Supporting Document for the Draft Network Code on Emergency and Restoration

FOR PUBLIC CONSULTATION

13 October 2014

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TABLE OF CONTENTS

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TABLE OF FIGURES

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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 consultation of the Network Code on Emergency and Restoration (NC ER) and should be read in conjunction with that document.

The document has been developed in recognition of the fact that the NC ER, which will become a legally binding document after Comitology, inevitably cannot provide the level of explanation, which some parties may desire. Therefore, this document aims to provide interested parties with the background information and explanation for the requirements specified in the NC ER, as well as the document outlines the following steps of the work.

1.2 STRUCTURE OF THE DOCUMENT

The Supporting Document is structured as all other supporting documents for the NCs developed in line with the Framework Guidelines on Electricity System Operation. This Supporting Document is therefore presented as follows:

Background

- Chapter 2 introduces the legal framework within which the System Operation Network Codes have been developed.
- Chapter 3 explains the approach, which ENTSO-E has taken to develop the Network Code, outlines some of the challenges and opportunities ahead for System Operation and benefits of the NC ER.

Explanatory notes

- Chapter 4 deals with the requirements of the Framework Guidelines on Electricity System Operation (FG ESO) developed by the Agency for the Cooperation of Energy Regulators (ACER) and their implications regarding the NC ER.
- Chapter 5 deals with the explanation of requirements of the NC ER.
- Chapter 6 introduces the next steps in the process.

Appendices

- Appendix 1: Definitions used in NC ER
- Appendix 2: Current practices in Europe on Emergency and Restoration

1.3 LEGAL STATUS OF THE DOCUMENT

This document accompanies the Network Code on Emergency and Restoration, but is provided for information only.

Therefore it has no legally binding status.

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2 PROCEDURAL ASPECTS

2.1 INTRODUCTION

This chapter provides an overview of the procedural aspects of the 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 NC ER.

2.2 THE FRAMEWORK FOR DEVELOPING NETWORK CODES

The NC ER has been developed in accordance with the process established within the Third Energy Package, in particular in Regulation (EC) N° 714/2009. The Third Energy Package legislation establishes ENTSO-E and ACER and gives them clear obligations in developing Network Codes. This is shown in Figure 1 below:

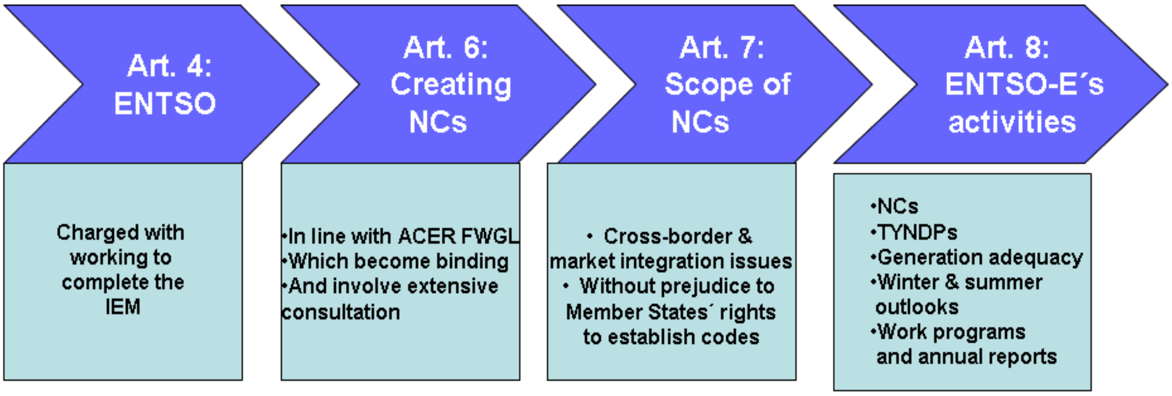

Figure 1: ENTSO-E's legal role in Network Code development according to Regulation (EC) N° 714/2009.

Moreover, this framework creates a process for developing Network Codes involving ACER, ENTSO-E and the European Commission, as shown in Figure 2 below.

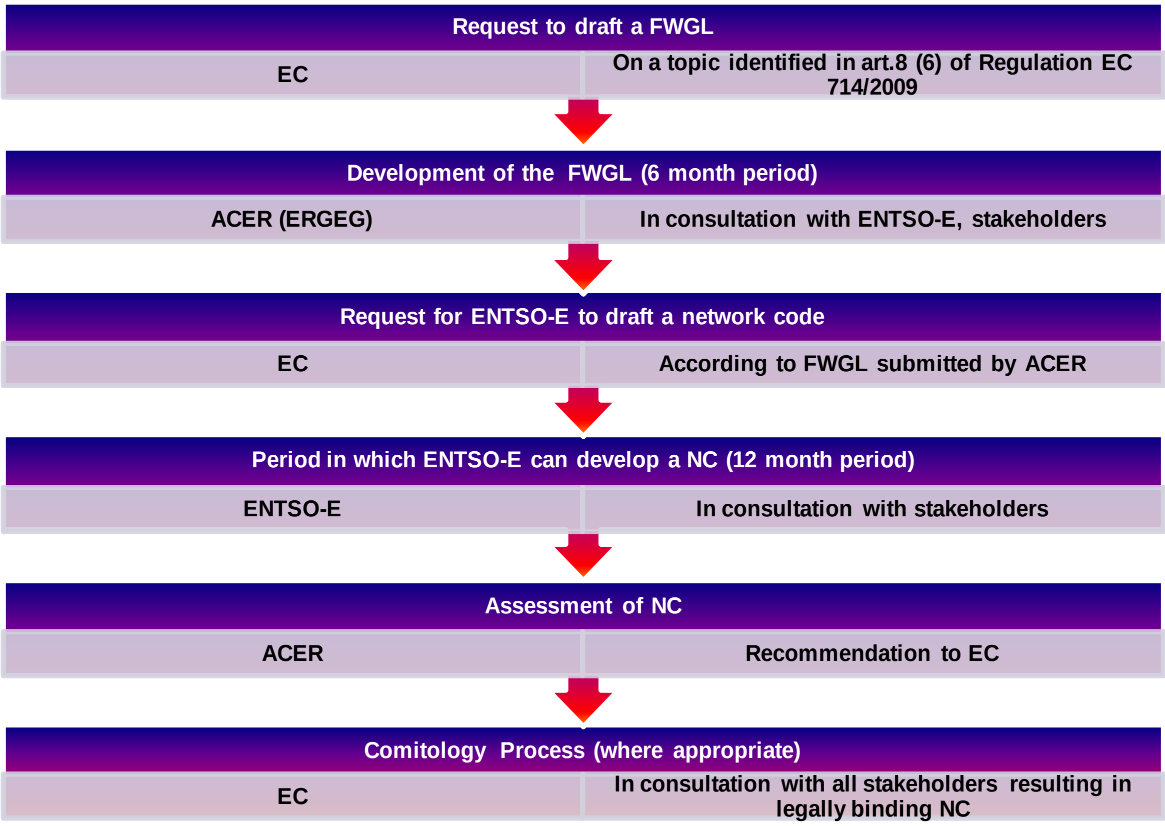

Figure 2: Network Codes' development process [Source: ENTSO-E]

The NC ER has been developed by ENTSO-E to meet the requirements of the Framework Guidelines on Electricity System Operation (FG ESO) [1] published by ACER in December 2011. ACER has also conducted an Initial Impact Assessment associated with its consultation on its draft FG ESO in June 2011 [2].

ENTSO-E was formally requested by the European Commission to begin the development of the NC ER on the 1 April 2014. The deadline for the delivery of the code to ACER is the 1 April 2015.

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3 SCOPE, STRUCTURE & APPROACH TO DRAFTING THE NC ER

3.1 INTRODUCTION

This chapter provides the overview of the background and place of the NC ER, covering the guiding principles for the Drafting Team in developing the NC ER, general structure and level of details of the code, challenges and opportunities ahead of system operation, interaction with other Network Codes, interaction with stakeholders during the network Code development process, describing how NRAs are involved and benefits of the NC ER.

ENTSO-E has drafted the NC ER to set out clear and objective minimum requirements for real-time operation when in Emergency, Blackout or Restoration states. The aim is to achieve, maintain and restore a satisfactory level of Operational Security of the interconnected Transmission Systems in real time, to support the efficient functioning of the European Internal Electricity Market (IEM), and to allow the integration of electrical Renewable Energy Sources.

Based on the FG ESO and on the Initial Impact Assessment (IIA) provided by ACER, the NC ER states the emergency and restoration principles in terms of technical means, considering compatible market solutions and as such provides support to maintain and restore the security of supply.

3.2 GUIDING PRINCIPLES

The guiding principles of the NC ER are to determine common Interconnected System operation framework, to ensure the conditions for maintaining and restoring Operational Security levels throughout the EU, as well as to determine common requirements for DSOs, power generating facilities and demand facilities connected to Transmission and Distribution Systems, which are relevant for the operation in emergency and restoration situations of the Interconnected System. These principles are essential for the TSOs to manage their responsibilities for ensuring a secure operation of the interconnected Transmission Systems with a high level of coordination, reliability, quality and stability.

Key objectives of the NC ER are:

- to prevent the propagation or deterioration of an incident, in order to avoid a widespread disturbance and Blackout State, and
- to ensure efficient and rapid restoration from Emergency or Blackout System States.

The requirements set out in the NC ER are building on 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 1950s (ENTSO-E Regional Group Central Europe (RGCE), former Union for Coordination of (Production) and Transmission of Electricity (UC(P)TE)), 1960s (ENTSO-E North, former Nordel), and 1970s (TSO Associations of Great Britain and Republic of Ireland, UKTSOA and ITSOA), distinguishes the NC ER and all other SO NCs from other Network Codes in following terms:

- The work on the SO NCs does not start from “scratch” but builds upon a wide and deep range of requirements, policies and standards already existing in the different European Synchronous Areas, adapting and developing further these requirements in order to satisfy the requirements from the FG ESO, to meet the challenges of permanent evolution of the energy sector as well as to support the effective and efficient completion of the IEM;
- The subject matter – system operation of the interconnected Transmission Systems of Europe – is vital, not just for the continuous and secure supply of European citizens with electricity, but

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also for the electricity market to function properly, efficiently and for the benefit of all Market Participants. 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" – TSOs 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 System Operators; nevertheless, firm 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 regulating power/balancing.

3.3 Background and Structure of the NC ER

Secure and efficient Transmission and Distribution Systems operation can be made possible, only if there is an obligation for the Transmission System Operators (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. Even though each TSO has one Responsibility Area, they are responsible for secure and efficient system operation as a common task:

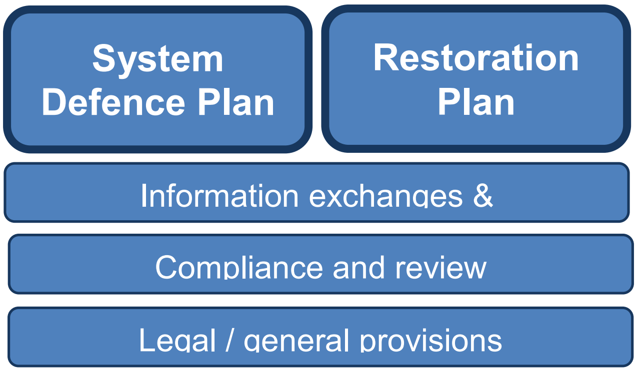
- All systems are to some extent interconnected, and a fault in one area will possibly affect another area. Hence, secure system operation requires close coordination and cooperation between the TSOs.
- Efficient system operation requires close collaboration between all stakeholders; the main purpose of the liberalisation, and therefore of the harmonisation, of the electricity sector was efficiency, more specifically utilizing efficiently the resources for balancing the system. This requires close collaboration and coordination with all stakeholders.

Secure and efficient Transmission and Distribution Systems operation can be made possible only if there is a well-organized preparation of real time operation.

The NC ER provides a basis for this preparation as it defines minimum requirements for ensuring efficient System Defence Plan and Restoration Plan. These minimum requirements will be applicable to all TSOs, DSOs and Grid Users of significance to the Transmission System.

The NC ER resides under the umbrella of the Network Code on Operational Security, and therefore shares the principles of supporting the coordination of system operation across Europe.

The NC ER structure is the following:



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For each Plan, three phases are identified:

1. Design: study phase consisting of defining the detailed content of System Defence Plan and Restoration Plan, according to structure detailed below
2. Implementation: preparatory phase consisting in the installation of all necessary means for the purposes of the System Defence Plan and Restoration Plan, procurement of services, deployment of Procedures defined in the System Defence Plan or Restoration Plan
3. Activation: operational phase consisting of system operational state leading to the use of one (or more) measure(s) from the System Defence Plan or Restoration Plan

3.4 Level of Detail

The System Operation NCs provide minimum standards and requirements related to system operation. The level of detail matches the purpose of the codes:

- harmonising security principles,
- clarifying and harmonising methods, roles and responsibilities of operators and grid users as well as to enable and ensure adequate data exchange in order to future proof the system for integrating innovative technologies and sustainable energy sources, operate the system in a safe, secure, effective and efficient manner and
- applying the same principles and procedures for different systems to establish a wider level playing field for Market Participants.

In order to achieve the necessary level of European harmonisation, ENTSO-E developed the SO NCs by taking a pan-European approach that focused on the most widely applicable requirements. This approach allowed at the same time more detailed provisions at the regional/national level where necessary, with the view of drafting Network Codes for electricity system operation that are open for future developments and new applications.

The FG ESO 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 taking into consideration a view of future industry trends, building up a coherent legal mechanism with the appropriate balance between level of detail and flexibility, which focuses on what-to-do, not so much on how-to-do.

Regarding NC ER, harmonisation principles are handled through a global framework, consisting of three coherently addressed levels:

- **The European wide level** deals with ensuring efficiency of the plans, with common principles for interaction with market mechanism, and with data exchanges;

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- **The Synchronous Area level** refers mainly to Frequency management, to System resynchronisation;
- **The Regional level** groups specific measures of the System Defence Plan such as Assistance for Active Power, Power Flows management, voltage collapse management.

With its strong coordination requirements, this three level framework will ensure a pragmatic and efficient harmonisation of emergency and restoration practices as promoted by the FG.ESO.

3.5 CHALLENGES AND OPPORTUNITIES AHEAD OF SYSTEM OPERATION

Today, in line with the challenging objectives addressed in the FG ESO, 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.

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

- effects resulting from fast growth of embedded generation from Renewable Energy Sources (RES);
- new capabilities of facilities: development of Demand Side Response, High Voltage DC (HVDC) capabilities thanks to new technology...
- needs resulting from the evolution (and completion) of the Internal Electricity Market (IEM).

3.6 INTERACTION WITH OTHER NETWORK CODES

The NC ER is being drafted as a 10th Network Code. Several processes and requirements provided in NC ER are influenced by previous related Network Codes. ENTSO-E sees the coordination of these interactions as an important objective. The most important interactions with other Network Codes have been dealt within the following way:

- The Network Codes on *System Operation* – these codes consist of the Operational Security NC (NC OS), the Load-Frequency Control and Reserves NC (NC LFCR), the Operational Planning and Scheduling NC (NC OPS) and this Network Code (NC ER). The NC OS is the 'umbrella' code of the System Operation Network Codes. It therefore sets the overall principles for system operation, describes data exchanges and reflects on the common issues with the NC LFCR, NC OPS and the NC ER while these latter three describe their specific processes in greater detail.

- The connection codes (NC Requirement for Generators (NC RFG), NC for Demand Connection (NC DC) and NC HVDC) establish the technical capabilities of the generation and Demand Units connected to the grid. The NC ER references to them in those provisions in which information related to technical characteristics is required. The translation of technical capabilities described in connection codes to operational criteria is done in the NC OS.

- The market codes (Capacity Calculation and Congestion Management (NC CACM), Electricity Balancing (NC EB) and Forward Capacity Allocation (NC FCA) define market processes and principles that shall apply as long as possible, unless NC ER situations making it impossible to perform these activities any longer.

3.7 WORKING WITH STAKEHOLDERS & INVOLVED PARTIES

The legally binding nature of Network Codes, which is achieved through the Comitology process, means that they can have a fundamental bearing on stakeholders' businesses. As such, ENTSO-E recognises the importance of engaging with stakeholders at an early stage, involving all interested parties in the development of the code, in an open and transparent manner.

ENTSO-E's stakeholder involvement comprised of 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 functioning of the Transmission System from an operational point of view that arose during the public consultation of the NC RfG, the first ENTSO-E stakeholder workshop on system operation was held on 19th March 2012 in Brussels. The 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 had the opportunity to express feedback and expectations.

In line with suggestions by stakeholders' organizations and following requests by the EC and ACER, ENTSO-E envisaged three workshops for NC ER with the DSOs Technical Expert Group and three Public Workshops with all stakeholders, both prior to, during and after the public consultation:

- The aim of the first NC ER Workshop, held on 9th July 2014 was to present and discuss the scope of the draft NC ER, which reflected the work completed by TSO experts. The workshop addressed the scope of the Network Code, updated stakeholders on its 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 NC ER Workshop (12th November 2014) during the public consultation is prsenting the draft NC ER for the formal public consultation after updates have been made to the Network Code based on stakeholder feedback received in the first workshop. The workshop provided stakeholders with the opportunity to discuss their views on the code and for a Q&A session.
- The third NC ER Workshop, after the public consultation, is expected to be held in the end of January or in February 2015.

In particular, the following items have been discussed with the DSO Technical Expert Group and with Market and Generation units' representatives, through exchanges and meetings (17 April, 9-10 July, 10 September, 12 November):

- Smartgrids
- Interaction between NC ER and market mechanisms
- Design and implementation of Low Frequency Demand Disconnection plans, and impact of embedded generation of these plans
- Periodic compliance testing of capabilities used in System Defence Plan and Restoration

3.8 INVOLVEMENT OF NATIONAL REGULATORY AUTHORITIES

The security of the Transmission System is the core business of the TSOs and often requires operational actions to be taken within a very short timeline. In that sense, the responsibility of adopting these measures cannot be shifted to the NRAs as it would otherwise lead to delays in the adoption of the necessary operational measures.

On the other hand, the involvement of the NRAs is foreseen for the approval of certain procedures and plans, listed in the Network Code. NRAs will thus have the opportunity to control a priori that these methodologies are compliant with the principles of transparency, proportionality and non-discrimination which the TSOs should respect.

NRAs will also always remain competent to act as a dispute settlement authority for any complaint that a party could raise against a TSO or DSO in relation to the TSO's or DSO's obligations.

Finally, the Network Code is without prejudice to the more stringent requirements which could be established in national legislation, as long as these requirements are not in contradiction with the provisions of this Network Code. In that sense, further involvement of the NRAs could be foreseen in national legislation as long as it does not go against the provisions of this Network Code.

3.8.1 Derogations

The code is in line with the framework guideline and evolution of existing practises should not need derogations in Member States.

3.9 BENEFITS OF THE NC ER

During the process of scoping the objectives and topics to be included in the NC ER, the objectives and topics defined by the FG ESO have been kept under careful consideration. The NC ER addresses all activities dealing with the preparation of operation and as expressed in the previous paragraph, opportunity has been taken to strongly improve the coordination between the TSOs on a Pan-European, synchronous area and regional level, from which the following significant benefits are to be expected:

- Developing the same principles in which the best practices are incorporated will result in improving the efficiency of system operation when in emergency and during system restoration.
- Introducing basis principles for the management of market mechanisms during emergency, blackout and restoration situations will result in more clarity and efficiency.

The efficiency objective is reached the following way:

- Economic efficiency is taken into account by TSOs in Defence and Restoration Plans design.
- The plans shall be designed with the objective to minimize the overall impact for the grid users using the minimum possible resources.
    - Defence Plans, and in particular load shedding (as a last resort), shall be designed with the objective to minimize the impact for the grid users (for example: using rotational load shedding or applying load shedding to non-preferable load) and also to minimize the total load that needs to be shed taking into account the constraints.
    - Demand Side Response services should be developed (including interruptible load processes). Grid users with interruptible load contracts are to be shed first (before any other load is shed).
    - Restoration Plans shall be designed with the objective to minimize the time to restore the whole system back to Normal State with the minimum resources available taking into account the constraints.

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- These plans need also to consider civil security and nuclear safety issues identified typically by the responsible national authorities when defining “high priority Grid Users” (economic efficiency versus security obligations). These constraints increase significantly the complexity of the problem; TSOs shall analyse different scenarios in order to select the optimum solution.

Globally, the benefits mentioned above cover the ability to maintain the high system security standard as it is nowadays and as it is appreciated by European citizens. With these benefits the TSOs lay a robust basis for facing the new energy transition challenges.

3.10 CONCLUSIONS

A key goal of the NC ER is to achieve as much as possible harmonised and solid technical framework for system operation when in emergency and for system restoration. Consequently, the requirements have been designed in order to ensure fast and efficient organisation that meets the objectives of a secure Interconnected System operation and the effective development of the IEM.

The requirements set out in the NC ER are building on a long history of existing common and best practices, lessons learned and operational needs throughout the European Transmission Systems.

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4 NC ER & FRAMEWORK GUIDELINES COMPLIANCE

This chapter aims to provide a short overview of the requirements of the Framework Guidelines on Electricity System Operation [1] issued by ACER on 2 December 2011.

The Framework Guidelines on Electricity System Operation (FG ESO) focuses on three key challenges, which shall be addressed by four objectives as Figure 3 shows.

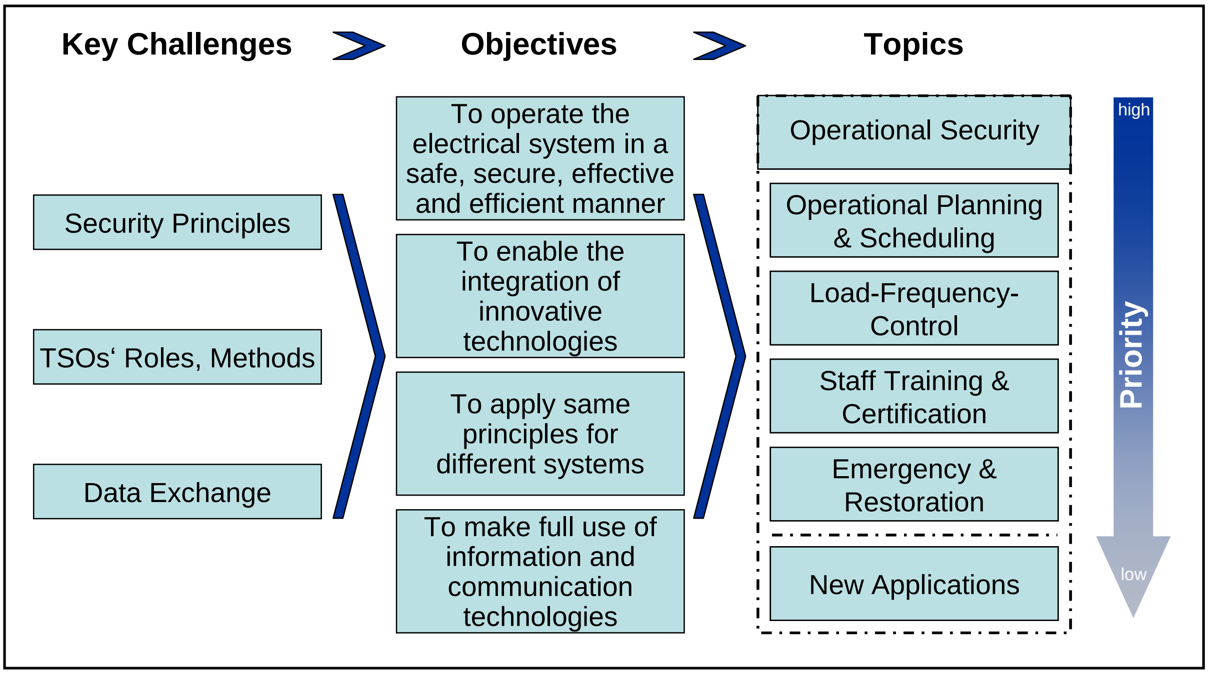

Figure 3: Structure and development flow of the Framework Guidelines on Electricity System Operation

The overall scope and objectives of the FG ESO is *"Achieving and maintaining normal functioning of the power system with a satisfactory level of security and quality of supply, as well as efficient utilisation of infrastructure and resources".* The FG ESO focuses on defining common principles, requirements, standards and procedures within Synchronous Areas throughout EU, especially regarding the roles of and the coordination/information exchange between the TSOs, DSOs and significant grid users.

The requirements described in the NC ER have been formulated in line with the FG ESO and the new developments on system operation, with the aim to ensure a satisfactory level of Operational Security and an efficient utilisation of the power system and resources by providing a coherent and coordinated operation.

According to the FG ESO, NC ER shall define the following criteria, unless when they are already defined in NC OS (items 1 and 4 below):

1. *The criteria for assessing when the power system is in the normal operating state and when it diverges from the normal state. This shall be defined for each synchronous area and shall be communicated between the synchronous areas and EU-wide, respectively within ENTSO-E.*
2. The process, principles and main characteristics for the elaboration of predetermined emergency and restoration plans and related activities on synchronous area level. The

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principles should be agreed at EU-level. Specific needs of grid users based on national regulation should be taken into account with a high priority level in the elaboration of restoration plans (e.g. fast power restoration on nuclear plants).

3. Application of the restoration plans and procedures for remedial actions;
4. *Principles and characteristics which cause the operating state to differ from the normal operating state, e.g. out-of-range disturbances, flows in the transmission network and on interconnections; active power reserves (automatically and manually activated reserves); reactive power reserves; status of network control system and stability of the system (voltage, frequency and angle);*
5. Load shedding procedures, involving DSOs where necessary, including criteria and taking into account local islanding provisions, responsibilities and efficiency evaluation, but also the design of automatic load shedding systems. A non-discriminatory, transparent and efficient manner of the load shedding shall be ensured;
6. Common principles in system protection settings to ensure system security, efficient usage and reliability (also during critical operating state and restoration state); the related procedures shall be co-ordinated among TSOs to ensure interoperability within and between synchronous areas. System protection shall limit the consequences of operational disturbances to a minimum;
7. Minimum requirements to inform significant grid users in case of alert and critical operating states. Duties of significant grid users in such situations shall be clearly stated.
8. Procedure for restoration of regular market operations after technical restoration.

The NC ER was developed according to the principles defined in the ACER Framework Guidelines on Electricity System Operation of 2 December 2011.

5 NC ER: EXPLANATION OF REQUIREMENTS

5.0 INTRODUCTION

This chapter aims at providing the reader a basis for understanding the requirements in the NC ER and is based on the questions and concerns raised by the stakeholders at the workshops held during the NC ER development process.

It has the same structure as the NC ER to ease the reading.

5.1 GENERAL PROVISIONS

5.1.1 Subject matter and scope

Explain the boundaries of this Network Code summarize its key objectives and clarify those affected by it. Define precisely the concept of Significant Grid User for this Network Code and introduce the necessary cross-references with all other affected Network Codes in order to have fully consistent approach to this key concept.

As in all other Network Codes, the subject matter and scope of this System Operation Code are defined in terms target audience and Significant Grid Users, dependencies with other Network Codes and goals are defined in this Article.

For the “Significant Grid Users”, NC ER includes the same users than in NC OS, with the addition of HVDC Systems and DC-connected Power Park Modules, which are not yet included in NC OS definition.

Type A Power Generation Modules are also mentioned sometimes in NC ER, with the objective to be able to integrate them in the processes defined in the code. At the moment it is not current practice and it is not planned to use Type A Power Generation Modules in Restoration Plans, but NC ER should let this possibility open for the future.

This article also includes a paragraph about possible delegation of tasks to Regional Security Coordination Initiatives in the Emergency and Restoration context. It must be noted that such a delegation is included in NC OS and apply to any System States. But one could ask if there could be a specific role for Regional Security Coordination Initiatives (RSCI) in Emergency, Blackout and/or Restoration states.

During Emergency, the RSCI will perform the same activities than in Normal and Alert states. For instance, in case of preparation of a measure of the System Defence Plan (Manuel Demand Disconnection, Assistance for Power Supply, power flows management ...), requiring coordination between several TSOs due to the area concerned, the RSCI will support this coordination, through Security Analysis studies etc...

During Restoration, an RSCI could provide coordination services, especially during resynchronisation phase and/or top-down strategy. The RSCI are not directly “involved” in the grid restoration, thus they are available to ensure a global overview of the situation, manage the multi-TSO communication, ensure a share understanding of the situation etc...

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5.1.2 Definitions

Explain the terms used in this Network Code, while ensuring the same terms are used in existing EU law and other ENTSO-E Network Codes. The definitions have been introduced according to the following principle (i) first use definitions from the EU Directives and Regulations if existing; (ii) second use existing definitions from the other ENTSO-E Network Codes the development of which is in a more advanced phase than this Network Code; (iii) only if no definitions from (i) and (ii) can be applied introduce a new definition in this Network Code.

Cross-references with other ENTSO-E Network Codes: none (but using the definitions from all other ENTSO-E Network Codes)

The definitions applicable specifically in this Network Code are introduced in this article; the definitions from the Directive, Regulation and those which are already introduced in other Network Codes are used as they are.

The Appendix 1 of this document lists all the definitions used in the NC ER. In addition, the on-line tool "ENTSO-E Metadata Repository" gives access to already defined terms. https://emr.entsoe.eu/glossary/bin/view/GlossaryCode/GlossaryIndex

5.1.3 Regulatory aspects

Address the regulatory aspects of relevance for all Network Codes in the area of system operation in a common and coherent way.

Cross-references with other ENTSO-E Network Codes: referring to the capabilities required in the NC RfG and NC DCC for the Power Generating Facilities, Demand Facilities an HVDC links and the conditions for those which are not a subject of relevant provisions – binding them to those technical requirements applying to them pursuant to the Member State national legislation.

The principles to be respected in the whole code and by fulfilling the requirements of this Network Code need to be appointed in one place.

5.1.4 Recovery of costs

Define provisions for recovery of costs related to the obligations from this Network Code, including assessment by NRA, recovery via Network tariffs, providing any necessary additional information by the TSOs.

Required NRA approval: general NRA involvement and key role in costs assessment, recognition and recovery through the regulated Network tariffs

The issues related to the recovery of costs in relation with this Network Code are introduced in line with the equivalent provisions of the other Network Codes.

5.1.5 Consultation and coordination

This article gives general principles to define how "consultation" and "coordination" shall be organised, from a general point of view, each time such a process is required in the code. It aims at providing clarity

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on these two processes that are essential to operate a system, interconnected between several countries, and with strong interactions between the TSO, the DSOs and the grid users.

- Consultation is used each time a decision has to be made, taken into account possibilities and constraints from different parties.
- Coordination is used each time, in addition to a decision, actions have to be performed by several parties.

5.1.6 Confidentiality obligations

Ensuring that obligations for confidentiality are specified in a clear and unique way, applicable to all TSOs and respective other entities, most notable RSCIs.

The provisions for confidentiality are important for TSOs and any other entities.

5.1.7 Agreement with TSOs not bound by the Network Code

Clauses introducing the obligation for Agreement with TSOs not bound by this Network Code shall be implemented to guarantee that they also cooperate to fulfil the requirements under this Network Code.

5.2 SYSTEM DEFENCE PLAN

5.2.1 Remedial Actions & System Defence Plan measures

The Network Code CACM defines a Remedial Action as a measure applied by a TSO in order to maintain Operational Security. Remedial Actions serve, in particular, to fulfil the (N-1)-Criterion and to maintain Operational Security Limits. It must be understood as Remedial Actions being mainly dedicated to Normal and Alert States whereas System Defence Plan measures are to be used specifically in Emergency State when (N-1)-Criterion and Operational Security Limits are already violated.

Additionally, it has to be considered that System Defence Plan measures are complementary to Remedial Actions and can be activated while Remedial Actions are ongoing. We can, for example, imagine the following situations:

- An Emergency State declared a few minutes after an Alert State with Remedial Actions still ongoing.
- Only one Operational Security Limit being violated at the same time (e.g. frequency limit is violated while power flows are secured). In that case the TSO is in Emergency State and activate System Defence Plan measures to manage the frequency deviation but this TSO may also need to activate at the same time Remedial Actions to manage power flows.

Remedial Actions may include, but are not limited to the following:

- re-dispatching or counter trade actions (including Demand Side Response and increase/decrease energy storage);
- topology changes in the network;
- adjusting flows by phase shifters and other flow controlling devices;
- use of reactive power devices (tap-changers, reactors, capacitor banks, SVC, etc.);
- request (or control if available) additional voltage/reactive support from power plants;

- HVDC Systems active and reactive power control;
- System Protection Schemes actions.

System Defence Plan measures may include, but are not limited to the following:

- start or stop/disconnection of Power Generating Modules;
- Demand disconnection or Energy Storage disconnection;
- instruction to Significant Grid Users to change their Active and Reactive power outputs;
- instruction to DSOs to change voltage regulator set-points on transformers on their grid;
- behaviour change of the Load Frequency Control Structure (e.g. freezing the automatic activation of FRR);
- Low Frequency Sensitive Mode activation;
- HVDC Systems active and reactive power control;
- System Protection Schemes actions (including Automatic Low Frequency Demand Disconnection and On-Load Tap Changer Blocking Schemes);
- Requesting maximum or minimum values of Reactive Power to SGUs in coordination with DSOs;
- Assistance for Active Power;
- Cross-Zonal Allocated Capacity curtailment.

5.2.2 General Principles

5.2.2.1 Design of the System Defence Plan

The System Defence Plan is essentially a document describing automatic (Schemes) and manual (Procedures) measures that aim at limiting the extension of disturbances and at stabilizing the system when in Emergency, in order to return to Normal State as soon as possible with minimal impact on grid users (incl. end customers) using the Restoration Plan. It is elaborated by each TSO, taking into account the prescriptions of NC and possible local specificities.

At the moment System Defence Plans across Europe are based on:

– Inter-TSO agreements in Synchronous Areas (e.g. Operation Handbook Policy 5 in Continental Europe);
– Bilateral contracts between TSOs;
– National law provisions.

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As previous system disturbances[1] have shown large-scale system failures do not respect national or TSO responsibility area borders. With the growing integration of European electricity market and stronger interconnection between TSOs, the risk for large scale incidents remains high. Therefore NC ER introduces a new pan-European layer harmonizing all System Defence Plans and ensuring their interoperability. Still, there is the possibility for local specificities to be covered by national laws and synchronous area agreements respecting different historical development and different characteristics of synchronous zones.

Since the System Defence Plan affects almost every grid user (DSOs, Power Generating Modules, HVDC operators, ...) it has to be made by the TSO, which is an entity with oversight over all grid users. When designing the System Defence Plan, TSOs have to make sure that:

- measures of the Plan, implemented mostly by individual grid users, complement each other instead of countering;
- the measures are adequate to cope with expected problems;
- only the necessary amount of measures to cope with the problem is activated to and thus minimizing impact on grid users and duration of disturbance and therefore maximizing economic efficiency.

To ensure the System Defence Plan is non-discriminatory, efficient and effective[2] each TSO has to notify its concept to the NRA or other authority if specified by national law, after entry of the NC into force and every time significant changes are made.

The economic efficiency of the System Defence Plan cannot be assessed by looking at the Plan alone. Instead the impact on the whole society has to be considered. This is a very complex task for a TSO, operator of a power system, to do. The code therefore considers the System Defence Plan as economic efficient when the three previous bullets are met. After entering into force of relevant Network Codes (most notably NC RfG and NC DCC) the TSO also has to respect that some grid users are already subject to requirements of these Codes while others are still subject to previous rules. As the number of users compliant with new Codes will grow, TSOs will have to use their new capabilities, taking into account grid configuration and overall efficiency.

Individual measures of the System Defence Plan introduced in NC ER are described in chapter 5.2.1.

5.2.2.2 Implementation of the System Defence Plan

The implementation of the measures of the System Defence Plan is the phase consisting in the development and installation of all necessary means and in the procurement of services necessary to allow the activation of the plan; the implementation is carried out by TSOs and notified DSOs and Significant Grid Users which have a major role in implementing the System Defence Plan. Concerning Significant Grid Users and new type A Power Generating Modules connected on the Distribution System, DSOs will have most of the time a role in the implementation (e.g. roof-mounted PV modules), through the notification process described in the NC.

[1] See for example incident report https://www.entsoe.eu/fileadmin/user_upload/_library/publications/ce/otherreports/Final-Report-20070130.pdf

[2] In line with Regulation (EC) No. 714/2009.

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For a Significant Grid User and new type A Power Generating Modules implementing a System Defence Plan may mean for example:

- Changing settings of existing protections or frequency regulation
- Altering procedures during Emergency States
- Installing or setting relays for automatic schemes

5.2.2.3 Activation of the System Defence Plan

A part of the System Defence Plan measures is covered by the automatic schemes. Activation of these measures is a matter of design of the scheme and real-time operational conditions. There is no human action required to activate such measures.

Manual activation of the System Defence Plan measures can be necessary for example in the following situations:

- The system is in Emergency State and no Remedial Action is available (as described in chapter 5.2.1).
- Intraday and close to real-time studies show an Emergency State is imminent and no Remedial Action is available. A given example is the manual Demand Disconnection to avoid a drop of frequency. In this case the TSO may need to activate this measure before the actual drop of frequency or the risk will be a drop too quick for the TSO to react before activation of Automatic Low Frequency Demand Disconnection in its Synchronous Area.
- In case a specific procedure had been defined by the TSO and notified to NRA. An example can be the coming 2015 solar eclipse, where a specific procedure could be needed to cope with the drop of photovoltaic generation that the eclipse would trigger.

5.2.2.4 TSO coordination in Emergency State

The basic principle in Emergency State is that all TSOs will provide to the TSO in that state all the possible assistance without putting their own system at risk.

A TSO is not allowed to knowingly put the rest of the interconnected system at risk. Therefore, a manual or automatic opening of a cross border interconnector shall be among the last measures to be considered. It should always be co-ordinated together with the neighbouring TSOs, unless an immediate risk for personal safety or equipment damage exists.

The assistance to a neighbouring TSO can be provided through both AC and HVDC interconnections and through both manual and automatic actions. The principles of the HVDC automatic actions are specified in the NC HVDC.

5.2.3 Measures of the System Defence Plan

5.2.3.1 Frequency deviation management Procedure

Frequency management is covered in the System Defence Plan through a Procedure and the Automatic Low Frequency Demand Disconnection Scheme and the Automatic high Frequency Control Scheme.

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The Frequency management Procedure:

- includes manual and automatic actions,
- covers under- and over-frequency deviations,
- applies before activation of the Automatic Low Frequency Demand Disconnection Scheme and for smaller deviations.

The Automatic frequency deviation control Schemes:

- includes only automatic actions,
- covers over- and under-frequency deviations.

The criterion to enter Emergency State due to frequency deviation is defined in NC LFC&R. This criterion is used by NC ER to define the activation condition of the Frequency management Procedure.

When this criterion is reached, first measure of the System Defence Plan is to ensure the LFC settings do not endanger the system security. For instance, in Continental Europe, this would be achieved by freezing the automatic activation of Frequency Restoration Reserve. Indeed in such a situation, the first priority of TSOs shall be to support frequency, while limiting the amount of cross-border exchanges that are activated without manual control and therefore potentially endanger the interconnected transmission system.

During the frequency deviation, different behaviours can have an impact on frequency:

- The activation of Demand Side Response and Limited Frequency Sensitive Mode will procure a power support in addition to the FCR and FRR provided by Power Generating Modules,
- Some Power Generating Modules (especially embedded generation) can disconnect from the grid, increasing frequency deviation.

Each TSO shall take into account above mentioned behaviours (having positive and negative impacts) and ensure that the combination of these behaviours, in addition to complementary actions in its Responsibility Area, will result in a support of frequency:

- Under-frequency deviation: overall netted power increase,
- Over-frequency deviation: overall netted power decrease.

For instance, in case of disconnection of type A Power Generating Modules due to under-frequency deviation, the concerned TSO will have to compensate, in collaboration with DSOs and SGUs, this loss of generation through manual and/or automatic activation of power and/or demand disconnection.

Among the measures that TSOs can activate manually to support frequency before nomination of the Frequency Leader, there are for instance activation of Power Generating Module active power, manual demand disconnection, remote cease of active power of new type A Power Generating Module (as defined in NC RFG).

5.2.3.2 AUTOMATIC LOW FREQUENCY CONTROL SCHEME

This article provides a European framework for the design of the automatic low Frequency control scheme, which includes the Automatic Low Frequency Demand Disconnection (ALFDD) scheme.

In a highly meshed power system, like a Synchronous Area, frequency instability phenomena are a matter of concern when it comes for instance to system splitting. Especially when the system is separated along highly loaded transmission corridors, the remaining isolated areas suffer a high amount of sudden surplus or deficit of power which results in frequency deviation.

In such a case it is of utmost importance to stabilize the frequency above the disconnection threshold for generating units (47.5 Hz).This is achieved by adequate Automatic Low Frequency Demand Disconnection Scheme.

Although past incidents revealed a sufficient operation of load shedding schemes implemented in the different European Synchronous Areas, there is a need for binding rules and adjustments. This is motivated by:

- the principle of solidarity which necessitates an improved harmonisation of Automatic Low Frequency Demand Disconnection Scheme;

- the regulatory framework;

- the technical development of load shedding relays;

- the clarification of relevant system dynamics and requirements.

Against the background that the concept must be robust in a wide range of scenarios and taking into account the existing load shedding schemes, a study is ongoing in order to establish exact parameters to be included for Continental Europe.

The automatic low frequency control scheme designed by the TSO shall ensure that Limited Frequency Sensitive Mode is activated before activation of Low Frequency Demand Disconnection scheme during an under-frequency event.

The following set of rules for the Low Frequency Demand Disconnection Scheme, as described in the code, has to be considered as temporary:

- load shedding of customer consumption is allowed below a certain value of frequency and mandatory below another value;

- a stepwise total percentage of the reference load should be operated under load shedding relays in the range in which demand disconnection is mandatory;

- at the first stage at least a certain percentage of reference load should be shed, which should be complemented for each individual TSO according to the loss of generation at this stage induced by the frequency drop due to non compliance with grid requirements;

- below the mandatory value, the stepwise load shedding plan should be complemented by an individual mitigation of the loss of generation. TSOs should adapt their own load shedding plan in order to compensate the additional loss of generation;

- frequency steps should be smaller than or equal to a certain value, depending on number of steps and characteristic of load shedding relays;

- in each step not more than a certain value of the reference load shall be disconnected, depending on the number of steps and characteristic of load shedding relays;

- maximum disconnection delay should be below a certain value including breakers operation time; in general no intentional time delay should be added;

- frequency measurements for demand disconnection devices should be maintained below a maximum inaccuracy.

Besides the aforementioned binding rules the following options for individual solutions are accepted:

- pumps can be automatically disconnected according to a predefined scheme, with and without intentional delay;

- the gradient of the frequency can be utilized in a defined frequency range.

It is important to note that article 9(2).c of NC ER and the definition of Demand in NC ER ensure that for each specified frequency step defined in this article, disconnected Demand will correspond to a specific netted value (load – generation) covering both following situations:

- Generation (mainly embedded generation) connected behind DSOs disconnection relays; and
- Generation that would disconnect due to the frequency deviation before the frequency reach admissible disconnection thresholds defined in NC RFG.

TSOs and DSOs have to take these situations into account when implementing the ALFDD scheme.

5.2.3.3 AUTOMATIC HIGH FREQUENCY CONTROL SCHEME

This article provides a framework for the design and the coordination at European level of the high Frequency control scheme.

The motivations for having an automatic high frequency scheme are the same as for low frequency. Besides, a lack of automatic control in severe high frequency transients could bring to a massive disconnection of Power Generating Modules resulting in an extreme under-frequency, with a concrete risk of system collapse.

The established rules use the Limited Frequency Sensitive Mode, provided by generators as required in [NC RfG], as the primary method to control over-frequency.

In the case it is not sufficient, the scheme should be complemented by a step-wise linear disconnection of Power Generating Modules.

5.2.3.4 VOLTAGE DEVIATION MANAGEMENT PROCEDURE AND AUTOMATIC SCHEME AGAINST VOLTAGE COLLAPSE

Keeping Voltage at the optimal value (e.g. to minimize losses) in Normal System State is mostly not a cross-border issue. The exception is keeping voltage at bordering substations where a reactive power flow on interconnectors caused by voltage difference on each side of the border increases interconnector loading. Other than that, changing voltage within range of a few kilovolts has negligible cross-border impact and therefore is considered a local issue.

When a TSO is in Emergency State the situation is quite different. In general, this state means that the system is weakened and large voltage deviations occur. Still, the biggest impact on voltage has the source closest to the problem. Therefore each TSO has to prepare its Voltage management Procedure using measures as follows:

1. Excitation of synchronous machines
2. Reactive Power sources (such as reactors, capacitors, STATCOM, VSC…)
3. Changing Reactive Power flow at Connection Point of Transmission Connected Distribution Networks and Transmission Connected Demand Facilities (thus using embedded reactive power sources)
4. Help from neighbouring TSO
5. Manually disconnecting load (only in under-voltage)

The procedure described above applies to problems which develop slowly (minutes) and operators have time to activate appropriate measures. In case voltage problems appear too quick for operator to react (seconds, e.g. after cascade tripping) TSOs have to prepare Automatic Schemes against Voltage Collapse. Since these measures are automatic they have to be tailored to local grid configuration. The Network Code only gives high-level requirement and specifies basic Schemes:

- Automatic On-Load Tap Changer Blocking Scheme to prevent tap changers from trying to keep voltage at the secondary side of the transformer during over/under-voltage on the primary (TSO) side. This would further deteriorate voltage in the transmission system and ultimately cause voltage collapse. Therefore blocking is mandatory but the conditions have to be set case by case respecting local grid configuration.
- Automatic Low Voltage Demand Disconnection Scheme to lower transmission elements loading and thus raise voltage (not mandatory). This Scheme utilizes functionality required by NC DC; TSOs therefore have to take into account which Transmission Connected Distribution Networks and Transmission Connected Demand Facilities are able to provide this functionality. Special Protection Schemes are another measure which can be applied to counter voltage problems. These Schemes may have multiple functionalities (even grid splitting) and have to be tailored to suit local grid conditions and overall grid topology[3]. If a TSO decides to use a Special Protection Scheme it has to at least inform affected parties (SGUs, neighbouring TSOs) about expected effect on their equipment or grid.

5.2.3.5 POWER FLOW MANAGEMENT PROCEDURE

The Operational Security Limits for power flow in the grid are specified in the NC OS.

In the NC OS, it is also stated that the TSOs have the right to use Redispatching of available Significant Grid users. In Emergency state, the instruction of an active power set-point as described in NC ER can be decided by the TSO independently from provisions given by NC OS and NC CACM (redispatching procedure) and shall be executed by the instructed Significant Grid Users.

Additionally, the TSOs have the right to disconnect Significant Grid Users and to instruct new type A Power Generating Modules to cease to produce Active Power in line with NC RFG. This can be done directly by the TSOs or indirectly though the DSOs.

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[3] Whether the grid is an island (such as GB, IR), a meshed grid with many AC connections to neighbouring TSOs (CH, CZ) or elongated grid with a few AC connections to neighbouring TSOs (IT, SE).

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5.2.3.6 Assistance for Active Power and Manual Demand disconnection procedures

This section aims at explaining the interaction and complementarity between some measures described in the Network Codes Electricity Balancing, Capacity Allocation and Congestion Management and Emergency and Restoration.

NC EB introduces the Common Merit Order List

In Normal and Alert States, in order to balance their Responsibility Area, TSOs can activate offers from the Common Merit Order List (CMOL) within their Coordinated Balancing Area (NC Balancing). This CMOL offer activation is limited as TSOs can only activate outside their Responsibility Area an offer volume:

- that can transit on the interconnected system,
- smaller or equivalent to the available offer volume from their LFC area, in the CMOL.

When in Emergency State, TSOs can activate offers from the CMOL, without being restricted to available offer volume from their LFC area. Nevertheless in case of absence of Adequacy (NC OPS), the offers available in the CMOL could not be sufficient to ensure system Balance. In such a case, Network Codes foresee some exceptional mechanisms.

NC ER introduces the Assistance for Active Power

The Assistance for Active Power is a measure of the System Defence Plan that aims at providing a TSO facing absence of Adequacy with exceptional power sources:

- Within the LFC area of the requesting TSO, all technically available power from Balancing Service Providers and Significant Grid Users shall be put at disposal of the TSO, even if not offered on the market.
- Within the Coordinated Balancing Area of the requesting TSO, all technically available power from Balancing Service Providers and Significant Grid Users (including Unshared bids as defined in NC Balancing) shall be put at disposal, even if not offered on the market.
- The requesting TSO shall have an access to the CMOL offers from Coordinated Balancing Areas it does not belong to, through neighbouring TSOs. The standard products exchanged in different Coordinated Balancing Areas can be different (duration, activation time...), therefore specific dispositions shall be described in dedicated procedures in order to ease the activation of such a measure.

It is important to note that D-1 and intraday absence of Adequacy is defined in NC OPS that stipulates TSOs shall inform NRAs in such a situation (Article 49 NC OPS). ENTSO-E underlines it is not in the mission of a TSO to suggest solutions to solve the inadequacy (most of the time, the causes for inadequacy will be firmly outside of the control and outside of the responsibility of the TSO; solutions may be politically sensitive or costly…). Nevertheless, if the inadequacy persists in real time, TSO mission is to ensure the security of the system by applying all available actions. NC ER defines assistance for Active power as an action to be triggered by TSOs in case the inadequacy has not been solved at a point in time critical for system security management (mainly from intraday to close to real-time).

NC CACM introduces the Cross-Zonal Allocated Capacity curtailment

The Cross-Zonal Allocated Capacity curtailment can be used by TSOs facing an “emergency situation”, to be understood as a specific situation leading to Emergency State, mostly in case of:

- absence of Adequacy; or
- cross-border power flow issue.

In these cases TSOs can, in coordination with neighbouring TSOs, curtail cross-zonal capacities already allocated. For implicit auction mechanisms, this action corresponds to a reduction of nominated exchanges on a border and will thus impact the imbalance of one or more Balancing Responsible Partie(s).

In case of absence of Adequacy, this measure shall be activated after Assistance for Active Power has been requested, and is not sufficient.

NC ER introduces the Manual Demand Disconnection

This measure of the System Defence Plan, as the Cross-Zonal Allocated Capacity Curtailment, shall be activated by TSOs in case of absence of Adequacy, after Assistance for Active Power has been requested but is not sufficient. It is a complementary measure to Cross-Zonal Allocated Capacity Curtailment.

Manual Demand Disconnection can also be a System Defence Plan measure for power flow or voltage management and risk or actual low frequency deterioration due to lack of adequacy.

5.3 RESTORATION PLAN

5.3.1 General principles

The restoration of the system is based on general principles that apply everywhere in Europe and are based on the coordination between TSOs. The TSOs will assist each other in circumstances in which restoration becomes a necessity. System restoration is done whenever there has been an Emergency or Blackout state and the system has stabilised.

Aside from harmonised procedures that are described within this chapter, each TSO will develop its own Restoration Plan. This Restoration Plan is a national plan for restoration of national grids, taking into account all the specificities that vary across Europe, such as the specific layout of the grid, the TSOs, DSOs and Significant Grid Users involved, and the possible locations of black start units. The section of the Network Code on General Principles describes the requirements for the design, implementation and activation of the restoration plan.

5.3.1.1 DESIGN OF THE RESTORATION PLAN

The aim of the restoration plan is to restore the system to Normal State as fast as possible. Each TSO will design a Restoration Plan in coordination with any parties that are involved in the plan, including TSOs, DSOs, and Significant Grid Users. The Restoration Plan shall be notified to National Regulatory Authorities or equivalent national authorities. It shall include procedures for re-energisation, for frequency management, for re-synchronisation, and for communication.

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In the design of the Restoration Plan, each TSO shall take into account the specificities of its own system. This includes the expected behaviour of generation and demand in its Responsibility Area, specifically that of Significant Grid Users and of aggregated type A Power Generating Modules that could have an impact on restoration. It also includes the characteristics of its network, including the voltage levels under his responsibility. The TSO will also need to take into account specific needs of high priority Significant Grid Users, which are appointed in accordance with Article 32(10) of NC OS.

The TSO will also take into account capabilities of connected parties, in order to make optimal use of the resources available within the system in its restoration plan.

An important part of the Restoration Plan is the choice of the power sources capable of re-energisation located within the Responsibility Area. Each TSO needs to be able to re-energise its system using a Bottom-up Re-energisation Strategy if necessary. For this the TSO shall identify the power sources with the required capability in its Responsibility Area, and appoint the ones necessary to be able to complete the Bottom-up Re-energisation Strategy.

5.3.1.2 Implementation of the Restoration Plan

The implementation of the restoration plan consists of the preparation of necessary measures, such as the installation of measurement equipment and the application of specific settings such as for instance settings for automatic reconnection of generation. Involved DSOs, SGUs and new type A Power Generating Modules shall ensure the implementation and availability of required measures.

5.3.1.3 Activation of the Restoration Plan

The activation of the Restoration Plan is done when the system is sufficiently stabilised after an Emergency State, or when there has been a blackout and the system is being restored. The measures defined in the plan will then be activated in accordance with the necessary strategy.

5.3.2 RE-ENERGISATION

When there has been a blackout or a partial blackout, part of the network of one or more TSOs will need re-energisation. In this situation, TSOs can apply either a top-down or a bottom-up re-energisation strategy, or a combination of the two. In case of a top-down re-energisation strategy, assistance of another TSO is required. In case of a bottom-up re-energisation strategy, there is a need for resources to be available in the network of the TSO, including power sources such as black-start units that are capable of re-energising (part of) the network.

5.3.2.1 Re-energisation procedure

Within the Restoration Plan, each TSO shall include at least local measures based on these two re-energisation strategies, that will enable the TSO to carry out these strategies in practice. Scenarios will be developed in order to make the choice between top-down and bottom-up re-energisation strategies and combinations thereof.

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In order to apply a top-down re-energisation strategy, assistance is required from a neighbouring TSO. For this reason the TSO will exchange information with those neighbouring TSOs who may provide this assistance, in order to coordinate the application of the Top-down re-energisation strategy.

5.3.2.2 RE-ENERGISATION STRATEGY

When re-energisation is necessary in real-time, the TSO will decide on a strategy to apply, considering the conditions of directly connected systems, the power sources capable of re-energisation in its Responsibility Area, and to decide on the expected duration of possible re-energisation strategies. The strategy the TSO decides upon may include a Top-down strategy. In that case the TSO will ask the support of neighbouring TSOs, who are then obliged to provide assistance unless it will lead its system to Emergency or Blackout States. If no TSOs are able to provide assistance under these terms, the TSO needing re-energisation shall use a bottom-up re-energisation strategy.

During the re-energisation process, each TSO shall manage the connection of Demand and generation within its Responsibility Area, with the aim of maintaining the frequency close to the Nominal Frequency with a maximum tolerance of the Maximum Steady-State Frequency Deviation. DSOs shall assist the TSO in this process by connecting the requested amount of generation and Demand. In case automatic connection settings apply in its Responsibility Area, the TSO shall take these settings into account.

5.3.3 FREQUENCY MANAGEMENT

In case a Synchronous Area has been split into several Synchronised Regions, or after a large scale frequency incident, the usual balance between generation and load has suffered a disturbance that warrants coordinated frequency management. The Network Code includes a description of the coordination of frequency management in these situations, which takes some of its concepts such as 'Frequency Leader' from the Continental Europe Operation Handbook Policy 5.

5.3.3.1 FREQUENCY MANAGEMENT PROCEDURE

The System Frequency of a Synchronous Area needs to be restored back to the Nominal System Frequency. In case the Synchronous Area is split into several Synchronised Regions, this means that these regions need to be resynchronised. The frequency management procedure of the restoration plan deals with the restoration of frequency in both the Synchronised Area and in the Synchronised Regions. It includes the appointment of frequency leaders, specific measures for frequency management after frequency deviations and after a synchronous area split, frequency management during re-energisation, and the reconnection of generation and demand.

5.3.3.2 APPOINTMENT OF FREQUENCY LEADERS

The Nordic Synchronous System uses coordinated frequency management (among which the appointment of frequency leaders) also in the Normal State.

The Baltic Area coordinates their frequency with Russia, so for the Baltic Area this would not apply either.

Whenever the Synchronous Area is split into multiple Synchronised Regions, a Frequency Leader shall be appointed for each of those Synchronised Regions. A Frequency Leader shall also be appointed for

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the entire Synchronous Area in case there is no split of the system, but a large frequency incident has occurred that takes the system outside of the frequency limits for alert state as defined in NC LFCR.

The choice for a Frequency Leader is in principle a mutual decision by all the TSOs of the Synchronised Region. When making a selection, the TSOs will take into account the amount of available Active Power Reserves, the available interconnection capacity, and the availability of measurements of frequency and on Critical Grid Elements.

However, in order for this selection process to have a certain outcome, the Network Code provides a default value, appointing the TSO with the largest K-factor (defined in NC OS) as the Frequency Leader in case the TSOs do not otherwise agree.

Once a Frequency Leader has been appointed, this TSO shall inform all other TSOs of the Synchronous Area of its appointment. The TSO will remain Frequency Leader until:

- another TSO is appointed as Frequency Leader for the particular Synchronised Region,
- until its region is resynchronised with another Synchronised Region, and a new Frequency Leader is appointed for the resultant Synchronised Region, or
- until the Synchronous Area is fully resynchronised and the System Frequency is back within the limits for Normal State as defined in NC LFCR and LFC Area uses its own load frequency controller again.

In order to support frequency management in general and the process of selecting Frequency Leaders, each TSO is required to monitor which Synchronised Regions its system belongs to, who the other TSOs in those Synchronised Regions are and what Active Power Reserves are available in its own Responsibility Area.

5.3.3.3 Frequency management after Frequency deviation

After a large frequency deviation that takes the system frequency outside of the limits for alert state but does not cause a system split, a Frequency Leader is appointed for the Synchronous Area. This TSO will then become responsible for frequency management in the Synchronous Area. To this end, all other TSOs shall suspend the manual activation of Frequency Restoration Reserves and Replacement Reserves, and shall follow the instructions of the Frequency Leader in regards to the settings for automatic activation of reserves.

The Frequency Leader shall manage the manual activation of Frequency Restoration Reserves and Replacement Reserves in the Synchronous Area with the aim of regulating the System Frequency back to the Nominal Frequency, taking into account Operational Security Limits. The other TSOs shall support the Frequency Leader by activating Reserves in their Responsibility Area when necessary.

5.3.3.4 Frequency management after Synchronous Area split

When the Synchronous Area is split into several Synchronised Regions, each of these regions will appoint a Frequency Leader in the manner described above. The Frequency Leader for each of the Synchronised Regions will carry out the responsibilities for its Synchronised Region as described above, and shall be supported by the other TSOs of the Synchronised Region.

5.3.4 RESYNCHRONISATION

5.3.4.1 RESYNCHRONISATION PROCEDURE

When the Synchronous Area is split into multiple Synchronised Regions, these will need to be resynchronised once their frequency permits. This will be a stepwise process, in which the Resynchronisation takes place between pairs of Synchronised Regions until the whole Synchronous Area has been resynchronised. The resynchronisation procedure deals with this process of resynchronisation, and includes the appointment of Resynchronisation Leaders, and the strategy for Resynchronisation. It shall also include principles, based on national considerations of local grid situations, for the maximum phase angle, frequency difference and voltage difference for closing lines.

5.3.4.2 RESYNCHRONISATION LEADER

When the Synchronous Area is split into multiple Synchronised Regions, Resynchronisation Leaders shall be appointed to pairs of regions in order to manage the resynchronisation between those pairs of regions.

The appointment of a Resynchronisation Leader is generally done by a mutual decision of the TSOs of the two Synchronised Regions that will be reconnected to form one Synchronised Region. There are some minimum requirements for the Resynchronisation Leader. The Resynchronisation Leader must have control over a substation in operation equipped with a parallel switching device on the border between the two Synchronised Regions. He must have access to frequency measurements from both Synchronised Regions, and access to voltage measurements on the substations between which the Resynchronisation Points could be located, which means that there needs to be a location on which to resynchronise within its Responsibility Area. He must also be able to control the voltage at this potential Resynchronisation Point.

Once a Resynchronisation Leader is appointed, he shall inform all other TSOs of the Synchronous Area of its appointment, so that other TSOs are aware of the progress toward resynchronisation of the entire Synchronous Area. The TSO shall remain Resynchronisation Leader until the Resynchronisation strategy as described below has been completed. A Resynchronisation Leader shall be chosen for each new resynchronisation.

5.3.4.3 RESYNCHRONISATION STRATEGY

There are three basic steps in the resynchronisation strategy:

1. the preparation;
2. the actual Resynchronisation, which is done by physically linking the two Synchronised Regions at the Resynchronisation Point, and
3. the creation of additional links between the Synchronised Regions to strengthen the connection.

The preparation consists of two parts. Part 1: The Resynchronisation Leader shall define the allowable limits for the frequency difference between the two Synchronised Regions, for the active and reactive power exchange, and he shall define the settings for the automatic activation of reserves within the Synchronised Regions,. Before defining these things, the Resynchronisation Leader shall agree upon these topics with the Frequency Leaders of the involved Synchronised Regions.

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Aside from defining these limits and settings, during part 2 the Resynchronisation Leader shall also select the Resynchronisation Point, taking into account the Operational Security Limits in the Synchronised Regions. He shall define and prepare all necessary actions for the Resynchronisation of the two Synchronised Regions at this Resynchronisation point. Such actions could include for instance local switching operations to provide an optimal grid topology, or ensuring the manning of a crucial substation. Similarly, he shall define and prepare in coordination with the relevant TSOs subsequent actions for the creation of additional connections between the Synchronised Regions. Finally, he will assess the readiness of the Synchronised Regions for Resynchronisation, taking into account the limits and settings defined. These steps will be done after consultation with both the Frequency Leaders of the Synchronised Regions, and the TSOs operating the involved substations.

When all these steps have been prepared to satisfaction, the Resynchronisation Leader shall perform the Resynchronisation. Once the connection has been made at the Resynchronisation Point, further connections will be created to strengthen the system. Afterwards, a new Frequency Leader will be appointed for the newly created Synchronised Region.

5.4 MARKET INTERACTIONS

During Emergency and Restoration, some of the “regular” processes and activities, related to market and scheduling, cannot be operated any longer. This chapter aims at defining framework for interaction between System Operation and Market mechanisms, during Emergency and Restoration, clarifying the impacted activities and general principles to be applied.

Three topics are identified:

1. ER situations that lead to modify/suspend some of the market activities
2. Market activities restoration after technical restoration of the grid
3. Settlement principles in between

The current draft includes general ideas related to the three above-described topics.

5.5 INFORMATION EXCHANGE & COMMUNICATION, TOOLS & FACILITIES

This chapter serves to explain the requirements set in NC ER on Information Exchange and Communication, Tools and Facilities needed to guarantee a secure operation of the electricity network at any time.

5.5.1 Information exchange

Information Exchange is an essential topic for the work of the TSO and for guaranteeing a secure operation of the grid. Therefore the general provisions of Articles 16 to 29 [NC OS] are detailed in this NC especially for Emergency, Blackout and Restoration State.

To be able to gather all the necessary information from DSO and SGU according to Articles 16 to 29 [NC OS] and to make sure that there is a common understanding of the most important information between all involved parties the following information are specified in the NC ER.

During an Emergency, Blackout and Restoration state DSO shall provide the TSO with information about at least:

- existing part of their Network in Island Operation: DSO shall inform the TSO about existing islands in the responsibility area of the DSO and the power plants (conventional and hydro but so far no other RES) of Type C or D connected to the island. This is essential for the TSO so he can take this into consideration while thinking about the best strategy to restore the grid.
- ability to synchronize parts of their Network in Island Operation: DSO shall inform the TSO about the ability to synchronize existing inlands in the DSO grid or synchronize existing inlands to the TSO grid. Additionally DSO shall provide TSO with the information about the possible connection points from DSO to TSO grid.
- capability to start Island Operation: DSO shall inform the TSO about the possibility to build up islands in the DSO grid. This also includes information about power plants (conventional and hydro but so far no other RES) of Type C or D which are in House Load Operation or Black Start Capable able to build up an island.

Also during Emergency, Blackout and Restoration State SGU and Type A Power Generating Modules, shall directly or through an aggregator, according to Article 3(6) [NC RfG], if declared necessary for restoration by the TSO, provide the TSO with information about at least the following conditions:

- current status of the installation: SGU and Type A Power Generating Modules shall inform the TSO about the current status of operation of each power plant, e.g. out of operation, Island Operation, House Load, Operation, etc.
- operational limits: Besides the current status of the power plant also the operational limits are necessary for the TSO. This means the minimal and maximal Operating Point (in the current situation).
- Full Activation Time and time to increase generation: The time period between the activation request by TSO and the corresponding full activation of the concerned product is of interest for the TSO (time for starting processes till synchronization to the grid). Besides this timeframes for the increasing of generation, also other are essential for the TSO to be able to organize the further process of the restoration.
- time critical processes: Furthermore, SGU and Type A Power Generating Modules shall inform the TSO about time critical processes related to a power plant, e.g. how long can a power plant stay in House Load Operation, maximum time of station blackout e.g. before damaging the equipment.

Besides the information to be exchanged between TSO, DSO and SGU the common understanding of this information is also very important. Therefore TSO shall in coordination with other directly connected TSO determine priority information to exchange, if essential for operation and restoration in Emergency, Blackout and Restoration State.

To guarantee an effective communication between the TSO, each TSO shall establish a “checklist” with the most important information to be exchanged in case of Emergency, Blackout and Restoration State. Besides this “checklist” each TSO shall inform its direct connected TSO about at least:

- known circumstances that lead to the concerned System State: known or presumed origins leading to a certain situation shall be notified between the TSO.
- the extent and borders of the Synchronised Region or Synchronised Regions to which its Responsibility Area belongs: The TSO need to know about possible connection points to other TSO and therefore the information about the extent and borders of the Synchronised Regions.
- restrictions to operate Synchronised Regions: The TSO need to know about limitations of a Synchronised Region. Maybe a Synchronised Region has limited supply (e.g. hydro pump storage or limitation of fuel) and needs support from another Synchronised Region.
- other technical or organizational restrictions: The TSO shall inform the other TSO about any problem with their communication channels. If there is an existing problem with one channel the TSO should know to use the other available communication channel. Also if a TSO prefers to use one specific communication channel he shall give this information to the other TSO so they know which channel to use.

If a TSO has problems with the main control room, the other TSO need to know about it. (for instance evacuation to the backup control room). This can be for several reasons e.g. if there is a problem in the main control room with the backup power supply of the SCADA system or the ability of switching.

In addition, each TSO shall inform the Frequency Leader of its Synchronised Regions about at least:

- restrictions to maintain Island Operation: Since the Frequency Leader defines the amount of power (upwards and downwards) to be requested from each TSO of the concerned area he needs information about the overall generation and the connected load of the island. The Frequency Leader needs to know about the amount of generation reserve that can be mobilized (upwards in case of under-frequency situations, downwards in case of over-frequency situations), and the free secondary reserve capability. Also the capacity margin of interconnectors (import in case of under-frequency situations, export in case of over-frequency situation) is important to know.
- additional available generation and Demand: Besides what is stated before, the Frequency Leader needs information about possible limits of additional generation and Demand to be connected to the island and especially information about the frequency limits which should not be exceeded (e.g. 50.2 Hz in Germany due to the disconnection and reconnection of PV generation).
- availability of Operational Reserves: The Frequency Leader needs to know if the TSO in its Synchronized Region have any problems/limitations with their frequency controller which might cause problems during and after the re-synchronisation. In addition the Frequency Leader needs to know about limitations of frequency regulation of certain TSO (e.g. Estonia can use a HVDC with Finland to regulate the Frequency but only within limited time).

All TSO shall exchange information between each other in Emergency, Blackout and Restoration State and define additional information if necessary, including at least:

- Active and Reactive Power time limits at Interconnectors: Time limits on Interconnectors mean e.g. that the amount and duration of assistance of a TSO is limited to certain duration of time.
- potential problems making assistance for Active Power necessary: This can be the case if there is a need for additional power supply to fire up e.g. a coal power plant when a TSO does not have any generation to do that in his own grid. This is not related to assistance for nuclear power plants or surface mines; it is “just” assistance and not immediate.

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NC ER aims to achieve a common understanding/procedure between TSO of when and how the mentioned parties should be informed about an incident.

5.5.2 Voice communication channels

This article aims to ensure in Emergency, Blackout and Restoration State voice communication between the in System Defence and Restoration Plan involved parties, to exchange the necessary information for operating or restoring the system. Therefore each TSO, DSO and Significant Grid User and Type A Power Generating Modules, directly or through an aggregator, shall establish in cooperation with the other parties at least two independent voice communication channels.

Concerning the establishment of voice communication channels to Significant Grid Users, this involves either a communication directly with the power plant or with a dispatch centre. Communication to those parties is essential for TSO to securely operate and restore the system.

Voice communication of TSO and DSO includes communication between themselves (company internal) and each other and additionally also to other premises e.g. substations, backup control rooms, regional (control) centres, headquarters, crisis centres etc.

To ensure communication in any case, backup power supply for at least 24 hours needs to be established. This means that at least one communication channel needs to be backed up e.g. with a diesel generator for guaranteeing functionality for at least 24 hours in case of the loss of primary power source. Additionally at least one of the communication channels shall be prioritized. This means the respective party always has a free line for the other connected party and a Calling-Line-Identification-Presentation (CLIP) so that a direct identification of the calling party is possible to decide if it is 1st priority to take the incoming call or not. Another important aspect is that at least one of the communication channels does not use public communication channels. This means a private connection between respectively two of the mentioned parties without using the lines of a public network.

All means mentioned in this NC aim to detail the requirements set up by the NC OS but no new communication links are requested. NC ER does not pledge the involved parties to set up new communication links which are not covered by the NC OS.

5.5.3 Facilities

For each TSO and all DSO and Significant Grid User identified in the Restoration Plan critical tools and facilities necessary to operate and restore the system, as defined in Article 8(15) [NC OS], have to be available in any system state. Therefore in case of loss of primary power supply at least backup power supply for 24 hours has to be established. This specifically includes not only TSO but also the DSO and Significant Grid User.

To guarantee that the TSO can operate their system in case of any problem concerning the main control room, e.g. fire, each TSO has to have a second control room, a so called backup control room. This backup control room does not have to be manned at all time since TSO are not obliged to operate from the backup control room as long as the main control room is available. To be able to operate the system also from the backup control room it shall be equipped at least like the main control room. Additionally the backup power supply for the backup control room shall be ensured for at least 24 hours for the same reasons the main control room needs to have backup power supply. Another important topic is that the backup control room has to be geographically separate. The backup control room needs to be at least

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in a separate building and not right next to the main control room. This ensures that impacts on the main control room do not directly influence the backup control room as well.

Related to the backup control room is also the preparation of an evacuation procedure for moving from the main control room to the backup control room. The maximum time for this evacuation shall not exceed three hours. In case there is a need to move to the backup control room each TSO has to be prepared how to proceed. This means it needs to be clear, which things and which equipment from the main control rooms need to be taken to the backup control room. Also it needs to be clear for the staff how to reach the backup control room on the fastest way. Through preparing such a procedure TSO have to be able to fully operate their system again from the backup control room within a maximum time of three hours. This evacuation procedure shall also include the organisation to operate the system during the evacuation. During the time of moving to the backup control room the TSO has to make sure that his system is observed and operated e.g. through its regional control centres. The procedure also needs to include measures that guarantee that the backup control room is available and accessible at any time (e.g. streets and entrance need to be free of snow, trees).

One of the most important facilities for TSO besides the control rooms are substations. Ensuring the operability of substations necessary for the restoration is essential for operating the system and for the restoration. Therefore backup power supply of equipment in these substations is necessary. The equipment includes e.g. switching devices. Usually all substations are remote controlled and therefore power supply needs to be guaranteed to be able to operate the grid and handle the restoration process. In case of loss of primary power supply it has to be guaranteed that e.g. switching can be performed in the identified substations. Backup power supply in case of substations can be implemented for e.g. 24h but also for a certain amount of switching.

5.6 COMPLIANCE & REVIEW

5.6.1 General principles

Defence and Restoration Plans are prepared on the basis of the best TSO/DSO knowledge, supported by technical analyses and experience. Nevertheless, Defence and Restoration Plans normally are not verifiable in practice during normal operation of the system. There is a chance that some plans may never be realised and some equipment (i.e. under frequency relays) may never be triggered. For this reason it is difficult to ensure that prepared Plans are reliable without on site tests. Some of the equipment tests can be done during maintenance (i.e. relays, protections), but most functions or capabilities need special dedicated approaches (i.e. Black Start Capability). In addition it is important to check the procedures for necessary cooperation and coordination during an Emergency and/or Blackout System State.

Testing of SGU (PGM + Demand Facility providing DSR + HVDC System Owner) capabilities/services that are used for ER purposes is already required by Articles 34 and 35 [NC RfG], Article 38 [NC DC] and Article 66 [NC HVDC].

The only really missing requirement regarding testing SGU capabilities is the frequency of these tests.

Thus the NC ER refers to existing NC for the methodology to perform the tests, while adding a requirement for the definition of frequency for these tests. The frequency shall be decided at national level, while respecting minimum requirements for those of the capacities that are seen as most important in the system defence and restoration plans.

In addition, according to Article 33 [NC OS], TSO, DSO and Significant Grid User with Connection Point directly to the Transmission System can test standard procedures for Emergency State and Restoration, which is seen as necessary. Thus the NC ER will set some general principles regarding global testing of System Defence Plans and Restoration processes.

5.6.2 COMPLIANCE TESTING OF TSO, DSO and SIGNIFICANT GRID USER CAPABILITIES

5.6.2.1 COMPLIANCE TESTING OF PGM CAPABILITIES

Black start capabilities are to be tested on a minimum basis of once every 3 years. This corresponds to current practice in most of the TSOs. Black start capability is essential in Bottom-up strategy for restoration.

Houseload capability is an important mean for bottom-up strategy in a restoration and therefore the availability has to be ensured after modernisation or in case two unsuccessful consecutive tripping in real operation.

5.6.2.2 COMPLIANCE TESTING OF DSR

According to NC DC, DSR means demand offered for the purposes of, but not restricted to, providing Active or Reactive Power management, Voltage and Frequency regulation and System Reserve.

The DSR capability to modify their demand consumption after receiving an order, entail a useful tool for TSO and DSO to provide a quick and efficient response in emergency situations. Given the critical nature of the situations in which this capability is going to be used, TSO and DSO shall be completely sure about their proper performance in the contracted time frame. Therefore, a periodic test of the availability and capability is needed.

Regarding of test periodicity, and taking into account this service is mainly provided by industrial consumers which are not very familiar with Electricity System System Operation, real experience shows that one test/per year should be enough to ensure a proper functioning. This test would not be required if this capability has had a successful real activation in the period between test.

The test to be performed should consist of following a real activation order from TSO or DSO for time, load reduction and duration specified.

5.6.2.3 COMPLIANCE TESTING OF HVDC CAPABILITIES

Using HVDC black start capability is quite new for several TSOs. The requirement on periodicity test shall be the same as for PMG with this capability since this capability is essential in Bottom-up strategy for restoration.

5.6.2.4 COMPLIANCE TESTING OF DSO RELAYS

Since LFDD scheme is addressing EU-wide phenomena (major frequency deviation), it is fundamental to ensure that the relays works properly all over Europe. For this reason, common minimum requirements for testing these relays have to be defined.

The test shall ensure that the requirements defined in testing methodology described in the NC DC are fulfilled. The frequency of 5 years allows to use the regular maintenance of the devices to perform these tests.

5.6.2.5 TESTING OF COMMUNICATION CHANNELS AND TOOLS

It is essential that communication is functioning properly in all states, especially in emergency, restoration and black-out states.

The test shall ensure that all needed systems for the communication channels work in the different states especially in black-out state.

5.6.2.6 TESTING OF TSO'S FACILITIES

Main testing activity related to TSO's facilities relies on testing the backup power supply sources. Only periodic tests allows to ensure the proper functioning of diesel generator and other energy storage devices, to be used in case of absence of the main power source.

5.6.3 COMPLIANCE TESTING OF SYSTEM DEFENCE PLANS AND RESTORATION PLANS

5.6.3.1 PERIODIC REVIEW OF SYSTEM DEFENCE PLAN

The NC DC requires yearly notification on LFDD implementation. Thus, TSO has to consider these notifications, and propose modifications to DSO in order to solve situations in which the LFDD implementation does not fulfil the LFDD design.

When designing the system defence plan, the current situation is taken into account. Due to on-going evolutions of the network and all other elements of the system, TSO regularly updates some measures of the system defence plan. In order to ensure consistency of these modifications, it is necessary to add milestones to check the whole defence plan. Thus a periodic review of the whole system defence plan is needed, to ensure its effectiveness.

5.6.3.2 COMPLIANCE TESTING AND PERIODIC REVIEW OF RESTORATION PLAN

Responsible national authorities can identify specific grid users needs to be taken into consideration while designing System Defence Plan and Restoration Plan. For some of these specific grid users, periodic testing may be needed. For instance, power supply of auxiliaries of nuclear power plant from an external source has to be regularly tested. The TSO and the power plant define one or more re-energisation paths. These paths have to be tested, according to a frequency and methodology to be defined between the TSO and the concerned plants taking into account the requirements of responsible national authorities.

These tests shall be organised with all involved parties.

In addition, similar to the system defence plan, the restoration plan has to be reviewed regularly, in order to assess its effectiveness, while considering all recent developments in the system.

5.6.3.3 TESTING OF COMMUNICATION PROCEDURES

The proper functioning of the communication is essential in emergency, restoration and black-out states. Therefore the communication procedure needs to be tested and trained periodically with all relevant parties.

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6 NEXT STEPS

In this chapter, ENTSO-E briefly summarises the main steps of the Network Code development process with a special focus on those that will occur between the submission of the Network Code to ACER and its application.

6.1 PUBLIC CONSULTATION COMMENTS

At the end of the Public Consultation, ENTSO-E will analyse all the received comments and prepare a new version of the document, to be presented and discussed during a third Public Workshop.

A chapter will be added to the supporting document, providing information how the result of the public consultation has been taken into account in this new version of the NC.

6.2 SUBMISSION TO ACER

Regulation (EC) N° 714/2009, and in particular its Article 6, defines a clear Network Code development process.

The process begins with the set up by the Commission of an annual list of priorities amongst the 12 areas where Article 8(2) of Regulation (EC) N° 714/2009 foresees the need for a NC. The annual priority list must be adopted after consultation with the relevant stakeholders.

Once a priority list is established, the Commission shall request ACER to develop and submit to it a non-binding framework guideline. The framework guideline is intended to set clear and objective principles with which the Network Code should be in line.

The development by of a framework guideline is followed by a request from the Commission for ENTSO-E to develop a Network Code within a twelve month period. The Network Code to be developed by ENTSO-E within that period shall be subject to an extensive consultation, taking place at an early stage in an open and transparent manner.

At the end of these 12 months ENTSO-E delivers a Network Code and set of explanatory documents to ACER for its assessment.

6.3 THE ACER OPINION

ACER has three months to assess the draft prepared by ENTSO-E and deliver a reasoned opinion. In doing so, ACER may decide to seek the views of the relevant stakeholders.

ACER can decide to recommend to the Commission that it adopts the code if it’s satisfied that it meets the requirements of the framework guideline or can provide a negative opinion; effectively meaning the code is returned to ENTSO-E.

6.4 THE COMITOLOGY PROCEDURE

The NC prepared by ENTSO-E shall only become binding if, after being recommended to the Commission by ACER, it is adopted via the Comitology procedure.

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The Comitology process will be led by the Commission who will present the draft text to representatives of Member States organized in so-called “committee”. The Comitology procedure used for the Network Codes (called regulatory procedure with scrutiny) grants the European Parliament and the Council important powers of control and oversight over the measure adopted by the committee.

For that reason, it is unclear how much time the process can take in practice. Our working assumption is that it will take about 12 months from the issuing of the ACER opinion (if positive) to the conclusion of the Comitology process.

6.5 ENTSO-E STEPS DURING THIS PERIOD

Meeting the requirements of the NC ER as soon as practicable is a significant challenge for ENTSO-E. During the period in which the code is being considered by ACER and the Commission, ENTSO-E will continue work to prepare for the delivery of the requirements of the Network Code.

6.6 ENTRY INTO FORCE

The Network Code will enter into force 20 days after its publication. However, due to the various consultations and approvals the application of different parts of the code will be triggered by the timing of regulatory decisions. Because of uncertainties about the ACER opinion, the timings of the Comitology process, the time needed to deliver parts of the code and the time needed to approve parts of the code (which could include a referral to ACER) it is not possible to say exactly when each part will apply. A close working relationship between ENTSO-E, ACER, national regulators and the Commission is, in our view, necessary to ensuring the ER code can be implemented as quickly as possible.

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7 LITERATURE & LINKS

[1] "Framework Guidelines on System Operation" (FG SO), ACER, 2 December 2011.

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

[3] Nordic Grid Code https://www.entsoe.eu/fileadmin/user_upload/_library/publications/nordic/planning/070115_entsoe_nordic_NordicGridCode.pdf

[4] UCTE Operational Handbook https://www.entsoe.eu/publications/system-operations-reports/operation-handbook/

[5] NationalGrid – Complete Grid Code http://www.nationalgrid.com/NR/rdonlyres/67374C36-1635-42E8-A2B8-B7B8B9AF2408/58810/00_GRID_CODE_FULL_I5R2.pdf

[6] EirGrid - Grid Code Version 4.0 http://www.eirgrid.com/media/Grid%20Code%20Version%204.pdf

[7] SONI – Grid Code http://www.soni.ltd.uk/upload/SONI%20Grid%20Code%20-%2020%20July%202012.pdf

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8 APPENDICES

8.1 APPENDIX 1 DEFINITIONS USED IN NC ER

The reference tool for all definitions used in the Network Codes is the ENTSO-E Metadata Repository (Search for Definitions): https://emr.entsoe.eu/glossary/bin/view/GlossaryCode/GlossaryIndex.

In order to ease the reading, definitions used in the draft NC ER are listed below. They are produced only for indicative purpose.

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

Active Power [NC RfG] – The real component of the Apparent Power at fundamental Frequency, expressed in watts or multiples thereof (e.g. kilowatts (kW) or megawatts (MW)).

Active Power Reserve [NC OS] – The Active Power which is available for maintaining the frequency.

Adequacy [NC OPS] – The ability of in-feeds into an area to meet the demand in this area.

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

Balancing Service Provider [NC EB] – A Market Participant providing Balancing Services to its Connecting TSO, or in case of the TSO-BSP model, to its Contracting TSO.

Blackout State [NC OS] – The System State where the operation of part or all of the Transmission System is terminated.

Black Start Capability [NC RfG] –The capability of recovery of a Power Generating Module from a total shutdown through a dedicated auxiliary power source without any energy supply which is external to the Power Generating Facility.

Bottom-up Re-energisation Strategy [NC ER] – A strategy that does not require the assistance from other TSOs to re-energise part of the system of a TSO.

Closed Distribution Network [NC DC] – A Network classified as Closed Distribution Network pursuant to Article 28(1) of Directive 2009/72/EC at national level. Article 28 of Directive 2009/72/EC defines such a Network as a system which distributes electricity within a geographically confined, industrial, commercial or shared services site and does not (without prejudice to a small number of households located within the area served by the system and with employment or similar associations with the owner of the system) supply households customers. This Closed Distribution Network will either have its operations or the production process of the users of the system integrated for specific or technical reasons or distribute electricity primarily to the owner or operator of the Closed Distribution Network or their related undertakings.

Common Merit Order List [NC EB] – A list of Balancing Energy bids sorted in order of their bid prices, used for the activation of Balancing Energy bids within a Coordinated Balancing Area.

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Connection Point [NC RfG] – The interface point at which the Power Generating Module, Demand Facility, Distribution Network or HVDC System is connected to a Transmission Network, offshore Network, Distribution Network, or HVDC System, as identified in the Connection Agreement.

Coordinated Balancing Area [NC EB] – A cooperation with respect to the Exchange of Balancing Services, Sharing of Reserves or operating the Imbalance Netting Process between two or more TSOs.

Cross-Zonal Allocated Capacity [NC CACM] – The capability of the Interconnected System to accommodate energy transfer between Bidding Zones. It can be expressed either as a Coordinated Net Transmission Capacity value or Flow Based Parameters, and takes into account Operational Security Constraints.

Demand [NC ER] - The netted value of Active Power seen from a given point of the system, computed as (load – generation), generally expressed in kilowatts (kW) or megawatts (MW), at a given instant or averaged over any designated interval of time.

Demand Facility [NC DC] – A facility which consumes electrical energy and is connected at one or more Connection Points to the Network. For the avoidance of doubt a Distribution Network and/or auxiliary supplies of a Power Generating Module are not to be considered a Demand Facility.

Demand Side Response [NC DC] – Demand offered for the purposes of, but not restricted to, providing Active or Reactive Power management, Voltage and Frequency regulation and System Reserve.

Distribution System [swiss electricity market glossary] – High, medium or low voltage electricity grid for supplying end consumers or electricity supply companies.

Emergency State [NC OS] – The System State where Operational Security Limits are violated and at least one of the operational parameters is outside of the respective limits.

Energy Storage [NC ER] – A device being used for storage of electrical energy and that can be used to balance the supply and the demand in the Network, e.g. water pumped-storage or batteries.

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

Frequency Leader [NC ER] – The TSO managing Frequency within a Synchronised Region in order to restore System Frequency back to Nominal Frequency.

Frequency Restoration Reserves [NC LFCR] – Frequency Restoration Reserves (FRR) means the Active Power Reserves activated to restore System Frequency to the Nominal Frequency and for Synchronous Area consisting of more than one LFC Area power balance to the scheduled value.

Full Activation Time [NC EB] – The time period between the activation request by TSO and the corresponding full activation of the concerned product.

HVDC System Owner [NC HVDC] – A natural or legal entity owning a HVDC System.

Interconnector [Regulation 714/2009] – Interconnector means a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States.

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Island Operation [NC RfG] – The independent operation of a whole or a part of the Network that is isolated after its disconnection from the interconnected system, having at least one Power Generating Module supplying power to this Network and controlling the Frequency and Voltage.

K-Factor [NC OS] – A factor used to calculate the frequency bias component of the ACE of a LFC Area or a LFC Block.

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

Load Frequency Control Structure [NC LFCR] – The basic structure considering all relevant aspects of Load- Frequency Control in particular concerning respective responsibilities and obligations (Process Responsibility Structure) as well as types and purposes of Active Power Reserves (Process Activation Structure).

Low Frequency Demand Disconnection [NC DC] – An action where demand is disconnected during a low Frequency event in order to recover the balance between demand and generation to restore system Frequency to acceptable limits.

Low Voltage Demand Disconnection [NC DC] – A restoration action where demand is disconnected during a low voltage event in order to recover Voltage to a sustainable level within acceptable limits.

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

Network [NC RfG] – Plant and apparatus connected together in order to transmit or distribute electrical power.

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

On Load Tap Change Blocking [NC DC] – An action that blocks the on load tap changer(s) during a low voltage event in order to stop transformers from tapping and suppressing Voltages in an area further. Often employed in association with LVDD.

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

Operational Security [NC CACM] – Keeping the Transmission System within agreed security limits.

Operational Security Limits [NC OS] – The acceptable operating boundaries: thermal limits, voltage limits, short-circuit current limits, frequency and Dynamic Stability limits.

Power Generating Facility [NC RfG] – A facility to convert primary energy to electrical energy which consists of one or more Power Generating Modules connected to a Network at one or more Connection Points.

Power Generating Module [NC RfG] – Either a Synchronous Power Generating Module or a Power Park Module.

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Re-energisation [NC ER] – The process of energising parts of the system that have been disconnected by reconnecting generation and Demand.

Reference load [NC ER] – The total load of a LFC Area including all consumption connected to both transmission and distribution systems and the losses on both transmission and distribution systems. It is usually calculated as the sum of all generation on the transmission and distribution systems (measured or estimated), excluding house load of power plants and importation balance of the LFC Area.

Regional Security Coordination Initiative [NC OS] – A regional unified scheme set up by TSOs in order to coordinate Operational Security Analysis in a determined geographic area.

Remedial Action [NC CACM] – Any measure applied by a TSO or several TSOs, manually or automatically, in order to maintain Operational Security. In particular, Remedial Actions serve to fulfil the (N-1)-Criterion and to respect Operational Security Limits; they can be used to relieve or contribute to the relief of Physical Congestions. They can be applied pre-fault or post-fault and may involve costs.

Replacement Reserves [NC LFCR] – Replacement Reserves (RR) means the reserves used to restore/support the required level of FRR to be prepared for additional system imbalances. This category includes operating reserves with activation time from Time to Restore Frequency up to hours.

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

Restoration [NC OS] – The System State in which the objective of all activities in Transmission System is to re-establish the system operation and maintain Operational Security after a Blackout State or Emergency State.

Restoration Plan [NC ER] – The summary of all technical and organisational measures to be undertaken to restore the system back to Normal State.

Restoration Plan Instruction [NC ER] – Instruction to be issued by the TSO to a DSO or to a Significant Grid User for the purpose of Restoration Plan activation.

Resynchronisation [NC ER] – Synchronising two Synchronised Regions by connecting the two Synchronised Regions at the Resynchronisation Point.

Resynchronisation Leader [NC ER] – The TSO in charge of Resynchronisation of two Synchronised Regions.

Resynchronisation Point [NC ER] – The substation used to connect two Synchronised Regions by closing circuit-breakers.

Significant Grid User [NC OS] – The existing and new Power Generating Facility and Demand Facility deemed by the TSO as significant because of their impact on the Transmission System in terms of the security of supply including provision of Ancillary Services.

Synchronised Region [NC ER] – A subpart of a Synchronous Area covered by interconnected TSOs with a common System Frequency not synchronised with the rest of the Synchronous Area.

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Synchronous Areas [NC OS] – An area covered by interconnected TSOs with a common System Frequency in a steady operational state such as the Synchronous Areas Continental Europe (CE), Great Britain (GB), Ireland (IRE) and Northern Europe (NE);

System Defence Plan Instruction [NC OS] – Instruction to be issued by the TSO to a DSO or to a Significant Grid User for the purpose of System Defence Plan activation.

System Defence Plan [NC OS] – 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 [NC OS] – The electric frequency of the system that can be measured in all parts of the Synchronous Area under the assumption of a coherent value for the system in the time frame of seconds, with only minor differences between different measurement locations.

System Protection Schemes [NC OS] – The set of coordinated and automatic measures designed to ensure fast reaction to Disturbances and to avoid the propagation of Disturbances in the Transmission System.

System State [NC OS] – The operational state of the Transmission System in relation to the Operational Security Limits: Normal, Alert, Emergency, Blackout and Restoration System States. .

Top-down Re-energisation Strategy [NC ER] – means a strategy that requires the assistance of other TSOs to re-energise part of the system of a TSO.

Transmission Connected Demand Facility [NC DC] – A Demand Facility which has a Connection Point to a Transmission Network.

Transmission Connected Distribution Network [NC DC] – A Distribution Network which has a Connection Point to a Transmission Network.

Transmission System [Swiss electricity market glossary] – Electricity grid used to transmit electricity over long distances within the home country and to connect up with foreign grids. Transmission systems are usually operated at the 220/380 kV voltage level.

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8.2 APPENDIX 2 CURRENT PRACTICES IN EUROPE ON EMERGENCY AND RESTORATION

See online document:
https://www.entsoe.eu/Documents/Network%20codes%20documents/NC%20ER/140527_NC_ER_Current_practices_on_Emergency_and_Restoration.pdf

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