

Proposal Document

**Design of the System Defence
Plan for Ireland**

In accordance with the requirements of
Articles 11 and 4.5 of the Commission
Regulation (EU) 2017/2196
establishing a network code on
electricity emergency and restoration

18/12/2018



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Proposal

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1. Background

COMMISSION REGULATION (EU) 2017/2196, establishing a Network Code on Electricity Emergency and Restoration (NCER) came into force on the 18th of December 2017. This network code details the requirements for each TSO to develop a System Defence Plan (SDP). This SDP should detail a TSO's business processes, procedures and measures in managing events on the power system. In EirGrid, the requirements of the SDP are captured in the pre-existing business processes.

This SDP has been designed based on the requirements set out within Article 11 of the NCER. The measures and actions outlined in this document will be activated depending on the 'state' of the power system.

The requirements of the SDP are detailed in Article 11 – Article 22 of the NCER. The high level requirements of these articles include;

- Design of the SDP
- Implementation of the SDP
- Activation of the SDP
- Measures of the SDP

The Terms and Conditions for System Defence Providers, as defined in NCER, are conveyed through the Connection and Operating Conditions of the Grid Code and Part 3 of SI 445/2000¹. In the recent past, there has been an extensive process of consultation on modifications to the Grid Code and the development of system services contracts.

Where appropriate, system services contracts were procured through a tendering process. This is expected to continue for the foreseeable future.

EirGrid does not propose to change any Grid Code clauses with respect to System Defence services.

The relevant legislative and Grid Code articles relating to the SDP are listed in the table below.

¹ <http://www.irishstatutebook.ie/eli/2000/si/445/made/en/print>

Table 1 – SDP Requirements

Article	Text	Currently Defined Within
Article 11 – Article 22	Detailed requirements of the SDP to include design, implementation, activation and measures	SI 445/2000 Part 3 8(1)(a),(b). Grid Code OC2, Operational Planning. Grid Code OC4, System Services. Grid Code OC5, Demand Control. Grid Code CC10, User Protection and Power Quality. Interconnector Operating Protocol (as agreed with TSO).

The measures and remedial actions detailed in this document will be enacted depending on the status of the power system and or market conditions in Ireland.

2. Design of the System Defence Plan

The design of the SDP has been carried out in accordance with the requirements of Article 11 of the NCER. This article details the specific requirements of the SDP and what should be considered when drafting.

The following requirements shall be taken into account;

- Operational security limits set out in accordance with Article 25 of Regulation (EU) 2017/1485²
- Behaviour and capability of load and generation within the synchronous area
- Specific needs of the high priority significant grid users
- Characteristics of the transmission system and of the underlying DSO system

This document is drafted taking into account the policies and procedures currently in place. This document will include all existing agreements in place with relevant stakeholders where these exist.

2.1 Provisions of System Defence Plan

Article 11 of the NCER states that the SDP shall contain the following provisions;

- The conditions under which the SDP is activated
- The SDP instructions to be issued by the TSO
- The measures subject to real time consultation or coordination with the identified parties

2.2 Technical and Organisational Measures

Article 11 details the technical and organisational measures that should be considered in the drafting of the SDP. These include;

- Automatic under-frequency control scheme
- Automatic over-frequency control scheme
- Automatic scheme against voltage collapse
- Frequency Deviation Management Procedure

² <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN>

- Voltage Deviation Management Procedure
- Power Flow Management Procedure
- Assistance for Active Power Procedure
- Manual Demand Disconnection Procedure
- Inter-TSO assistance and coordination in emergency state

These measures should comply with the following principles;

- Their impact on the system shall be minimal
- They shall be economically efficient
- Only those measures that are necessary shall be activated
- They shall not lead to the TSO's transmission system or the interconnected system into an emergency or blackout state.

3. Activation of the System Defence Plan

3.1 Conditions for activation of System Defence Plan

EirGrid shall activate a measure of the SDP based on the following criteria;

1. The system is in an emergency state in accordance with the criteria set out in Article 18(3) of Regulation (EU) 2017/1485³ and there are no remedial actions available to restore the system to the normal state.
2. Based on the operational security analysis, the operational security of the transmission system requires the activation of a measure of the SDP pursuant to Article 11(5) in addition to the available remedial actions.

EirGrid will issue instructions to the relevant stakeholders as required.

Any measure or procedure of the SDP will be activated in coordination with the DSO, Significant Grid User (SGU) and Defence Service Providers. All instructions issued by EirGrid must be executed without undue delay.

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN>

4. Measures of the System Defence Plan

The measures of the SDP are detailed in Article 15 through to Article 21 of the NCER: EirGrid has a number of processes and procedures detailing the business' response to events that may cause a system emergency. Actions taken by the business will depend on the likely severity of the forecasted event.

Any measures to be implemented by the DSO will be communicated by EirGrid.

4.1 Automatic under-frequency control scheme

In accordance with the detailed requirements of the automatic under-frequency control scheme in Article 15 of the NCER:

1. Arrangements are in place for the automatic disconnection of demand based on falling frequency of the network. This process is revised to account for the connection of embedded generation. See Grid Code OC4.3.3.
2. The requirement for the Automatic under-frequency demand disconnection is detailed in the Ireland Grid Code under section OC5, Demand Control.
3. A scheme for the automatic triggering of pumped storage plant in an under frequency event is in place. This automatic scheme is detailed in an existing business process.
4. This measure requires the TSO to identify any additional system protection schemes to arrest falling frequency. This is the responsibility of the TSO and assessments are made based on the changing nature of the power system in line.

4.2 Automatic over-frequency control scheme

In accordance with the detailed requirements of the automatic over-frequency control scheme in Article 16 of the NCER:

1. Grid Code requires generators/demand customers to install over frequency control schemes as a minimum and/or as required by the TSO (CC.10.9.2, CC.10.10.2, CC.10.11.2).
2. Commercial agreements are in place that provides high frequency response services to EirGrid.

4.3 Automatic scheme against voltage collapse

In accordance with the detailed requirements of the automatic scheme against voltage collapse found in Article 17 of the NCER:

1. The Grid Code details the requirements for 'Automatic low voltage demand disconnection' (OC5.7) and states the TSO can determine the requirements to mitigate risks associated with voltage collapse. Under-voltage load shedding relays are installed on the transmission system to help mitigate this risk.
2. EirGrid has identified the system services required to operate the power system with increasing levels of renewable/non-synchronous generation. Specific products have been procured and contracted to allow EirGrid the ability to manage system voltage. These are detailed in Appendix 7.1 below.
3. Studies are carried out in real time to ensure the limits detailed in the Operational Security Standards are met under normal operating conditions and in the event of a secured event on the transmission network.
4. Capacitor and Reactor banks are installed at various locations to provide EirGrid the flexibility of managing a changing voltage profile throughout the year.

4.4 Frequency Deviation Management Procedure

In accordance with the detailed requirements of the Frequency Deviation Management Procedure scheme can be found in Article 18 of the NCER:

1. The operating frequency requirements for users connecting to the transmission system in Ireland are detailed in the Grid Code (CC.7.3.1.1). Specific limits include;
 - operate continuously at normal rated output at Transmission System Frequencies in the range 49.5Hz to 50.5Hz
 - remain synchronised to the Transmission System at Transmission System Frequencies within the range 47.5Hz to 52.0Hz for a duration of 60 minutes;
 - remain synchronised to the Transmission System at Transmission System Frequencies within the range 47.0Hz to 47.5Hz for a duration of 20 seconds required each time the Frequency is below 47.5Hz;
 - remain synchronised to the Transmission System during rate of change of Transmission System Frequency of values up to and including 0.5 Hz per second;
 - sustained operation at the specified Minimum Generation within the range 49.8 to 51.0 Hz;
2. EirGrid operates the power system with a Primary Operating Reserve (POR) requirement of 75% of the largest single infeed. This is required to be in place at all times.

3. The Operating Reserve requirements are detailed in the Grid Code under section OC4.6.3.2.
4. System Service contracts are in place with providers who have been identified as being able to provide operating reserve to manage system frequency/events in the following timescales;
 - Primary Operating Reserve (POR) (5-15 seconds)
 - Secondary Operating Reserve (SOR) (15-90 seconds)
 - Tertiary Operating Reserve 1 (TOR1) (90 seconds – 5 mins)
 - Tertiary Operating Reserve 2 (TOR2) (5 mins – 20 mins)
5. Replacement Reserve Synchronised (RRS) and Replacement Reserve Desynchronised (RRD) are two system service products that provide a further option for managing frequency in a system event.

4.5 Voltage Deviation Management Procedure

In accordance with the detailed requirements of the Voltage Deviation Management Procedure found in Article 19 of the NCER:

1. EirGrid is required to operate the transmission system within the voltage limits detailed in the Operating Security Standards. This is achieved using synchronised generators operating within their reactive power capabilities and static sources of reactive power.
2. OC4.4, Voltage Control of Ireland Grid Code details the strategy and objectives of the TSO in managing system voltage within the required limits.
3. Ongoing studies of the network are carried out in real time assessing the impact on voltage depending on the changing schedule of generation. This also includes varying levels of non-synchronous generation such as wind energy and the impact this will have on voltage.
4. A business process is in place that details how voltage should be managed and the actions that should be taken to mitigate a variety of risks/scenarios

4.6 Power Flow Management Procedure

In accordance with the detailed requirements of the Power Flow Management Procedure found in Article 20 of the NCER:

1. Power flows are managed by EirGrid within the technical limits of installed equipment on the power system.
2. SDC2, Scheduling and Dispatch Code No.1 details the requirements of generators in declaring to the TSO their availability to generate.
3. SDC2, Scheduling and Dispatch Code No.2 details the requirements the TSO must follow when dispatching generation on the power system
4. Special protection schemes are identified and installed to mitigate damage to equipment from thermal overloads.
5. EirGrid publishes an 'Operational Constraints Update' detailing the rules in scheduling generation and managing power flows on the network. This document is kept up to date and any changes to these are communicated to the industry.

4.7 Assistance for Active Power Procedure

In accordance with the detailed requirements of the Assistance for Active Power procedure can be found in Article 21 of the NCER:

1. Commercial agreements are in place with neighbouring TSO's for assistance in an emergency situation. This emergency assistance is provided via the HVDC interconnector.
2. Where a forced outage of a generating unit has occurred and has the potential to put the system into an emergency state, Grid Code allows the TSO to request alterations to existing agreed maintenance outages to alleviate system issues. This is covered under section OC2.7.2 of the Grid Code.

4.8 Manual Demand Disconnection Procedure

In accordance with the detailed requirements of the Manual Demand Disconnection Procedure found in Article 22 of the NCER:

1. OC5 of the Grid Code, Demand Control, details the requirements of the TSO and DSO in identifying when and how customer demand should be disconnected.
2. Manual demand disconnection is carried out in conjunction with the DSO. A business process exists detailing how this should be carried out in conjunction with the DSO.

5. Appendix

5.1 Contracted System Services

Service	Description
Synchronous Inertial Response SIR	Provision of Inertia from synchronous machines that can operate with low minimum generation point.
Fast Frequency Response FFR	MW delivered between 2 and 10 seconds in response to automated frequency trigger
Primary Operating Reserve POR	MW delivered between 5 and 15 seconds in response to automated frequency trigger
Secondary Operating Reserve SOR	MW delivered between 15 to 90 seconds in response to automated frequency trigger
Tertiary Operating Reserve 1 TOR1	MW delivered between 90 seconds to 5 minutes in response to automated frequency trigger
Tertiary Operating Reserve 2 TOR2	MW delivered between 5 minutes to 20 minutes in response to a control / dispatch instruction
Replacement Reserve – Synchronised RRS	MW delivered between 20 minutes to 1 hour in response to a control / dispatch instruction
Replacement Reserve – Desynchronised RRD	MW delivered between 20 minutes to 1 hour in response to a control / dispatch instruction from a zero megawatt starting

	position.
Ramping Margin 1 RM1	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
Ramping Margin 3 RM3	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
Ramping Margin 8 RM8	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
Fast Post Fault Active Power Recovery FPFAPR	Active power recovery within 250 ms of a voltage fault
Steady State Reactive Power SSRP	Reactive power response within 40ms of a voltage fault
Dynamic Reactive Response DRR	MVAr capability during large (>30%) voltage dips

5.2 Automatic low frequency demand disconnection

This table is included in the annex of the NCER and is required depending on the requirements of the TSO.

Automatic low frequency demand disconnection scheme characteristics:

Parameter	Values SA Continental Europe	Values SA Nordic	Values SA Great Britain	Values SA Ireland	Measuring Unit
Demand disconnection starting mandatory level: Frequency	49	48,7 – 48,8	48,8	48,85	Hz
Demand disconnection starting mandatory level: Demand to be disconnected	5	5	5	6	% of the Total Load at national level
Demand disconnection final mandatory level: Frequency	48	48	48	48,5	Hz
Demand disconnection final mandatory level: Cumulative Demand to be disconnected	45	30	50	60	% of the Total Load at national level
Implementation range	± 7	± 10	± 10	± 7	% of the Total Load at national level, for a given Frequency
Minimum number of steps to reach the final mandatory level	6	2	4	6	Number of steps
Maximum Demand disconnection for each step	10	15	10	12	% of the Total Load at national level, for a given step

5.3 Definitions

- ‘defence service provider’ means a legal entity with a legal or contractual obligation to provide a service contributing to one or several measures of the system defence plan;
- ‘restoration service provider’ means a legal entity with a legal or contractual obligation to provide a service contributing to one or several measures of the restoration plan;
- ‘high priority significant grid user’ means the significant grid user for which special conditions apply for disconnection and re-energisation;
- ‘restoration plan’ means all technical and organisational measures necessary for the restoration of the system back to normal state;
- ‘re-energisation’ means reconnecting generation and load to energise the parts of the system that have been disconnected;
- ‘top-down re-energisation strategy’ means a strategy that requires the assistance of other TSOs to re-energise parts of the system of a TSO;
- ‘bottom-up re-energisation strategy’ means a strategy where part of the system of a TSO can be re-energised without the assistance from other TSOs;
- ‘resynchronisation’ means synchronising and connecting again two synchronised regions at the resynchronisation point;
- ‘Resynchronisation point’ means the device used to connect two synchronised regions, usually a circuit breaker.