical scenarios are hypothesised and physical risks are involved - are covered by the System Operation Network Codes, topics related to the operation of the electricity market - where market scenarios are hypothesised and financial risks are involved - are covered by the CACM NC, taking into account the physical risks described in the System Operation Network Codes.

  A data list containing the information required as an input for building and implementing a Common Grid Model (CGM) has been shared among the CACM NC, the OS NC and the OPS NC for the following reason: while the Common Grid Model is to be used for capacity calculation, it shares the same technical data that TSOs require for the calculation of load-flows in order to carry out network Security Analysis, taking into account the fulfilment of the (N-1)-criterion.

  Furthermore, in order to ensure the appropriate coherency and compatibility and to reach an agreement on the legal approach of the different Network Codes, an internal ENTSO-E Workshop on Capacity Calculation and System Operation Network Codes was organised in December 2011.

- The Grid Connection Codes: *Network Code on Requirements for Grid Connection Applicable for All Generating Facilities (RfG NC) and the Demand Connection Code DCC NC)*

  Transmission System Operators are responsible for defining operational practices and operational requirements for Grid users, in order to make the best use of the available infrastructure and to reach European energy policy targets. It is a common practice for TSOs to review these operating practices periodically even if fundamental changes are not frequent. Operating practices have to be adapted to the system evolution, with the load and the generation mix (type and location of generating units) as major drivers, but must at the same time be within reach of the Grid User's technical capabilities.

  Since Grid User's installations are built to operate for a few decades, it is essential that the Connection codes are designed to anticipate the operational needs of the future system. Having this perspective in mind, the RfG NC and DCC NC set out requirements for the technical capabilities of generation and demand to ensure power system security and safety.

  Operational thresholds

  As a consequence, the approach taken by the OS NC differs from that of the Grid Connection Codes. The reason why no concrete values appear in the OS NC is that operational thresholds for voltage and frequency might be different for different synchronous areas and in different timeframes. Indeed, if relevant and for justified reasons, the thresholds might be different or more stringent than the common ones even for each TSO. Therefore, quantitative values are to be set and periodically reviewed by TSOs, either individually or in agreement with neighbours, in order to fulfil the guiding principles of the NC OS.

Based on the fact that the definition of operational thresholds is intrinsically related to system performance and with the aim of taking into account the above mentioned existing differences between each synchronous area and specificities of isolated systems, the ENTSO-E Incidents Classification Scale introduces different thresholds into the classification principles by defining the following specific thresholds: definition of loss of generation, definition of loss of load, frequency deviation and percentage of peak load affected by black out.

In this context, it should also be noticed that every isolated system can have different thresholds suitable for the system. For example, in the case of Spanish isolated systems (SEIE) incidents do not have impact on other TSOs, and usually are not even relevant at national scale[3].

Differentiation by type of Generating Facilities

For a systematic and consistent addressing of the Generating Facilities in the requirements, and in order to reach consistency in the terminology used and appropriate cross referencing between the OS NC and the RfG NC, the OS NC has adopted the differentiation by type of Generating Facilities defined in the RfG NC in the following manner:

a)A Synchronous Power Generating Unit or Power Park Module is of Type A if its Connection Point is below 110 kV and its Maximum Capacity is 0.8 kW or more;

b) A Synchronous Power Generating Unit or Power Park Module is of Type B if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO This threshold shall not be above the threshold for Type B Power Generating Modules according to table 1;

c) A Synchronous Power Generating Unit or Power Park Module is of Type C if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO. This threshold shall not be above the threshold for Type C Power Generating Modules according to table 1;

d) A Synchronous Power Generating Unit or Power Park Module is of Type D if its Connection Point is at 110 kV or above; .a Synchronous Power Generating Module or Power Park Module is of Type D as well if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO. This threshold shall not be above the threshold for Type D Power Generating Modules according to table 1.

3 „Incident Classification Scale Guidelines“, ENTSO-E, March 2012.

Synchronous Area	Maximum capacity threshold from which on a Power Generating Module is of Type B	Maximum capacity threshold from which on a Power Generating Module is of Type C	Maximum capacity threshold from which on a Power Generating Module is of Type D
Continental Europe	1 MW	50 MW	75 MW
Nordic	1.5 MW	10 MW	30 MW
Great Britain	1 MW	10 MW	30 MW
Ireland	0.1 MW	5 MW	10 MW
Baltic	0.5 MW	10 MW	15 MW

[Source: "Network Code on Requirements for Grid Connection Applicable for All Generating Facilities", ENTSO-E]

Table 1: Thresholds for Type B, C and D Power Generating Modules

3.8 CLARIFICATION ON SOME CONCEPTS USED IN THE OS NC

As a result of the comments by stakeholders in the 2nd Workshop of the OS NC, which was held on 2ndJuly 2012,in particular the two terms "Common Grid Model" and "Significant Grid User "are clarified in more detail in this Supporting Document.

3.8.1 Common Grid Model (CGM)

The CGM is an ENTSO-E wide data set used to prepare a model which can be used to analyse different scenarios. These scenarios are valid to enable security analysis and capacity calculation to be performed. To perform the analysis, the whole Common Grid Model or the necessary part of it is used. The scenarios are prepared for different time frames: Year ahead, Week ahead, Day ahead and Intraday. All of them are used for Contingency analysis; and the Day ahead and Intraday ones are also used for Capacity Calculation.

The CGM comprises at least the transmission system of 220 kV and higher voltage network, an equivalent model of the lower voltage grid with influence and the sum of generation and withdrawals in the nodes of the transmission network. It is formed by merging the individual data sets provided by every TSO as stated in the article 17(3) of the OS NC. The individual data provided by each TSO comes from its own observability models. The Individual data sets, so-called individual grid models, are part of the Common Grid Model, as reflected in the figure below:

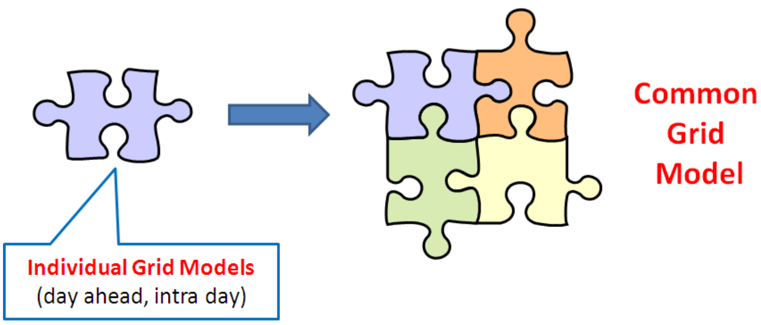

Figure 3: individual grid models versus common grid model

Whereas the OPS NC describes the procedure to prepare the CGM scenarios in each time frame for contingency analyses, it is in the CACM NC where the requirements for building the CGM scenarios for capacity calculation purposes are set.

The next figure gives an overview of the building of the CGM and whether the respective actions are performed on TSO level or coordinated on a regional level:

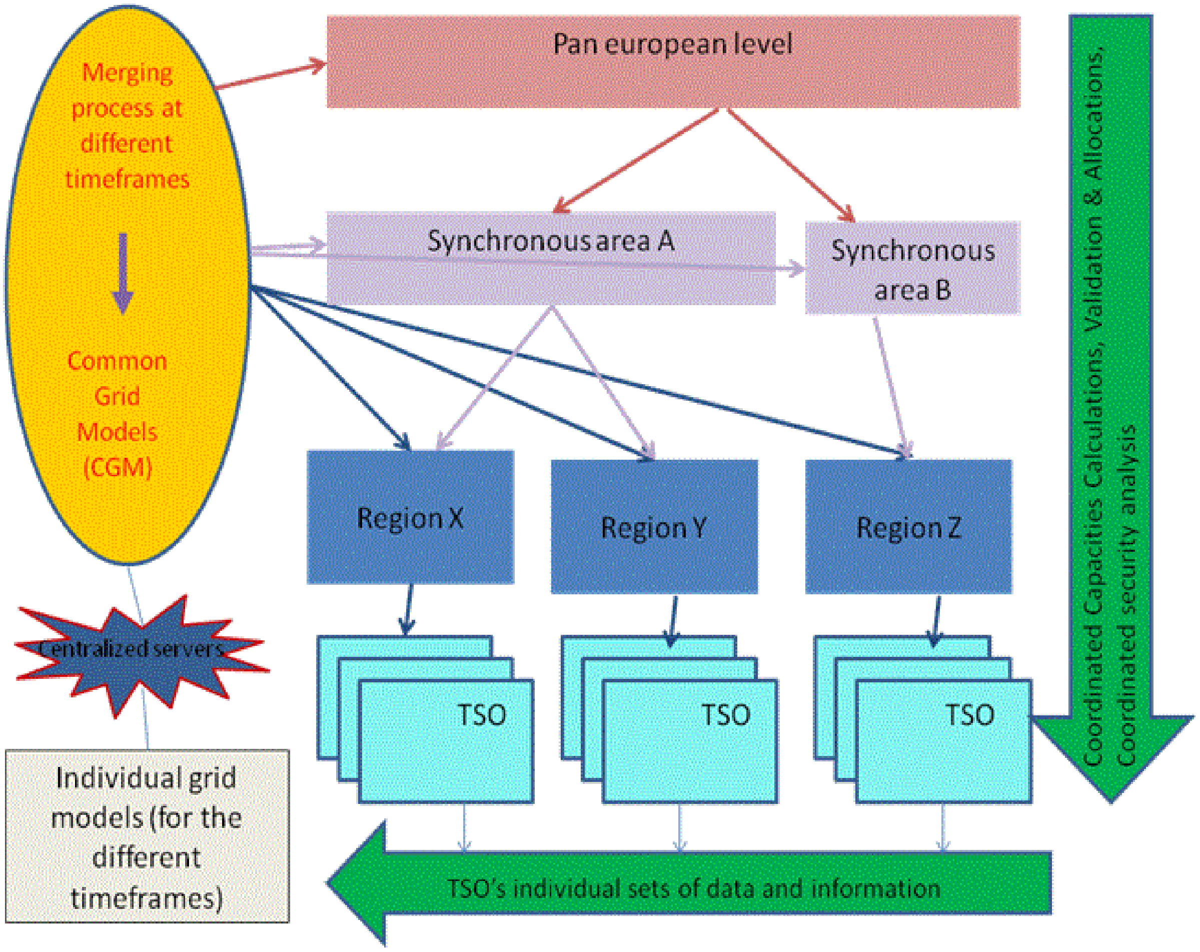

Figure 4: Overview of CGM building process: data and info exchange

The OS NC focuses on the Common Grid Model scenarios relevant for the purpose of security analysis, each TSO uses the data from its observability area to build, within each relevant time frame, the individual data set for the Common Grid Model. This process is carried out considering certain conditions and covering zones to allow coordinated security analysis such as congestion and power flow management. It has to include relevant characteristics of the connected generation, consumption and distribution and transmission equipment and take into account planned outages.

The data from its observability area within the relevant timeframe permits the TSO to monitor its system and to perform the contingency analysis in order to assess the system state for contingencies and to set up the required remedial actions. The merging of all the Individual Grid Models forms the ENTSO-E Common Grid Models that allows monitoring of the whole system and the performing of coordinated contingency analysis where there is influence between more than one TSO.

3.8.2 Significant Grid User

According to the SO FG, Significant Grid User is defined as “pre-existing grid users and new grid users which are deemed significant on the basis of their impact on the cross border system performances via influence on the Control Area’s security of supply including provision of ancillary services”. This has been the approach followed by the OS NC, defining the significance by considering the impact of a grid user on the cross border system performance, regardless of the connection point voltage.

As stated in article 7.11 of the OS NC, each TSO shall thereby define the threshold of significance of the Grid Users, which shall be submitted to the relevant National Regulatory Authority and which depends on the size of the Transmission System, the number and size of Power Generating Facilities and Demand Facilities connected to the Transmission System and the composition of the generation mix.

3.8.3 Observability area versus responsibility area

Due to the increase of interconnections between TSOs, security assessment has become more and more interdependent. As a consequence the TSO has to take into account the influence of the surrounding grid on its responsibility area by analysing the external transmission network which has influence on its responsibility area, this introduces the concept of observability area.

The OS NC therefore sets the following definitions for the terms observability area and responsibility area:

Observability Area means “the area of the relevant parts of the Transmission Systems, relevant DSOs and neighbouring TSOs, on which TSO shall implement a real-time monitoring and modelling to ensure reliability of the respective Responsibility Area. “

Responsibility Area means “a coherent part of the interconnected system operated by a single TSO with physical loads and generation units connected within the area.”

The following figure reflects in a schematic way the above mentioned definitions with the purpose of clarifying what is exactly meant under each term and how are those terms linked:

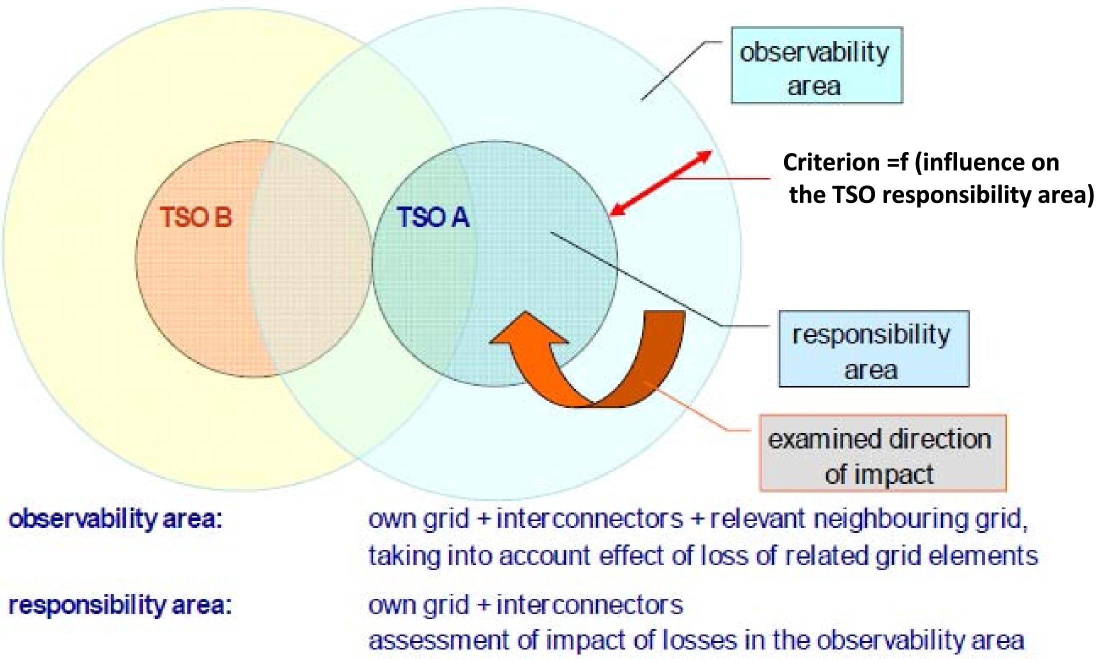

Figure 5: Definitions on observability area and responsibility area of a TSO

3.9 WORKING WITH STAKEHOLDERS& INVOLVED PARTIES

The legally binding nature of network codes achieved through the Comitology process implies that they can have a fundamental bearing on stakeholders businesses. As such, the ENTSO-E recognised the importance of engaging with stakeholders at an early stage, involving all interested parties at the earliest possible phases in the development of the code, in an open and transparent manner.

ENTSO-E's stakeholder involvement comprises workshops with the DSO Technical Expert Group and public stakeholder workshops, as well as ad-hoc meetings and exchange of views with all interested parties as necessary.

Due to the many questions concerning the function of the Transmission System from an operational point of view that arose during the public consultation of the RfG NC, the first "unofficial" ENTSO-E stakeholder workshop on System Operation was held on 19thMarch 2012 in Brussels with an aim of explaining the key concepts in and around System Operation. A further aim of the workshop was to present information focusing on the operation of an interconnected Transmission System, and the physical basis for scoping and drafting the System Operation network codes. Stakeholders have also had the opportunity to raise questions, express feedback and expectations.

In line with suggestions by stakeholder organizations and following requests by the EC and ACER, ENTSO-E has scheduled four "official" workshops with the DSO Technical Expert Group and four "official" workshops with all stakeholders before, during and after the public consultation:

- The aim of the first OS NC Workshops (20thApril 2012) was to present and discuss the scope of the draft OS NC, which reflected the work completed by TSO experts as of 5 April 2012. The workshop addressed the scope of the network code, provided an update on the present state and allowed for discussion and a Q&A session. Stakeholders in attendance included DSOs, industrial electricity consumers, generators, energy traders and turbine suppliers.

- The aim of the second OS NC Workshops (2ndJuly 2012) was to present updates made to the network code and to present the main content of the first version of this Supporting Document based on the stakeholder feedback received in the first OS NC workshop. The workshop was an opportunity for stakeholders, including DSOs, industrial electricity consumers, generators, energy traders and turbine suppliers, to provide feedback on the current status of the network code.

- The aim of the third OS NC Workshops planned during the public consultation will be to discuss in detail the remarks by the respondents in the consultation and to explain any outstanding issue or questions on System Operation or Operational Security, which might be raised by the respondents.

- The aim of the fourth OS NC Workshops planned for December 2012 will be to present the final version of the OS NC including the relevant amendments resulting from the public consultation.

4 RELATIONSHIP BETWEEN THE OS NC & FRAMEWORK GUIDELINES

The OS NC sets the pan-European basis for ensuring on a high level secure and coordinated System Operation, facing the three key challenges identified by the SO FG:

- To define harmonised Security Criteria.
- To clarify and harmonise TSOs roles, responsibilities and methods.
- To enable and ensure adequate data exchange.

The requirements described in the OS NC have been formulated in line with the SO FG and the new developments on System Operation, with the aim of maintaining the necessary level of Operational Security. The OS NC can therefore be defined as a benchmarking for the objectives and key challenges addressed in the Framework Guidelines: the Operational Security issues raised by the FWGL SO are addressed in eleven categories of requirements and these are further described in section 5 of this document.

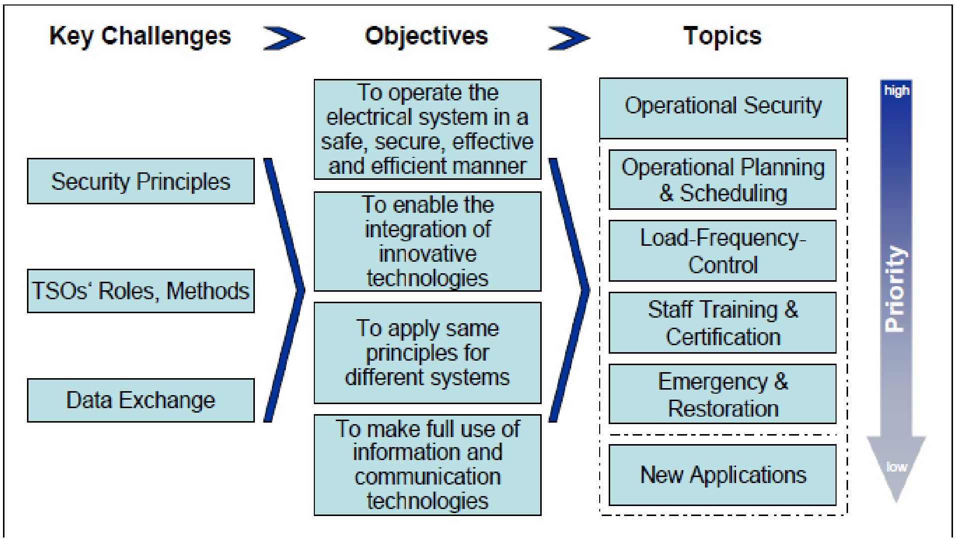

Figure 6. Structure and development flow of the Framework Guidelines on Electricity System Operation.

The OS NC reflects the common issues described by the OPS NC and the LFCR NC with the following reasoning:

- The bases of OPS including the principles, key tasks and activities conducted prior to the real-time operation are set out in the code, whereas the description of further details is part of the OPS NC.
- Whereas article 7 of the OS NC sets the general framework for the frequency control management, it is in the LFCR NC where concrete issues are described in greater detail.

As an instrument required for the maintenance and further improvement of normal operation and whose importance was emphasised in the ERGEG Guidelines of Good Practice for Operational Security [4], it has been considered appropriate to address the topic of Operational Training and Certification in the OS NC with a general focus and with its own chapter(5). More details regarding Training will be developed within a separate NC on Operational Training and Certification.

Emergency and Restoration, as an issue focusing on defence plans and restoration of the system after a major disturbance or a blackout, but also analysing events afterwards, has been considered to be beyond the framework of a “regular” System Operation. Thus it will be addressed separately in a later NC on Emergency & Restoration.

5 OBJECTIVES OF THE OS NC

This chapter describes the objectives that the OS NC sets out to achieve by means of the defined standards and requirements.

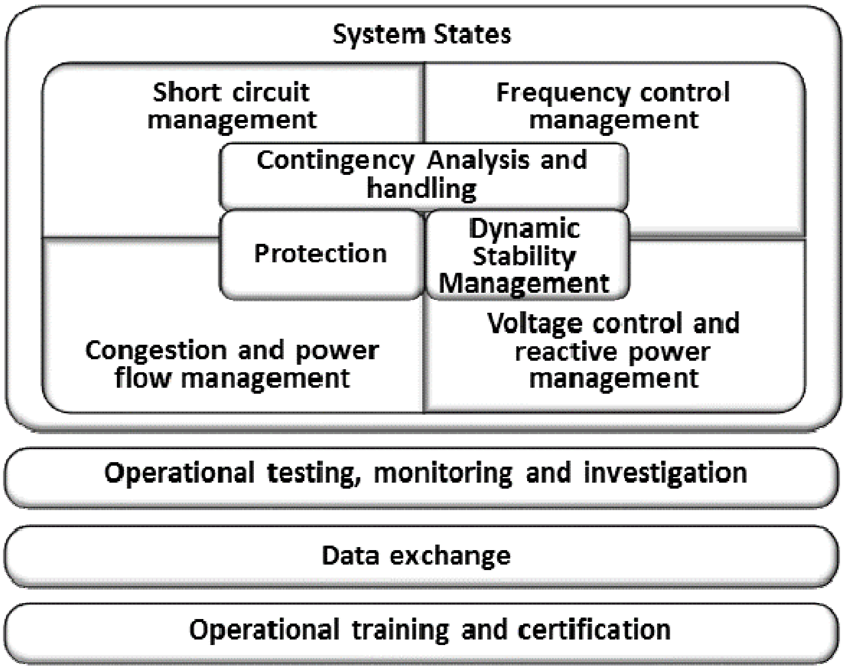

Figure 7: Structure and provisions of the Operational Security Network Code

5.1 SYSTEM STATES

A continuous monitoring of the System State, based on the real-time measured values of operational parameters with permanent online mutual information about the System State within affected TSOs and with a common set of definitions for the states across all TSOs, provides for effective State Estimation and for control actions in order to keep the system in a Normal State or return to it as soon and close as possible in case of disturbances.

The increased system coordination achieved by monitoring the System State contributes to a coherent and coordinated behaviour of the interconnected Transmission System, both in each Control Area and between Control Areas.

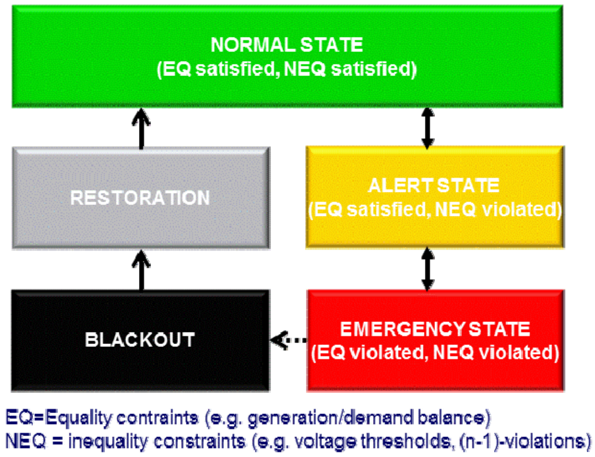

Figure 8: System States in the framework of the OS NC

5.2 Frequency Control Management

The scope of frequency control management is to maintain a continuous balance between generation and demand, ensuring frequency quality and stability within each Synchronous Area. For this purpose, TSOs shall procure adequate upward and downward active power reserve and shall define criteria, according to which the quality and stability of the frequency shall be assessed. What's more, in line with the NC on LFCR and the NC on Balancing, common criteria are set for the dimensioning and establishment of control reserves.

TSOs should be aware of parameters that can lead to frequency deviations and check them in order to take joint measures to limit the effects on their system balance. Increasing power exchanges between control areas, the intermittent nature of the RES generation and, the difficulties in forecasting load/generation variations due to normal operation evolution and/or disturbances, market driven imbalances –e.g. ramping at the hour shift- impose great challenges on the TSOs for balancing demand and generation. Furthermore, the robustness of the system in terms of stability is deteriorating, as the increasing volume of power stemming from RES does not contribute to the total inertia of the system. To the contrary, RES replaces synchronous generators and therefore alters the principles of the current power system operation.

The provisions of the OS NC take into consideration these emerging new factors and ensure uninterrupted operation while facilitating the flexibility of the TSOs in procuring the reserves in collaboration with their neighbouring TSOs.

5.3 Voltage Control and Reactive Power Management

Voltage conditions in a Transmission System are directly related to the reactive power situation at the system nodes. In order to compensate for an excessive consumption of reactive power, TSOs must make sure that the most efficient and effective producers feed / absorb sufficient reactive power onto the networks in addition to the reactive power from other devices installed in the networks or in Customer Facilities. TSOs must ensure a continuous and local reactive power balance to ensure a proper voltage level at the network.

In this context, the goal of voltage control and reactive power management is to ensure that:

- Voltage levels, reactive power flows and reactive power resources are monitored, controlled and maintained in real-time within the Operational Limits, in order to protect the equipment of the Transmission System and ensure its voltage stability.

- Adequate instantaneous reactive power reserve is available in spinning generators, reactors and capacitors in order to secure the technical functioning of the power system and to restore the Normal State after disturbances.

For this purpose, permanent online mutual observation and information exchange that takes place with neighbouring TSOs is established.

5.4 SHORT-CIRCUIT CURRENT MANAGEMENT

Short-circuit current management is required to prevent all types of Generating Facilities, network elements and related equipment from damage and to provide safety for persons, through the fast and selective disconnection of short-circuit faults.

The objective of short-circuit current management is therefore to keep the impact of short-circuit currents at a level that provides secure functioning of the Transmission System with system protection and its set-points. This implies:

- Enabling an accurate short-circuit current calculation by TSOs while following standardised principles and ensuring the required data provision from neighbouring TSOs, DSOs and Significant Grid Users.

- Monitoring the short-circuit currents and taking preventive and curative remedial actions if the Operational Security Limits are or tend to be violated.

- The required provision of information and communication to affected TSOs, DSOs and Significant grid users in order to be able to consider the effect of other Transmission and Distribution systems.

5.5 CONGESTION AND POWER FLOWS MANAGEMENT

Each Transmission System element has an operational power flow limit. These limits are defined with the aim of protecting the equipment and the people in the vicinity, also taking into account the technical constraints of the materials in order to avoid damage or premature ageing.

The scope of congestion and power flow management provisions is therefore to establish the operational means to maintain power flows below operational power flow limits on every part of the Transmission System. To be able to monitor and control operational parameters in the system it is necessary to have precise information about System States and an accurate State Estimation. For this, each TSO has to control operational parameters inside its own Responsibility Area and, with coordination, take into account the Observability Area of neighbouring systems; this implies structural and real time data information exchange between affected TSOs and between TSO and DSOs in its Responsibility Area. When necessary, individual or coordinated Remedial Actions shall be prepared and/or applied to avoid violation of Operational Security Limits.

5.6 CONTINGENCY ANALYSIS AND HANDLING

Article 11 of the OS NC covers the N-1 security principle, a long established deterministic standard which is common amongst TSOs. With the aim of maintaining the Operational Security of the

Transmission System, contingency analysis consists of simulating the tripping of network elements. This analysis is conducted based on the observability areas of the TSOs, respecting Operational Limits whilst preparing and carrying out pre-fault and / or post-fault remedial actions where required.

The key principles to be followed in relation to contingency analysis, which also outline the overall goals and objectives of contingency analysis in real-time and in operational planning phase are:

One goal

“No cascading with impact outside my border”

Two obligations

1 - Obligation for each TSO to monitor the consequences of the events defined in its contingency list (= normal + exceptional contingencies) and warns its neighbours when its own system is at risk at any operational planning stage and in real time

2 - Mandatory coordination by bi-multilateral, even regional actions to better assess the consequences of any domestic TSO’s decision

Three behaviours

1 - “Be aware of the risks”, even if not sufficiently covered by remedial action due to too high costs (potential emergency situations)

2 - “Best efforts” to set-up remedial actions, that is not always possible or sufficiently efficient by one single TSO to cover exceptional contingencies

3 – Be aware of impacts of domestic operational decisions (switching, redispatching, outage planning, capacity assessment) on neighbouring systems

Risk assessment: a concern

Each TSO is only responsible for the operation of its own network. But it is required to inform relevant neighbors in case it assumes some risks to come from outside or to come from inside to be propagated abroad.

Inter-TSO coordination

Bilateral, multi-lateral or regional coordination is requested to assess risks.

Thus, the objectives of contingency analysis and handling in the OS NC can be summarised:

- To ensure prevention and/or remedy in terms of control actions required to maintain Operational Security, for all credible contingencies affecting the Transmission System.
- To coordinate both analysis and control actions, wherever it is necessary, to ensure the best result – Operational Security of own and the interconnected Transmission System.
- To rely on adequate data and information: real-time, forecast, Common Grid Model and sufficient exchange between TSOs and especially from DSOs and Grid Users.
- To elaborate pan-European standard provisions for Contingency Analysis in order to maintain Operational Security while maximizing system utilisation.

5.7 PROTECTION

Equipment protection is used to protect transmission assets from faults. System Protection Schemes are used to detect abnormal system conditions and take predetermined, corrective actions to preserve system integrity and provide acceptable system performance. System Protection Schemes are nowadays widely used by many TSOs in most Synchronous Areas.

System protection functions shall be analysed, with relevant network calculations, considering correct and incorrect functioning. If unacceptable consequences are forecast, functionality and redundancy of the scheme have to be accordingly adjusted to fulfil system security requirements. The functionality and operational status have to be monitored, communicated and coordinated between neighbouring TSO and other parties affected by the system protection.

5.8 DYNAMIC STABILITY MANAGEMENT

The goal of the Dynamic Stability Assessment (DSA) is to ensure awareness of the TSO staff regarding the current and future planned operating state of the Transmission System with respect to stability, in the N situation and the potential (N-1) situation. In addition, DSA supports the decisions in relation to the most effective and efficient remedial actions to be initiated to prevent disturbances or correct their consequences if disturbances occur.

The extensive use of DSA allows different applications, not only in real-time operation, but also in operational planning phases. An emphasis must be put on training of staff operating and making use of DSA as well as to the continuous maintenance of models and simulation engines via on site tests and validations.

The OS NC focuses on the different scopes that can be taken for the DSA depending on the characteristics of the correspondent Transmission System:

Presently DSA is only an issue for a few Transmission Systems where closer to real-time DSAs are required (e.g. Nordic countries due to a system characterised by longer transmission lines). However, the future evolution of DSA will focus on its connection with Special Protection Schemes and Wide Area Measurement Systems, in order to face operating conditions for which fast automatic remedial actions are necessary and cannot be achieved through the manual intervention by the control room operator. In this framework, Dynamic Security Analysis will indicate, in relation to automatic protection systems, the most suitable adaptive logics to be triggered in case of critical contingencies, calling for fast emergency corrective actions.

5.9 OPERATIONAL TESTING, MONITORING AND INVESTIGATION

The objective of operational testing and monitoring is to ensure correct functioning of elements of the Transmission and Distribution System and Grid User's equipment; to ensure Generating and Demand Units continue to meet connection requirements and their declared availability and supply of ancillary services; to maintain and develop operational procedures; to train staff and to acquire information in respect of power system or equipment behaviour under abnormal system conditions.

Planning for and coordination of operational tests is necessary to minimise disruption to the stability, operation and economic efficiency of the interconnected system. For the efficient planning, coordination and implementation of tests, the TSOs require the cooperation of Grid Users in the provision of the necessary data.

As the power system is subject to various disturbances that could lead to a widespread incident, the TSOs will have to undertake investigations to determine the main causes and learning points of disturbances in order to avoid, if possible, their recurrence. The incidents classification scale developed by ENTSO-E [8] will provide the procedures for incident classification, analysis and reporting with the aim of monitoring system security levels and identification of improvements to reduce the risk of reoccurrence.

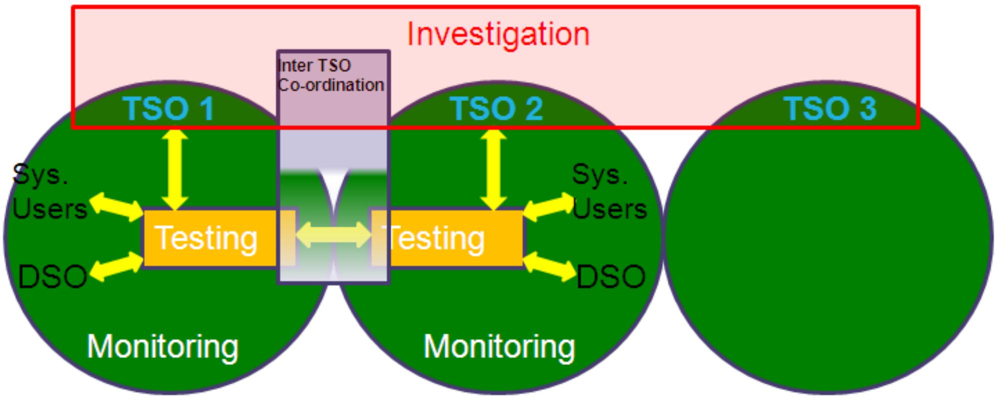

Figure 9: Coordination of tests between TSOs, DSOs and System Users

5.10 Data Exchange

As a consequence of the new developments on System Operation described in section 3.5, the increase of volume and dynamics of intra- and inter-regional power flows has significantly affected the security of System Operation. This tendency is set to further increase in the near and longer term future. What's more, the increased variable and dispersed generation on medium and low voltage levels replaces conventional generators in operation and this increases the TSOs challenges in managing the Transmission System in a safe and secure manner.

To underpin the security and stability of the electricity supply system, it is essential to assess the expected power flow in the Transmission Network as accurately as possible and to forecast the System State in order to avoid hazardous situations in real-time and to plan adequate measures. The required access by TSOs to data from DSOs and Grid Users has to be assured to facilitate this assessment by TSOs. Additionally, the OS NC covers the required access by DSOs to data from Grid Users directly connected to their Distribution Network in order to ensure security of supply.

For a high forecast accuracy, to ensure the security of the electricity supply system in the Control Area at maximum capacity utilisation and as an issue that directly influences operational planning and System Operation, it is critical to be able to accurately forecast all parameters of the network model and the system balance. While the TSO carries out the topology forecast on its own, the power balance creation requires both its own grid information and that of Distribution Networks. The accuracy of variable generation forecasts can be significantly improved closer to real-time operation, which heightens the focus on the data and information to be provided by TSOs, DSOs and Grid Users.

With regard to the exclusive responsibility of the TSO for system security and liability for its own actions, TSOs work on the principle that they must have full control over the tools used and a complete overview of the data quality in-house and externally-supplied information. Since mere trust in the accuracy of information without an appropriate level of assurance and control is not acceptable for reasons of liability, the OS NC establishes the right to TSOs to receive the required data with the aim of enabling the performance of accurate security analysis and, at the same time, establishes the obligation on stakeholders and involved parties to provide the therefore required data with an adequate level of quality and precision.

Due to the full unbundling introduced by the 3rd Energy Package, there is no reason for the avoidance of data provision to a TSO due to confidentiality matters.

Thus, the focus is on fast feasible data provision by DSOs and Grid Users necessary for detecting, forecasting and thus for carrying out Security Analysis of a Transmission System ahead of and in real-time, making possible increased coordination in System Operation between TSOs, DSOs and Grid Users.

5.11 OPERATIONAL TRAINING AND CERTIFICATION

In line with SO FG [1] and the Guidelines of Good Practice for Operational Security [4], operational training is required in order to guarantee that System Operators and other operational staff are skilled, well trained and certified to operate the power system in a secure way during all operational situations.

In this context, the OS NC sets up the goal of implementing a wide training and certification process, which will enable recognising and responding to abnormal operating conditions in appropriate timescales and, where appropriate, in a coordinated manner with other TSOs. What's more, the application of operational standards can be ensured by the development of programmes involving initial training, continuous staff development and regular certification re-assessment.

6 ADDED VALUES OF THE OS NC

While deciding on the objectives and major topics to be included in the OS NC, a constant screening process with the objectives defined by the SO FG has been carried out. The analytic approach taken for drafting the OS NC resulted in the current code structure. Reaching this point and by recognising that the added values of the code are inherently linked to its Objectives of the OS NC, the following benefits are to be expected by implementing the operational principles defined in the OS NC:

Added value	Related article of the OS NC
Apply the same operational security principles for System operation among European TSOs.	- The whole code
Improve the interconnected system safety and security.	- Articles 6 to 13
Optimise the detection of constraints in the Transmission System by enforcing coordination between TSOs and between TSOs, DSOs and Significant Grid Users.	- Articles 6, 11 - Chapter 4: Data Exchange
Reduce the risk of system-wide disturbances and the number of critical incidents, avoiding major incidents and limiting their consequences if they occur.	- Articles 6 to 13
Enhance uniform treatment of Significant System Users across Europe.	- Articles 6, 8, 11, 13 - Chapter 4: Data Exchange
Enable the integration of RES, maximising the output from intermittent generation whilst maintaining security of the	- Article 11 - Chapter 4: Data Exchange

Transmission System operation in an increasingly dynamic and changing future.	
Increase the potential for greater volumes of cross border exchanges, whilst ensuring existing levels of reliability are not reduced alongside ever increasing levels of RES intermittent output.	- Article 11 - Chapter 4: Data Exchange
Prepare the network for integrating distributed generation.	- Article 11 - Chapter 4: Data Exchange
Make efficient and effective use of smart grid applications.	- Chapter 4: Data Exchange
Provide the adequate conditions for exploiting the demand-side potential and integrating advanced power electronic systems.	- Article 14 - Chapter 4: Data Exchange
Improve conditions for data collection, handling and exchange.	- Article 5 - Chapter 4: Data Exchange
Provide a framework for the compatibility of tools.	- Chapter 4: Data Exchange, but mainly in NC OP&S
Enhance the coordination of the tests between involved parties in order to ensure the correct functioning of all elements connected to the Transmission System.	- Article 14
Provide a common framework for the training of operators.	- Article 29

Whereas the benefits mentioned above cover the improvement of system security and therefore the ultimate goal of preventing blackouts, concrete numbers depend strongly on the underlying disturbance scenario and the region. Moreover, the probability of such events must be taken into account.

It is evident from this fact that a quantitative analysis of the added values of implementing the requirements of the OS NC would require an assessment, of the implementation and additional operation costs, to be conducted in cooperation by the TSOs, DSOs and Significant Grid Users.

7 RESPONSES AND NEXT STEPS

7.1 OVERVIEW

This chapter provides information on how to respond to the consultation on the OS NC and provides an overview of the processes which ENTSO-E intends to follow in developing a final version of the OS NC for submission to ACER.

7.2 SUBMISSION OF RESPONSES

In order to allow similar comments to be considered and appropriately responded to, all responses should be submitted via the ENTSO-E consultation tool. A brief submission guide can be found at https://www.entsoe.eu/resources/consultations/submission-guide/.

It is anticipated that many stakeholders and involved parties may wish to discuss issues raised in this document. For this reason ENTSO-E has scheduled a third workshop for the 19th September 2012 at the ENTSO-E premises. The workshop will be structured in a way which enables parties with an opportunity to provide their views. Should you wish to attend, please contact Pilar.Munoz-Elena@entsoe.eu.

7.3 RESPONDING TO COMMENTS

ENTSO-E will endeavour to respond to comments raised by stakeholders, indicating how a comment has been taken into account or indicating the reasons for not doing so, via the consultation tool. This document seeks to answer some of the questions which we have been repeatedly asked during the process of developing the code up to date.

7.4 NEXT STEPS

This is the only formal consultation by ENTSO-E on the OS NC. The participants are invited to provide comments and views. Following the closure of the consultation ENTSO-E will process comments and reflect them in the text of the code where applicable. An updated code will be subject to internal approval and will be sent to ACER by the 1st March 2013 deadline. As indicated above, the answers to the comments in the consultation will be published.

In the fourth public workshop planned on the 20thDecember 2012, the amendments of the code resulting from the public consultation will be presented.

8 REFERENCES

[1] "Framework Guidelines on System Operation" (FG SO), ACER December 2011.

[2] "Initial Impact Assessment", ACER June 2011.

[3] "Necessary data and information for safeguarding the operational system security by the German Transmission System Operators according to Section 12(4) of the EnWG", August 2011.

[4] "Guidelines of Good Practice for Operational Security", ERGEG November 2008

[5] ENTSO-E Implementation and Compliance Monitoring Concept

[6] ENTSO-E, Developing Balancing Systems to Facilitate the Achievement of Renewable Energy Goals, Position Paper Prepared by WG Renewables and WG Ancillary Services, November 2011.

[7] "Deterministic frequency deviations – root causes and proposals for potential solutions", a joint EURELECTRIC – ENTSO-E response paper.

[8] "Incident Classification Scale Guidelines", ENTSO-E, March 2012.

[9] "Network Code "Requirements for Generators" in view of the future European electricity system and the Third Package network codes", ENTSO-E, May 2012 (Draft)