European Regulators Group for Electricity & Gas

Guidelines of Good Practice for Operational Security in Electricity

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1. Executive Summary

The Guidelines of Good Practice (GGP) for Operational Security in Electricity address the following general issues: the objectives and necessary contents of the regulatory framework for operational security of the EU transmission networks and synchronous areas; the applicability and intended audience(s) for such a framework; the relationship between the EU-wide framework and the grid codes and operational security rules of the individual Member States and/or control areas; derogation and change management procedures and enforcement and supervision/monitoring.

The specific issues covered in these GGP include:

- Roles and responsibilities of different stakeholders and market players;
- Organisational framework for technical rules and codes for synchronous power system operation;
- Technical framework for operational security including security criteria aspects, network operational planning and real-time operation aspects, etc.; and
- Training and certification provisions for the TSO staff.

These GGP are intended to provide an EU-wide framework and to serve as a basis for the technical rules and codes of EU synchronous areas like UCTE or Nordel. Many features of these GGP may not be applicable in networks which are either unattached or connected through DC to other synchronous areas.

The draft Guidelines of Good Practice for Operational Security in Electricity under public consultation between 10 April and 11 June 2008. Comments received from stakeholders have been reviewed and evaluated and incorporated into these final GGP accordingly.

An evaluation of responses received during the public consultation has been published in a separate document, which can be found on the ERGEG website (www.energy-regulators.eu).

2. General Provisions and Objectives for these Guidelines

Presently there is no obligatory framework for all EU TSOs and/or synchronous areas to comply with any common EU rules and provisions for operational security.

However, based on the experiences of, and fact-finding reports by ERGEG (and also by other stakeholders like UCTE or national regulatory authorities) following large disturbances and electricity supply interruptions in the past (e.g. 04 November 2006 in the UCTE synchronous area, 28 September 2003 blackout in Italy), it is evident that a number of issues which are presently either not addressed at all or not adequately dealt with within the existing technical rules and codes, can only be appropriately resolved through a common EU-wide approach. To that end, some key issues and conditions must be taken into account in order to achieve optimal results and maintain efficiency and effectiveness:

1. The ***grid codes of the EU Member States and/or control areas*** (TSOs) address the aspects of synchronous operation and connection of the grid users to the transmission grids. As such, those national/TSOs' grid codes are on the one hand tailored to the specific needs and situation in a given control area, but on the other hand they also build upon the common, synchronous area-wide technical rules.

   This means, for example, that whereas a frequency plan is an issue to be coordinated among all the TSOs of a synchronous area, its implementation and relation to load shedding or other measures must be achieved at the national/TSO level, within the respective grid code.

   To summarise, the national/TSOs' grid codes will always remain to a large extent specific and related to a given control area or region, but a part of each national/TSO grid code will also be a common and unified one throughout the EU, namely that part which implements the common technical rules of a synchronous area.

2. The ***interoperability and operational security rules of the EU synchronous areas*** (e.g. Operational Handbook of UCTE, Nordic Grid Code of Nordel) address all the aspects of synchronous operation and interworking/interaction of affected control areas/TSOs, including: load-frequency control rules, scheduling and accounting, emergency control measures, restoration procedures, etc.

   It is clear that the technical side and adequacy of these rules must be in line with experiences and operational practices and must be defined in a coherent and coordinated way by all the TSOs of a given synchronous area. However, the enforceability, legally binding character and an overall common EU approach are not as easily achievable in a liberalised market context, as was the case in the times of monopolies and vertically integrated undertakings.

   It is therefore of the utmost importance to provide a regulatory and legally binding framework for the technical rules for interoperability and operational security and that is precisely the intention and key objective of these Guidelines of Good Practice.

3. ***These Guidelines of Good Practice are intended to provide a basis for an EU-wide regulatory framework*** for achieving a common and effective application and compliance with the existing and new/forthcoming technical rules and codes for interoperability and operational security of the EU electric power transmission grids.

   It is further critical to clarify what is a covered by these guidelines and what must lie outside their scope, i.e.:

   a. These GGP specify at a "meta-level" which issues are within the technical rules and codes for operational security of the EU transmission grids/synchronous areas and in which way they must be defined and implemented; furthermore the Guidelines also address the issues of organisation, compatibility and coherence as far as necessary,

      but

   b. These GGP do not deal with any actual and detailed technical issue – this must remain an issue for the rules and codes mentioned already above. Furthermore,

many features may not be applicable in networks which are either unattached or connected trough DC to other synchronous areas.

An illustration of the relationship between these Guidelines (blue) and technical/operational rules and codes of the synchronous areas (red) is shown in Figure 1.

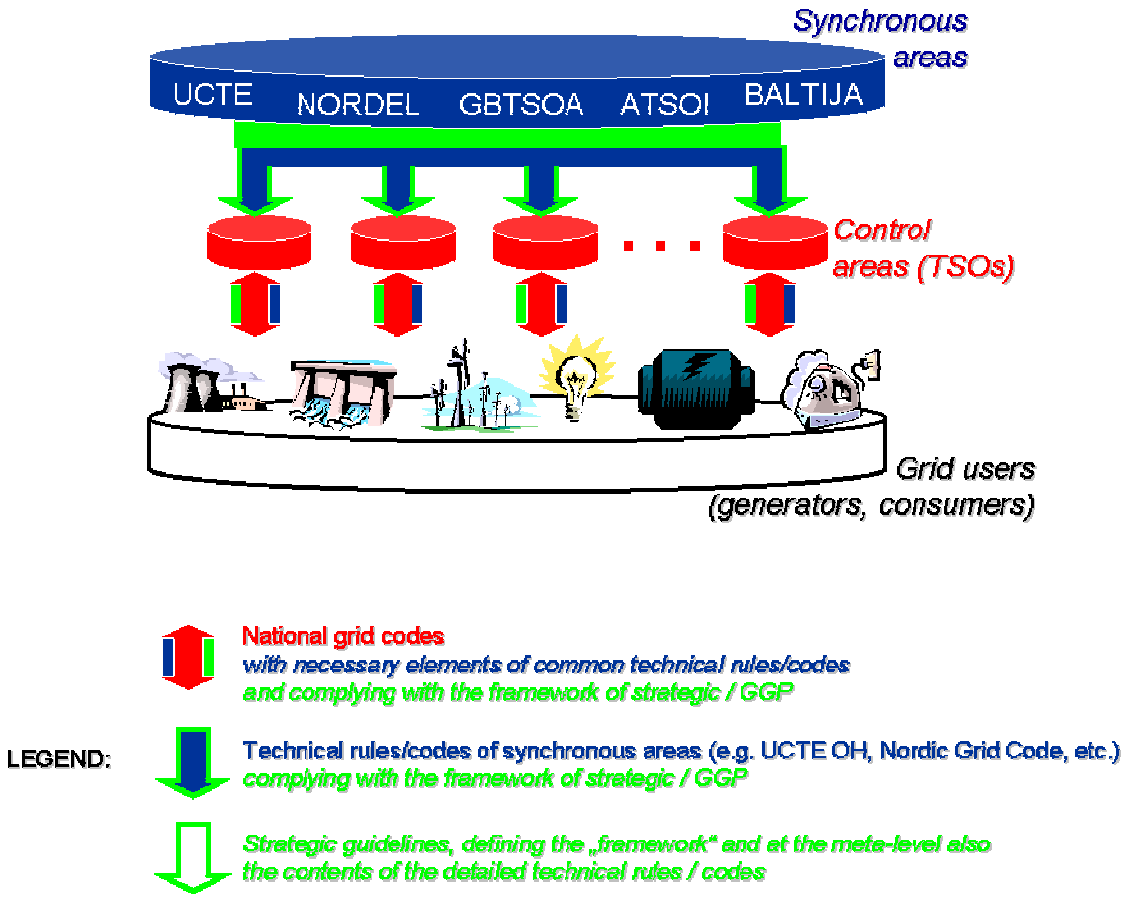

Figure 1: GGP on Operational Security vs. Technical rules & codes of synchronous areas

Whereas these GGP provisions could become legally binding if so decided by the respective EU bodies (Commission, etc.), it is important to emphasise that although the existing provisions of Regulation (EC) 1228/2003 foresee the possibility for such a framework in Article 8, it is anticipated that the future and forthcoming legal framework in the EU (the so called "Third Legislative Package") will contain further provisions that would in turn yield a further legal basis for such Guidelines.

Furthermore, it must also be emphasised that the scope of these Guidelines – similarly to the scope of the operational security and interoperability rules in the synchronous areas – represent a kind of a "lowest common denominator", or a minimum set of provisions that must be met by any affected TSO or stakeholder when designing technical rules and codes for operational security. Further provisions or a more detailed legally binding framework for specific technical rules would always exist and remain a matter for specific national implementation in the

Member States. Therefore it is necessary to, and inevitable that we will have to, address also those issues in these GGP, which go beyond the present scope of the EU legal framework.

Finally, whereas at present the Guidelines are for “Good Practice”, the regulators’ intention is clearly to work towards making such a framework also legally binding.

The Guidelines of Good Practice

3. Roles and Responsibilities of Different Stakeholders and Market Players

3.1. Regulators

3.1.1. For the secure operation of the power system, the regulatory authorities shall enable, enhance and enforce the cooperation and coordination among the TSOs, DSOs and other stakeholders and market participants through an adequate regulatory framework.

3.1.2. The regulators shall do everything in their power to ensure that in emergency situations the TSOs have full power to give dispatching orders to market participants to ensure system operation.

3.1.3. The regulators shall work together in providing such an adequate regulatory framework particularly related to issues of cross-border relevance.

3.1.4. The regulators shall monitor that the requirements set out in terms and conditions between TSOs and grid users, balance responsible parties or traders are suitable to ensure the operational security of the EU electric power transmission grids.

3.2. Transmission System Operators (TSOs)

3.2.1. The TSOs shall:

(1) follow up the actions of market participants and customers in order to achieve adequate operational security and efficient utilisation of the power system;

(2) prepare and distribute information about power system-related matters that have relevance to the secure operation of the power system, as well as matters that are of significance for the general security of supply;

(3) inform system operators in other countries about issues necessary for the secure operation, efficient utilisation and development of their installations, as well as about matters which are of significance for the security of supply in the synchronous area;

(4) inform the regulators about developments in the power system and the foreseen short term evolution of the balance between supply and demand;

(5) coordinate operation with DSOs, other TSOs, generators and large customers (who are connected at the transmission level);

(6) have the responsibility to implement appropriate defence and restoration plans and procedures (such as load shedding systems) in co-ordination with other TSOs;

(7) give dispatching orders to market participants to ensure system operation in emergency situations; and

(8) set terms and conditions in connection and access agreements and define clearly the requested information from market actors.

3.3. Distribution System Operators (DSOs)

This section refers to the DSOs which are directly physically connected to the transmission grid and those which are subsequently connected (e.g. as smaller DSOs) to other DSOs when it is relevant regarding secure operation of the EU electric power transmission grids.

3.3.1. The DSOs shall report to the TSOs relevant events (e.g. operational failures) in the distribution network and generation and consumption units connected to the distribution network.

3.3.2. The DSOs shall provide the TSOs with operational information on the distribution network and generation and consumption units connected to the distribution network that are necessary for operational security.

3.3.3. The DSO's shall execute the instructions given by the TSOs to ensure system operational security both in normal and in emergency situations.

3.3.4. The DSOs shall participate in emergency planning, restoration procedures and exercises planned and carried out by TSOs. In particular, the DSOs shall contribute to operational security by installing and maintaining load shedding systems, designed in coordination with TSOs.

3.3.5. When the previous requirements apply to subsequently connected DSOs, they shall be met in coordination with and, if necessary, by the intermediary of the other involved DSO(s). Particularly, the DSOs which are directly connected to the transmission grid shall ensure that the instructions from the TSO are transmitted to the subsequently connected DSO(s).

3.3.6. These requirements are specified in the agreement concluded between the DSOs and the TSO (or another DSO) on connection and access to the grid. The DSOs shall comply with this agreement.

3.4. Generators

3.4.1. The generators shall:

(1) comply with all valid provisions for load frequency control (when they are participating) and for dispatching when the system is operating under its normal operating state;

(2) in a critical state (i.e. when power system integrity is in danger), comply with instructions from TSOs/DSOs;

(3) participate in emergency planning, restoration procedures and exercises planned and carried out by TSOs; and

(4) provide the TSOs/DSOs with requested data.

3.4.2. These requirements and the data to be transmitted to the TSO are specified in the agreement concluded between generators and the TSO (or DSO) concerning connection and access to the grid. The generators shall comply with this agreement.

3.5. Consumption Units

3.5.1. The consumption units that are significant for the secure operation of the EU electric power transmission grids shall:

(1) in a critical state (i.e. when power system integrity is in danger), comply with instructions from TSOs/DSOs, and

(2) participate in emergency planning restoration procedures and exercises planned and carried out by TSOs.

3.5.2. These requirements and the data to be transmitted to the TSO are specified in the agreement concluded between the consumption units and the TSO (or DSO) concerning connection and access to the grid. The consumption units shall comply with this agreement.

3.6. Balance responsible parties

3.6.1. Balance responsible parties shall provide the TSO with all the data relevant to the secure operation of the system.

3.6.2. This requirement is specified in the agreement concluded between the balance responsible parties and the TSO. The balance responsible parties shall comply with this agreement.

3.7. Traders

3.7.1. Traders shall provide the balance responsible parties (or any other relevant actor) with all the data relevant to the secure operation of the system.

3.7.2. This requirement is specified in the agreement concluded between the trader and the balance responsible party. The traders shall comply with this agreement.

4. Rules for Synchronous Power System Operation

4.1. General Provisions

Regulation (EC) 1228/2003 states in Article 5 (2) that "*safety, operational and planning standards used by transmission system operators shall be made public*".

Since the operation of synchronously interconnected networks requires a high level of coordination between involved TSOs, common operational rules (in these GGP we use the term "rules" in the sense of the term "standards" which is referred to in Article 5 of the regulation above) need to be defined at synchronous area level and also between synchronous areas. Furthermore, parallel operation with a non EU (or non-EEA) synchronous system should have a proper cooperation agreement to ensure compliance with these guidelines.

Rules adopted in each synchronous area may differ to match specific constraints or specific technical practices. However, these rules shall, at the very least, meet the provisions of present guidelines in order to ensure the safe and efficient functioning of the integrated market.

Currently there are five main synchronous areas in the EU: UCTE, Nordel, Baltic IPS, Great Britain and Ireland (Northern Ireland and the Republic of Ireland).

Not all UCTE members belong to the EU or EEA. In this respect, this organisation should provide for a suitable operational security framework allowing its EU members to meet the requirements of the present Guidelines and obliging the other UCTE members to achieve a high level of operational security.

4.2. Rule Drafting Principles

4.2.1. TSOs of each synchronous area shall jointly adopt operational rules meeting the provisions set out in these guidelines.

When a synchronous area includes third countries, EU TSOs shall try to reach an agreement with the TSOs from these countries providing for a high level of operational security.

4.2.2. Within a synchronous area, TSOs shall jointly define a drafting procedure, describing the steps from its initiation to the implementation of the rules. This procedure shall provide for internal and external consultation. External consultation shall be conducted at an early stage and in an open and transparent manner with all appropriate stakeholders.

The rules should be regularly reviewed by TSOs according to the experience gained from their implementation. In this respect the drafting procedure shall provide for a revision process. This revision process can also be initiated at the request of a TSO or another stakeholder. The drafting procedure shall describe how such a request will be considered.

The drafting procedure shall be described in a public document.

4.2.3. The description of the rules shall be harmonised, as far as possible, across synchronous areas.

The description of each rule shall at least provide for:

(1) Objectives;

(2) clear, unambiguous and precise statement of the rule;

(3) measurable compliance criteria; and

(4) applicability.

The description of the rules shall leave no room for interpretation. In this respect, compliance criteria shall identify precisely what the TSOs have to do or which requirements they should meet to comply with these rules.

Where appropriate, the rules should point out the possible interdependencies with other stakeholders' behaviour (including information exchanges).

4.2.4. Synchronous area rules shall be published in an organised manner. Even if these rules apply to TSOs, they should be understandable by all affected parties.

4.2.5. Any new rule or modification of an existing rule shall be notified to the concerned regulatory authorities. The notifications shall be accompanied by sufficient explanations and results from the consultation process.

4.2.6. Where necessary, the synchronous area rules should be supplemented by provisions relating to the possible interfaces between synchronous areas. These provisions should be jointly defined and agreed by the TSOs of the involved synchronous areas. These rules shall meet the requirements applying to synchronous area rules.

When such an interface involves third countries, EU TSOs shall try to reach an agreement with the TSOs from these countries providing for a high level of operational security.

As far as they concern operational security, these agreements shall be made available at least for the relevant regulators.

4.3. Compliance Monitoring

4.3.1. TSOs of each synchronous area shall jointly establish a compliance monitoring process. This process should allow for periodic monitoring of the implementation of the operating rules. It should be carried out on a regular basis.

Compliance monitoring shall also provide for a review of the implementation of inter-synchronous area rules.

4.3.2. The organisation of the compliance monitoring process should be made public. Compliance monitoring shall be based on the compliance criteria defined for each rule. The measurement methodology has to be agreed among the concerned TSOs and described in a public document. If the compliance monitoring process relies on self-assessment by the TSOs, these TSOs must apply the agreed methodology.

The compliance monitoring process shall rely, at least partly, on on-site audits. The audit shall be executed by experts with relevant experience from non-affected TSOs and with the participation of independent auditors e.g. representatives from the Commission and the regulatory authorities. The appropriate implementation of self assessment methodology should be one of the aspects under review during these audits.

4.3.3. For a measurement of non-compliance, it may be necessary to define several non-compliance levels. In this case, these levels shall be clearly described for each rule.

4.3.4. The results of the compliance monitoring process shall be published in a report. This report shall be communicated to the relevant regulatory authorities.

The report shall contain at least:

(1) a presentation of the organisation of the compliance monitoring process for the considered period;

(2) a general overview of the operational security of the synchronous area as determined by the compliance assessment;

(3) a comprehensive description of any non-compliance: involved TSO, concerned rule, non-compliance level consequences of the non-compliance on operational security;

(4) a comparative analysis with the previous assessment periods; and

(5) feedback on the compliance monitoring process for the corresponding period, including proposals for improvements of the rules and of the compliance monitoring process.

Furthermore, the corresponding remedial measures and mitigation plans shall be sent at least to the relevant regulatory authorities when they cannot be made public for security reasons.

4.3.5. Any TSO, which can no longer comply with an operational rule, shall immediately inform the other TSOs of its synchronous area, the relevant regulatory authorities and any other TSO that might possibly be affected. Remedial measures shall be implemented without any delay to preserve secure system operation. These measures shall be agreed upon by the TSOs of the synchronous area and reviewed by the relevant regulatory authorities.

As soon as possible, the affected TSO shall establish a mitigation plan that will allow the TSO to comply with the violated rule(s). This plan shall be agreed by other affected TSOs.

4.3.6. If the non-compliance mitigation requires an evolution of the legal or regulatory framework, this shall be addressed in the mitigation plan. This also applies to any other externality.

The non-compliant TSO(s) and the concerned regulatory authority(ies) shall take all necessary action to remove the possible barriers to non-compliance mitigation.

5. Technical Framework for Operational Security

5.1. Security Criteria

Security criteria defined at the synchronous area level shall ensure optimisation between the high level of operational security and cost-effectiveness to achieve it.

5.1.1. General Provisions

5.1.1.1. Each TSO (or the responsible entity), shall have an obligation for the transparent and specific definition and description of the security criteria applied within its own control area that leaves no room for interpretation. These criteria shall be known by the regulatory authority and consistent with the rules defined at synchronous area level.

5.1.1.2. TSOs at the regional level and at the level of the whole synchronous areas shall define and implement security criteria and load-flow-based contingency analysis (including the dynamic and probabilistic ones in cases when a specific risk is deemed to be realistic) beyond their own control area borders, taking into account the following aspects:

(1) all interconnections between control areas;

(2) cross-effect of contingencies on critical network elements in one control area on the situation in the adjacent control area; and

(3) cross-effects of relevant external impacts (e.g. weather, social events, etc.) upon contingencies/security criteria between the control areas.

5.1.1.3. The definition of the security criteria shall contain both the reasoning for why a specific type and configuration of network element (circuit, transformer, busbar, double circuit, etc.) is included, and the actual list of those elements which are part of regularly executed contingency analysis (steady state).

5.1.1.4. Beyond the static approach, each TSO shall define the dynamic scenarios and possible adaptations to the contingency lists in advance for operational planning purposes.

5.1.1.5. Any effects from changes in the security criteria shall be explained by the involved TSO to the relevant regulatory authorities and communicated to the affected market participants.

5.1.1.6. Any adjustments to the existing security criteria at control area level shall be agreed upon by all affected TSOs (as for synchronous area according to paragraph 4.2)

5.1.1.7. The implementation of the defined security criteria shall be completed, at the very least, through the security assessment based on load-flow and shall be run on a periodic basis within the (n-1 or n-X) contingency analysis in each control area.

5.1.1.8. Security analysis should be performed using the best available data.

5.1.1.9. The actual outcome of the contingency analysis within the control areas that affects other control areas shall be exchanged between the involved TSOs.

5.1.2. Operational Planning

5.1.2.1. TSOs shall ensure that the interconnected network also meets the security criteria during planned outages. This shall be checked at all relevant stages of operational planning.

5.1.2.2. TSOs shall perform security analysis (n-1 (or n-x) contingency analysis) at each relevant stage of operational planning. TSOs shall ensure that their networks meet security criteria under the foreseen conditions (including cross-border exchanges) and do not jeopardise the operation of the interconnected networks.

5.1.2.3. TSOs shall ensure that network fault clearing does not lead to cascading outages violating security criteria.

5.1.2.4. At an operational planning stage, each TSO shall ensure that it has access to a sufficient level of ancillary services (e.g. active and reactive power reserves, balancing power) in real time to meet security criteria and the requirements set at synchronous area level. Cross-border exchange of active power reserves shall be agreed between TSOs.

5.1.2.5. Voltage control across interconnections between control areas (e.g. reactive power flows and voltage at boundary substations) shall be agreed by the TSOs involved. In principle, voltage control at boundary substations shall be planned to keep reactive power exchanges compatible with secure operation of the system.

5.2. Transmission Capacity Calculation

5.2.1. General Provisions

Given the importance of transmission capacity for promoting international trade, it is critical that TSOs perform their calculation in the most correct and transparent way, using definitions, principles, security criteria and methods that are understood by market players and approved by the regulatory authorities.

As stipulated in the CM guidelines (annex to Regulation (EC) 1228/2003), capacity calculation methods have to be coordinated within defined regions, including the use of a common transmission model dealing efficiently with interdependent physical loop-flows and having regard to discrepancies between physical and commercial flows.

Interconnection capacities may not be limited in order to solve congestions inside national grids without taking into account cost-effectiveness and the minimisation of the impact on the Internal Electricity Market.

These principles and methods should ensure effective competition, an efficient functioning of the Internal Electricity Market and the absence of discrimination between internal and cross border exchange.

5.2.2. Methodology for Transmission Capacity Calculation

5.2.2.1. TSOs must carry out all necessary studies for transmission capacity calculation and then provide to the market players that intend to import or export electricity the resulting information on transmission capacity that is available for commercial purposes.

5.2.2.2. In transmission capacity calculations, the TSOs shall apply the security criteria defined in 5.1.

5.2.2.3. The methodology used for these studies must be agreed between the involved TSOs, bearing in mind the recommendations and rules applicable on interconnected infrastructures.

5.2.2.4. As stated in article 5(2) of Regulation (EC) 1228/2003, the general scheme for the calculation of the total interconnection capacity and necessary margins based upon the electrical and physical features of the network shall be published and shall be subject to the approval of the regulatory authorities.

5.2.2.5. The transmission capacity that is available for commercial purposes must take into account a specific reliability margin required to cope with uncertainties related to system operation, generation-consumption balance and any missing information on the location of injections and off-takes.

TSOs shall identify precisely which uncertainties are covered by the reliability margin. This calculation method shall also be agreed among involved TSOs.

5.2.2.6. TSOs shall perform a calculation of both long-term (including the following year and the following months) and short-term transmission capacities (in particular for each hour of the following day and preferably also for the following week).

5.2.2.7. For long term capacity calculation, transmission capacity shall be based on the definition of forecasted worst-case scenarios. The calculation methodology shall include the determination of base case(s) taking into account different generation

(including different hydro and wind regimes), load and network topology scenarios and, if necessary, assumptions on loop flows generated by countries external to the region.

5.2.2.8. For short term capacity, the calculation of the technical transmission capacity shall include the determination of a base case indicating the level(s) of pre-existing flows taken as the starting point for the calculation process.

5.2.2.9. Principles for the determination of the base cases, and especially the conditions for the inclusion of specific types of exchanges in the base case should be transparent, non-discriminatory and ensure an efficient functioning of the electricity market. Those principles shall be approved by regulatory authorities as part of the general scheme (paragraph 5.2.2.4).

5.2.2.10. The security criteria applied for transmission capacity calculation shall be defined and approved by regulatory authorities as part of the general scheme (paragraph 5.2.2.4). Their coordinated and coherent implementation throughout the affected synchronous areas and the integrated electricity market shall be guaranteed by the TSOs through the compliance monitoring process and shall be regularly evaluated by the regulatory authorities.

5.2.2.11. For the different time frames, TSOs must exchange all necessary information to calculate transmission capacity in a co-ordinated and co-operative manner. In particular, each TSO shall use a common network model for calculation.

5.2.2.12. The transmission capacity available to the market shall be agreed by the affected TSOs of the interconnected systems and principles for agreement must be published.

5.2.3. Information and Data to be Published

5.2.3.1. The data and information to be published concerning capacity calculation shall include:

(1) the capacity calculation method applied by the TSOs, with a clear description, for the different time frames, of the principles used for the elaboration of base cases, of the reliability margins and of the applied security criteria, and

(2) maximum physical capacity and adopted reliability margin, duly justified, per electrical interconnection between adjacent TSOs (may group several interconnections) and if relevant per bottleneck or critical branch, for the different time frames.

The relevant base cases and hypothesis (with assumptions made for generation, load, DC interconnections and loop flows, including the flows of electricity through each interconnection, bottleneck or critical branch pre-existing to the allocation process), for the different time frames, shall be made available at least to the regulatory authority if requested.

5.2.4. Deadlines

5.2.4.1. The methods for capacity calculation covering all time frames to be applied during one considered period (by default the following year) should be submitted for approval to the regulatory authorities not later than 6 months before the beginning of this period

(only if methods change). Regulators shall finalise their review within 4 months after receiving the methods for approval.

5.2.4.2. Furthermore, TSOs shall jointly define and publish the deadlines for

(1) notification of long-term transmission capacity studies that must be sent for approval to regulatory authorities;

(2) publication of the transmission capacity available for imports and exports for each month; and

(3) update and disclosure of the hourly values of the transmission capacity available for commercial purposes, for the following week and for the following day or day plus two.

5.3. Co-ordinated Operational Planning

5.3.1. General Provisions

Operational planning of the electric power grids includes all the activities and tasks which are conducted prior to real-time operation.

Some operational planning and operational activities do not influence adjacent control areas and as such are left to implementation in each control area (according to the subsidiarity principle). These activities include preparation of schedules for power exchanges within own control area, preparation of internal redispatch, coordination of protection (except for protection at the interconnection tie lines), etc.

In the electricity market, network operation is characterised by volatile power flows and cross-border exchanges. As a result, operational planning, at least by neighbouring TSOs, must be conducted in a well coordinated and coherent manner.

Moreover, a high degree of coherence and co-ordination is necessary inside synchronous areas and between the synchronous areas.

5.3.2. Outage Scheduling for Maintenance

5.3.2.1. Outage scheduling for the purpose of maintenance of network elements shall be agreed among involved TSOs. Furthermore, involved TSOs shall exchange information on scheduled outages of significant generation and consumption units. In this respect, all scheduled outages that influence two or more TSOs shall be considered. TSOs shall establish a joint scheduling process providing for long-term and short-term planning of outages. This process shall be settled at the level of synchronous areas and agreed between the areas accordingly.

5.3.2.2. TSOs shall exchange detailed information about the scheduled outages. This shall include at least the following information:

(1) beginning, end and duration of unavailability for each affected network element, and generation and consumption unit,

(2) impact on cross-border capacity towards neighbouring TSOs,

(3) modification of transits through the control area affecting cross-border exchanges, and

(4) possible preventative and (in case of several failures or unplanned disturbances within a short time) remedial measures based on an analysis of probable/expected problem scenarios; these analyses shall be based on operational experiences and especially on lessons learned from large disturbances that have occurred in the past.

The TSOs shall ensure confidential treatment of the data exchanged.

5.3.2.3. Any changes in an outage schedule shall be notified to, and agreed with, all influenced TSOs without delay.

5.3.2.4. Furthermore, TSOs shall agree in advance on any specific joint measure or action required in relation to a planned outage.

5.3.2.5. All information regarding consequences of the planned outages that is of relevance to the market participants or any other affected stakeholders shall be published in due time by the TSOs in an appropriate format.

5.3.2.6. The yearly coordinated maintenance and revision plan shall be presented to the regulators for information and published for market participants. This plan shall include elements having relevance to the electricity markets. It shall be updated during the year to include any new relevant information.

5.3.3. Commissioning of New Equipment/Network Elements

5.3.3.1. TSOs shall coordinate commissioning and entering into operation of any network element. Furthermore, TSOs shall inform each other about commissioning of significant generation and consumption units.

5.3.4. Exchange Scheduling

5.3.4.1. TSOs shall agree on a common and uniform cross-border exchange programme including the format, processing, communication procedure and handling of changes.

5.3.4.2. For that purpose, TSOs shall define a process to aggregate and evaluate the cross-border exchange programmes at the synchronous area level.

5.3.4.3. TSOs shall agree on scheduling and actual execution of exchange programmes within and between synchronous areas. The organisation of respective exchange scheduling processes shall be made in line with electricity markets timetables and gate-closures.

5.3.4.4. TSOs shall exchange all the necessary data and information required in order to accomplish the tasks mentioned in 5.3.4.1 and 5.3.4.2. In this respect, TSOs shall in particular agree on data format, protocols, communication infrastructure and media.

5.3.5. Load-Flow Forecast

5.3.5.1. Before real-time operation, TSOs shall conduct load-flow forecasts in order to identify possible congestion and perform security analysis (n-1 (or n-x) contingency analysis). The results shall be aggregated, exchanged and cross-checked between neighbouring TSOs belonging to the same synchronous area.

5.3.5.2. Load-flow forecasts shall be performed at all relevant stages of operational planning from year-ahead to day-ahead. The frequency of load-flow forecasts shall be agreed among TSOs.

5.3.5.3. TSOs shall exchange the necessary data and information required to perform load-flow forecasts. This shall include at least the following information:

(1) real network model to forecast power flows over the interconnected network;

(2) configuration of all switchable or adjustable elements belonging to (1), including busbar couplers and phase shifting transformers; and

(3) load and injections at all nodes (to be defined) of the network model from (1).

5.3.5.4. TSOs shall agree on the data format and communication infrastructure used. The data exchange process shall use the best available data for each stage of operational planning.

5.3.5.5. When data has to be estimated (in particular for long-term forecast), TSOs shall agree on the method used.

5.3.6. Co-ordinated Security Approach

5.3.6.1. TSOs shall jointly apply the security criteria defined according to paragraph 5.1.

5.3.6.2. The protection system design and short circuit current shall be agreed between TSOs at interconnections.

5.3.6.3. In particular, protection systems installed at each end of cross-border lines shall be co-ordinated.

5.4. Network Operation

5.4.1. General Provisions

Network operation includes all the activities close to (before/after) real-time and actual real-time functioning of the electric power grid.

The actual network operation is closely linked to the short-time (close to real-time) operational planning including in addition specific activities which are carried out during the actual real-time operation.

5.4.2. Required Activities

5.4.2.1. TSOs shall regularly perform (within a predefined and mutually agreed time period):

(1) data collection and storage, state estimation, filtering out the faulty/wrong measurements;

(2) load flow calculation;

(3) static and dynamic stability analysis, when appropriate; and

(4) reactive power and voltage analysis in order to be able to identify conditions in which measures should be implemented in order to prevent voltage collapse.

5.4.2.2. TSOs shall perform a contingency analysis to regularly check and identify the necessary preventative actions. They shall perform these checks on a periodical basis (e.g. every 15 minutes) and before switching action of a network element during the real time operation (including new network elements entering into operation), if it may affect the security of the EU electricity transmission grids.

5.4.2.3. The operational/on-line information on the actual outcome of the contingency analysis within the control areas shall be exchanged between the affected TSOs. Furthermore, TSOs shall cooperate whenever it is required to accomplish the tasks requested by 5.4.2.1.

5.4.2.4. Associated with the decision support systems, TSOs shall establish a common monitoring system for increased efficiency in disturbance prevention and system defence in cases of disturbed or critical system conditions. Such a system shall enable the execution in real time of the functions of wide area monitoring (e.g. WAM-system and/or information on neighbouring control areas) as well as a range of preventative/remedy measures.

5.4.2.5. If a violation of a security criterion is detected, the TSO concerned shall prepare and possibly activate appropriate measures. All the other TSOs concerned shall be informed without delay. Any joint measure shall be coordinated between involved TSO.

5.4.2.6. Provisions for the Load-Frequency Control:

(1) A Load-Frequency Control mechanism shall be agreed among TSOs at synchronous area level. Load–Frequency control organisation, requirements and performance shall be clearly defined (at least as a part of synchronous system rules, see chapter 4),

(2) Provisions for the load-frequency control shall contain the directions and main principles for the market based procurement of balancing and automatically activated reserves, applicable for all TSOs, and

(3) Provisions for load-frequency control shall also consider the procurement of balancing and automatically activated reserves in an integrated balancing market with more than one control area participating.

5.4.3. Reconnection after Maintenance/Contingency of Network Elements

5.4.3.1. Activation of planned outages must be coordinated within real-time among all involved TSOs, in line with the provisions for planned outages within the operational planning.

5.5. Emergency Operation and Restoration

5.5.1. General Provisions

The extent of the effect of the disturbances on power system operation is reflected in the operating states that differ from the normal operating state. Recovery or restoration from the disturbed to the normal operating state shall occur as fast and efficiently as possible in order to avoid new disturbances and/or further deterioration of system security.

TSOs shall maintain restoration plans and have regular training for restoration, including actions across the borders, where appropriate.

5.5.2. Emergency Operation

5.5.2.1. TSOs shall define when the power system is in the normal operating state and when it diverges from the normal state. TSOs have to ensure that these definitions are common across the synchronous area and between synchronous areas in order to avoid adverse effects upon network operation.

5.5.2.2. TSOs shall define characteristics which cause the operating state to differ from the normal state, e.g. flows in the TSO grid and on interconnectors; active power reserves (primary, secondary, tertiary reserves); reactive power reserves; status of network control system and stability of the system (voltage, frequency and power angle).

5.5.2.3. TSOs shall communicate, in a transparent way, definitions and features of operating states that apply to the other affected TSOs.

5.5.2.4. In the case of disturbances, the TSO shall execute the remedial actions to restore the system to the normal operating state without delay. Remedial actions are dependent on the nature of the disturbance and they shall accordingly be used to restore the state of the system to normal as efficiently as possible within a predefined time frame set by the TSOs within a synchronous area. Procedures for remedial actions, including respective responsibilities, shall be defined by TSOs.

5.5.2.5. The TSO is responsible for remedial actions in the case of disturbances within its power system. In the case of disturbances on an interconnector, the TSOs concerned are responsible for the necessary actions on their side of the interconnector, unless otherwise agreed between the neighbouring TSOs. Agreements and coordinated procedures between neighbouring TSOs shall be implemented to complement the national rules and procedures. The remedial actions may include e.g. the activation of power or reactive reserves, automatic load shedding or any other emergency measure.

5.5.2.6. The design of automatic load shedding systems shall be harmonised and coordinated across synchronous areas. In this respect, the DSOs involved shall cooperate with TSOs. Responsibilities regarding the installation and maintenance of load shedding systems shall be clearly defined in each control area. Load shedding shall be carried out in a non-discriminatory manner. The efficiency of load shedding systems shall be regularly evaluated based upon large disturbances that have occurred and upon dedicated studies.

5.5.3. System Restoration

5.5.3.1. The TSOs are responsible for the restoration of the power system and may give orders (within the context of maintaining the power system operational security and integrity) to those connected to their network in order to efficiently restore the system operation.

5.5.3.2. TSOs shall establish predetermined restoration plans. These plans shall describe the sequence of actions that would allow restoration of normal operation after network collapse in a timely and reliable manner. The main characteristics of the restoration plans shall be defined and agreed by TSOs at synchronous area level.

5.5.3.3. Restoration plans must be coordinated among TSOs to allow the organised restoration of the whole synchronous area and shall be evaluated by regulatory authorities.

5.5.3.4. TSOs shall ensure that they have access to sufficient black start and islanding capability to allow for the efficient and fast restoration after power system blackouts. The black start capability shall be designed to re-energise the grid reliably and quickly.

5.5.3.5. To this end, the restoration plans are to be maintained by TSOs and their personnel are to be trained to manage these exceptional incidents. TSOs shall develop procedures to test the restoration plans. TSOs shall test these restoration plans regularly and make adjustments to these plans where appropriate. The process for this shall be described transparently and communicated to all involved parties by TSOs.

5.5.3.6. The restoration, after a blackout, of the affected part of the system shall be executed as soon as possible. The application of the restoration plan shall be coordinated among involved TSOs if is envisaged that the help of neighbouring TSOs will be required.

5.5.3.7. Any such event shall be analysed by the TSO and communicated to market participants and relevant regulatory authorities.

5.6. Interoperability

5.6.1. General Provisions

TSOs shall ensure that their system can operate as smoothly as possible with other TSOs' power systems. This requires co-ordination in protection measures and in the operation of the power systems. Furthermore, interoperability between different synchronous systems has to be ensured.

5.6.2. Interoperability

5.6.2.1. TSOs shall ensure interoperability of their power systems within and between synchronous areas.

5.6.2.2. TSOs shall apply common principles in system protection to ensure system security and efficient system usage in an interconnected power system. TSOs shall set requirements for system protection to maximise transmission capacity. System protection shall limit the consequences of operational disturbances to a minimum in the interconnected system. System protection procedures shall be co-ordinated

among TSOs. These procedures shall be described and agreed among relevant TSOs to ensure interoperability within and between synchronous areas.

5.6.2.3. The system protection measures shall be co-ordinated with the protection principles of each TSO control area.

5.6.2.4. For each interconnector TSOs shall define who is responsible for operation of that specific interconnector, and if both TSOs have responsibilities then the responsibility boundary for operation of the interconnector has to be agreed between TSOs. These responsibilities include switching schedules and operations, monitoring of operation and disturbance management.

Operation of interconnectors shall include definition of transmission and trading capacity, procedures to define transmission capacity, operation monitoring and control during system operation, voltage control, outage planning and disturbance handling. TSOs shall agree on procedures for operations of interconnectors.

5.6.2.5. TSOs having interconnections to other synchronous systems shall ensure that operation of these interconnections is compatible with interconnections within the synchronous system thus ensuring that secure system operation between synchronous areas is maintained. Effects of disturbances shall not spread from one synchronous system to another.

5.6.2.6. Any agreement relating to inter-TSO co-operation shall be formally established. In particular, it must specifically identify respective tasks and responsibilities.

6. Training and Certification

6.1. General Provisions

Dispatchers at the control rooms should have skills to maintain the secure network operation all the time in varying network conditions. To make decisions in ensuring secure network operation the dispatchers working at control rooms must be properly trained. The training should include both theory of network operation and practical training for different network situations.

The training should be planned and lead to a certification, which authorises the dispatcher to act in the control room. Furthermore, after first certification the skills should be developed through practical work in the control room and through planned continuous training, giving evidence of maintaining the dispatcher skills for the purpose of the renewal of the certification.

More co-ordination and co-operation are needed among the TSOs in the Internal Energy Market (IEM) and training of dispatchers should also include these aspects of cooperation and coordination across the borders.

6.2. Training and Certification

6.2.1. TSOs shall train their control room personnel (dispatchers) to ensure reliable system operation. This training shall include the initial training when a new dispatcher is appointed and continuous training for those working as dispatchers.

6.2.2. Initial training shall include theoretical studies, training on a dispatcher training simulator and on-the-job training under the supervision of an experienced dispatcher. TSOs shall define the detailed contents of the initial training including the above mentioned topics.

6.2.3. Every new dispatcher must pass the initial training to obtain certification. The TSO shall deliver a certification to the dispatcher candidate based on the TSO's qualification criteria. The certification authorises the dispatcher candidate to work in the control room as a dispatcher. The period of validity of the certification shall be predefined by the TSO. Furthermore, the TSO shall define the details of the certification process.

6.2.4. To maintain and extend the dispatcher's skills, continuous training will be applied to all individuals with a dispatcher position within the TSO. The TSO shall define the detailed contents and frequency of the continuous training programme including e.g. training with extreme and exceptional situations. Where appropriate, a dispatcher training simulator may be used for training. The training simulator should, as far as possible, resemble the actual control room equipment including the comprehensive national database with respective data from neighbouring networks at a sufficient level.

6.2.5. The renewal of the certification after expiry shall be based on the dispatcher's participation in a continuous training programme and the assessment of the dispatcher's performance in the control room.

6.2.6. Neighbouring control areas shall agree on a common language for contacts between their dispatchers. The dispatchers concerned shall have a sufficient skill in this language to carry out their tasks.

6.2.7. TSOs shall exchange operational experiences with their neighbouring TSOs. This exchange of information includes regular joint training between neighbouring TSOs to improve knowledge of characteristics of neighbouring grids and communication and coordination between dispatchers of neighbouring TSOs. TSOs shall agree on the inter-TSO training procedures and processes and monitor effects of training and adjust the procedures and processes where appropriate.

6.2.8. Each TSO shall have a coordinator responsible for training including designing, monitoring and updating the training process. The coordinator shall be responsible for defining procedures and processes including:

(1) qualification for dispatchers;

(2) training required for qualification;

(3) processes with documentation for initial and continuous training;

(4) process for accreditation; and

(5) requirements for trainers and training of trainers.

The initial training programme shall include an evaluation, where the skills of a candidate to perform the tasks of a dispatcher are tested by the trainers. The evaluation shall include a written document.

6.2.9. TSOs shall define the skills and the level of competence of the trainers. TSOs shall also ensure that trainers have adequate training both in this specific area and in pedagogical skills.

7. Glossary of Terms

The descriptions of terms provided here serve mainly the purpose of providing a common understanding of different subjects and apply in the first instance to the issues addressed in these Guidelines.

Therefore, some differences to already existing definitions in use in other situations and/or specifications are possible.

Alert (disturbed) state ..... an operating state which entails that all consumption is met and that the frequency, voltage and transmission are within the predefined acceptable limits/thresholds. In alert state, the reserve (margins) requirements are not fulfilled and faults in network elements or in generation (i.e. unforeseen disturbances/outages) will lead to further deterioration of system state.

In the alert state, the power system is stable and all operational reserves (for transmission and generation balance) have to be mobilised. It is not clear if (or in which time frame) it will be possible to fully return to security limits (it depends on the gravity of the alert and the possible risk of cascading events). The system is viable and operating within the acceptable operating constraints, however, in this case the system parameters are very close (still within or just beyond) to the security limits. The → dispatchers have serious uncertainties about returning to a normal state due to existing network or load/generation margin constraints, and the situation is potentially dangerous.

Critical state ..... an operating state entailing that compulsory load shedding has been applied and that further production shedding and network divisions may occur.

In the critical state, the system is not stable and its ”natural” evolution (phenomena such as tripping in cascade, frequency drop, loss of synchronism, power cuts, islanding) tends to bring it to an unstable and uncontrollable situation. Global security of the whole interconnected power system is endangered. Exceptional actions such as load shedding may be necessary to limit the spreading of the dangerous phenomena and prevent the collapse of part or of the whole power system. In this state, the system goes rapidly towards highly endangering conditions of operation with system parameters outside the limits fixed for operational security.

Dispatcher a member of the TSO staff in charge of real time operation and operational planning/preparations in the day-to-day electric power system functioning; the term dispatcher is used throughout these Guidelines as a synonym for the "Transmission System Operators' personnel in charge of system operation".

Flow-based calculation a calculation of → interconnection capacity which is based on the actual, physical load flows and the actual → interchange schedules (resulting from the trading nominations & generators schedules); one of the key features of the flow based capacity calculation is relying on a common and coordinated transmission grid model.

Interconnection a line (circuit)/or a set of lines (circuits) between two control areas or between two synchronous areas; an interconnection between two control areas can be an AC or a DC one, but in the latter case an AC/DC & DC/AC conversion is always necessary at both ends of the line. An interconnection between two synchronous areas can only be a DC one.

Interchange schedule scheduled electric power flow between the two interconnected systems (control areas in one or two adjacent synchronous areas); for each scheduling period, the interchange schedules are jointly agreed between the involved TSOs in charge of the related control areas.

Network collapse after network collapse, all loads in one or more parts of the control area are shed and further production shedding and network divisions occurs.

Normal state an operating state entailing that all consumption and production is in balance and requirements on ancillary services and framework conditions are met: frequency, voltage and electric power flows are within their predefined and allowed limits (thresholds) and reserve (margins) are sufficient. In normal state, the electric power system can withstand disturbances like unplanned outages without losing its functionality and without supply interruptions.

Operating states there are three types → *normal state*, → *alert (disturbed) state*, and → critical *state*; when the electric power system function and synchronous operation are interrupted, it is the state of → network collapse; an improvement of system operating states towards the normal one is achieved by → restoration

Restoration transition between the → operating states characterised by the network being restored, production being regulated, and frequency, voltage and/or transmission being restored to within predefined and allowed thresholds. During restoration, consumption is connected at a pace which the restored network and generation resources can accommodate.

Security criteria contain requirements and framework for the power system → security control. Although a great deal of expert knowledge is inherent in these criteria and a large portion of that knowledge is common to most EU transmission grids, there exist at present no standardised approaches beyond a vague definition of e.g. (n-1)

	use (but not specification/implementation) throughout synchronous areas.
Security control	aims to maintain the power system in the normal state or as close as possible to the normal state. If security degradation occurs, it is the security control task to ensure return as close and fast as possible to the normal state. Effective and successful security control results in an adequate and sufficient → security level.
Security level	is a function of the distances of the power system components' operational parameters from the limits (permitted values). Security level depends on the overall system conditions and defined various constraints like permitted voltage range, thermal circuit ratings, etc. Security level is influenced also by external conditions, e.g. weather, hydro-storage, situation in the interconnected systems, primary energy sources, market situation and prices, etc.
Transmission capacity	maximum physical power flow that can be set for each direction of a given interconnection.