Operating Security Standards

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EIRGRID

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Further information can be found at: http://www.eirgridgroup.com/legal/

Contents

1 Introduction

The Operating Security Standards (OSS) provides a set of standards on which operating procedures for the transmission system in Ireland shall be based. At all times, EirGrid, the Transmission System Operator (TSO), shall aim to operate the transmission system in accordance with the criteria stated in this OSS. EirGrid shall work in conjunction with SONI, the System Operator for Northern Ireland, in order to meet the criteria set out in this OSS.

However, in certain circumstances, it may be necessary to operate the transmission system outside of these criteria. Examples where this could happen include (but are not limited to) the avoidance of high risk operating conditions for the transmission system, transmission plant personnel or as provided for in the EirGrid Grid Code[1], System Defence Plan (SDP) or in the Power System Restoration Plan (PRSP).

2 Scope

The OSS shall apply to EirGrid. EirGrid shall work in conjunction with SONI to ensure the transmission system on the island of Ireland is operated securely.

3 Regulatory Framework

The OSS is produced in order to comply with the following documents:

- Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity Transmission System operation[2] (SOGL);
- Synchronous Area Operational Agreement (SAOA) for Synchronous Area IE/NI[3] (SAOA);
- Methodology for coordinating operational security analysis[4] (CSAM);
- EirGrid Transmission System Operator License Condition 16[5];
- EirGrid Grid Code[1] and
- EirGrid Transmission System Security and Planning Standards[6] (TSSPS).

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[1] EirGrid, EirGrid Grid Code

[2] European Commission, Establishing a guideline on electricity Transmission System operation
[3] EirGrid and SONI, Synchronous Area Operational Agreement (SAOA) for Synchronous Area IE/NI
[4] ACER, Methodology for coordinating operational security analysis
[5] The Commission for Energy Regulation, EirGrid Transmission System Operator License
[6] EirGrid, Transmission System Security and Planning Standards

4 Security Analysis Framework

The transmission system shall be operated within the criteria specified in the subsequent sections (5-8) in normal state and after contingencies. The contingency list comprises of:

- Ordinary contingencies;
- Exceptional contingencies with permanent occurrence increasing factor applied; and
- Exceptional contingencies with temporary occurrence increasing factor applied.

Permanent occurrence increasing factors may be applied based on (but not limited to) location or historical network design considerations. Temporary occurrence increasing factors may be applied based on (but not limited to) weather considerations. Application shall be in line with CSAM. Table 1 details examples of the different contingency types.

Ordinary contingency	**Exceptional contingency**	**Out-of-range contingency**
loss of a single: • circuit; • transformer (includes distribution system transformer); • phase-shifting transformer; • reactive compensation device; • component of a HVDC system such as a line or a cable or a single HVDC converter unit; • power generation unit(s); • demand facility.	• loss of network elements having common fault mode, for example busbar, HVDC grounding system, circuit breaker, measurement transformer; • loss of circuits supported on the same tower or loss of underground cables built in same trench; • loss of grid users having common process mode, for example two gas turbines supplying a single steam set; • loss of multiple generation units or demand facilities disconnected due to a voltage drop on the network or system frequency deviation.	• loss of two or more independent circuits

Table 1 – Examples of contingency types

The system shall be operated to ensure the following:

- Frequency parameters comply with Table 2;
- Voltage levels comply with Table 3;
- Equipment remains within loading limits as per Section 7;
- Dynamic stability is as per Section 8;
- No load shall be lost for an ordinary contingency unless tail fed;
- Multiple independent planned outages shall not tail feed more than 3% of system demand at a single location; and
- Load may be interrupted to connected customers where contracts permit (e.g. flexible demand, interruptible load, demand side response).

The transmission system may be operated outside of the system parameters defined in the OSS at instances (but not limited to) when:

- The intact transmission system deviates from the TSSPS.

After an occurrence of an event outside of the contingency list, the system may operate outside of normal standards. Such a situation shall initiate the SDP in order to return the system parameters within standards as per sections (5-8).

5 System Frequency

The transmission system shall operate at nominal frequency of 50 Hz and within the parameters outlined in the SAOA and in Table 2 below.

Parameter	**Value**
Nominal frequency	50 Hz
Standard frequency range	49.8 - 50.2 Hz
Maximum instantaneous frequency deviation	1 Hz
Maximum steady state frequency deviation	0.5 Hz
Time to recover frequency	1 Minute
Frequency recovery range	49.5 - 50.5 Hz
Time to restore frequency	15 Minutes
Frequency restoration range	49.8 - 50.2 Hz
Alert trigger time	10 Minutes
Maximum number of minutes outside standard frequency range	15000 per year
Maximum rate of change of frequency (RoCoF)[7]	1.0 Hz per second

Table 2 – System frequency parameters

[7] measured over a rolling 500 milliseconds period as per EirGrid Grid Code

6 Voltage Ranges

The transmission system shall operate within the voltage ranges as per Table 3.

Nominal voltage	Normal state range	Post-contingency range
400 kV	370 – 410 kV	360 – 420 kV
220 kV	210 – 240 kV	200 – 245 kV
110 kV	105 – 120 kV	99 – 123 kV
275 kV[8]	260 – 300 kV	250 – 303 kV

Table 3 – Voltage ranges

The maximum voltage step change for operational switching and ordinary contingencies shall not exceed 10%.

[8] 275 kV voltage level included due to Louth – Tandragee circuit

7 Plant Security Limits

This section explains how equipment shall be operated in normal state and after a contingency event.

7.1 Thermal Limits

All equipment on the transmission system shall be operated within rated capacity, including transitory admissible overload limits, as specified by the Transmission Asset Owner (TAO), so that thermal limits are not exceeded.

7.2 Short Circuit Levels

The 110 kV, 220 kV and 400 kV transmission networks are effectively earthed systems and operate such that line-to-earth voltage during single line-to-earth faults does not rise above 80% of the rated line-to-line voltage.

The transmission system shall be operated such that the actual short circuit levels do not exceed the short circuit rating of equipment on the system. Make and break short circuit currents shall not be greater than 90% of equipment rating as specified by TAO. Where 90% of equipment rating is greater than short circuit levels allowed in the Grid Code, the short circuit levels shall not go above Grid Code. Short circuit levels shall not be greater than 100% of equipment rating during switching (temporary coupling).

8 Dynamic Stability

The dynamic stability[9] of the transmission system shall be maintained for at least the following stability categories:

- **Transient stability:** the system shall remain stable and experience no loss of synchronism for faults cleared by primary protection. Fault types include:
    - three phase zero impedance line-end faults on transmission circuits, and
    - the loss of generators, interconnectors, large loads or reactive compensation devices.
- **Frequency stability:** the system frequency shall be maintained within the maximum instantaneous frequency deviations as defined in Table 2 in Section 5 following:
    - the loss of the largest power in-feed or the largest out-feed, or
    - the loss of interconnectors or tie lines.
- **Voltage stability:** the system voltages shall be maintained within the ranges listed in Table 3 in Section 6 following:
    - three phase zero impedance line-end faults on transmission circuits,
    - the loss of generators, interconnectors or reactive compensation devices,
    - the loss of heavily loaded circuits, or
    - the connection of large loads.

System stability shall be maintained and adequately damped. The system shall have adequate damping and the target damping ratio (ζ) shall be at least 0.05.[10]

[9] The definition of system stability from IEEE PES-TR77 (Stability definitions and characterisation of dynamic behaviour in systems with high penetration of power electronic interfaced technologies) applies.

[10] Cigré Technical Brochure 111, page 2-5

9 Acronyms and Definitions

9.1 Acronyms

Cigré	Conseil International des Grands Réseaux Electriques
CSAM	Methodology for coordinating operational security analysis
HVDC	High Voltage Direct Current
Hz	Hertz
IE	Ireland
kV	kilo Volt
NI	Northern Ireland
OSS	Operating Security Standards
PRSP	Power System Restoration Plan
RoCoF	Rate of Change of Frequency
SAOA	Synchronous Area Operational Agreement (SAOA) for Synchronous Area IE/NI
SDP	System Defence Plan
SOGL	Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity Transmission System operation
SONI	System Operator Northern Ireland
TAO	Transmission Asset Owner
TSO	Transmission System Operator

9.2 Definitions

Alert trigger time	The time before alert state becomes active.
Common fault mode	Single fault that will lead to loss of more than one network element.
Common process mode	Total or partial loss of one grid user will lead to the total or partial loss of others.
Contingency	The identified and possible or already occurred outage of an element of the transmission system, including not only the transmission system elements, but also significant grid users and distribution network elements if relevant for the transmission system operational security.
Contingency list	The list of contingencies to be simulated in order to test the compliance with the operational security limits.
CSAM	Methodology for coordinating operational security analysis.
Dynamic stability	The ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact.
EirGrid	The independent statutory electricity transmission system operator in Ireland.
Exceptional contingency	The loss of more than one network element due to common cause.
Frequency recovery range	The system frequency range to which the system frequency is expected to return in the IE/NI synchronous areas, after the occurrence of an imbalance equal to or smaller than the reference incident, within the time to recover frequency.
Frequency restoration range	The system frequency range to which the system frequency is expected to return in the IE/NI synchronous areas, after the occurrence of an imbalance equal to or smaller than the reference incident within the time to restore frequency.
Frequency stability	The ability of a power system to maintain frequency within specified ranges and return to those ranges after being subjected to a disturbance.
Maximum instantaneous frequency deviation	The maximum expected absolute value of an instantaneous frequency deviation after the occurrence of an imbalance equal to or smaller than the reference incident, beyond which emergency measures are activated.
Nominal frequency	Frequency value used as a target to operate the system at.
Normal state	A situation in which the system is within operational security limits in the N-situation or after the occurrence of any contingency from the contingency list, taking into account the effect of the available remedial actions.
N-situation	The situation where all planned outages are implemented and no contingency has occurred.

Operational security	The transmission system's capability to retain a normal state or to return to a normal state as soon as possible, and which is characterised by operational security limits.
Ordinary contingency	The occurrence of a contingency which leads to single network element outage.
Out-of-range contingency	The simultaneous occurrence of multiple contingencies without a common cause, or a loss of power generating modules with a total loss of generation capacity exceeding the reference incident.
Permanent occurrence increasing factor	A factor that explains a permanent increase of the probability of occurrence of an exceptional contingency.
Planned outage	Scheduled outage of equipment for example maintenance.
SAOA	Synchronous Area Operational Agreement (SAOA) for Synchronous Area IE/NI.
SOGL	Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation.
Standard frequency range	A defined symmetrical interval around the nominal frequency within which the system frequency of a synchronous area is supposed to be operated.
Steady state	State after occurrence of an imbalance, once the system frequency has been stabilised.
Steady state frequency deviation	The absolute value of frequency deviation after occurrence of an imbalance, once the system frequency has been stabilised.
Temporary occurrence increasing factor	A factor that explains a temporary increase of the probability of occurrence of an exceptional contingency.
Time to recover frequency	For the synchronous areas IE/NI, the maximum expected time after the occurrence of an imbalance smaller than or equal to the reference incident in which the system frequency returns to the maximum steady state frequency deviation.
Time to restore frequency	The maximum expected time after the occurrence of an instantaneous power imbalance smaller than or equal to the reference incident in which the system frequency returns to the frequency restoration range for synchronous areas with only one LFC area and in the case of synchronous areas with more than one LFC area, the maximum expected time after the occurrence of an instantaneous power imbalance of an LFC area within which the imbalance is compensated.
Transient stability	The ability of the power system to remain in synchronism in normal state and regain synchronism after being subjected to a disturbance.
Transitory admissible overload	The temporary overloads of transmission system elements which are allowed for a limited period and which do not cause physical damage to the transmission system elements as long as the defined duration and thresholds are respected.
Transmission plant	Fixed and movable items used in the generation and/or consumption of and/or supply and/or transmission of electricity.

Transmission system	The system consisting (wholly or mainly) of high voltage electric lines and cables operated by the TSO for the purposes of transmission of electricity from one power station to a sub-station or to another power station or between sub-stations or to or from any external interconnection including any plant and apparatus and meters owned or operated by the TSO or TAO in connection with the transmission of electricity.
Transmission System Operator	The licensed entity that is responsible for transmitting electricity from generators to regional or distribution operators.
Voltage stability	The ability of a power system to maintain steady voltages at all buses in the system after being subjected to a disturbance.