

Proposal Document

**Design of the System Restoration
Plan for Northern Ireland**

In accordance with the requirements of
Articles 23 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

Table of Contents

1. Definitions	4
2. Background	5
3. System Restoration Plan Overview	7
3.1. Design of the Restoration Plan.....	7
3.1.1. <i>Network Code Requirements</i>	7
3.1.2. <i>Provision of the Restoration Plan</i>	8
3.2. Activation and Re-energisation of the Restoration Plan	11
3.2.1. <i>Network Code Requirements</i>	11
3.2.2. <i>Provision of the Restoration Plan</i>	12
3.3. Frequency Management and Re-synchronisation	13
3.3.1. <i>Network Code Requirements</i>	13
3.3.2. <i>Provision of the Restoration Plan</i>	14
4. Article by Article Summary	16

1. Definitions

Relevant definitions as per Network Code on Emergency and Restoration

‘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.

2. Background

The System Restoration Plan provides a plan of action for TSO Control Engineers to restore the power system following a total or partial black out. SONI has had a Restoration Plan in place for many years. In the wake of the new Network Code requirements on Emergency and Restoration (NCER), the System Restoration Plan (SRP) is being revised as per the requirements of Commission Regulation (EU) 2017/2196 published on the 24th November 2017.

This proposal document is produced by SONI Ltd in its role as the Transmission System Operator in Northern Ireland (hereafter referred to as the 'TSO').

Following a consultation process on various aspects of the System Restoration plan as set out in Article 7 of the NCER, this document is being submitted to the regulatory authority in order to fulfil the requirements to submit a proposal on the design of the System Restoration Plan. The measures and actions outlined in this document will be enacted in the event of a partial or total black out of the Ireland power system. Note that for security and confidentiality reasons, the full details of the plan are not given here.

The relevant legislative and Grid Code articles relating to Power System Restoration are listed in the table below:

Requirement	Service	Currently Defined Within
Ancillary Service	TSO to ensure availability of ancillary services to operate the grid securely	SONI Transmission System Operator Licence - Condition 29
Black Start Definitions and Requirements	Availability of certain units to start up without external power supply	Grid Code CC.S1.1.1.4
	Availability of interconnectors to start up without external power supply	N/A
	Reference to Ancillary Service Agreement	SONI Transmission System Operator Licence - Condition 29
Re-energisation procedure	Power System Restoration and provision for TSO Restoration Plan	Grid Code OC7.4.6
Black Start Testing	Powers for TSO to carry out tests on Black Start Generators once per year.	Grid Code OC11.2 (f)

The main requirements of these articles include;

- Design of the System Restoration Plan
- Implementation of the System Restoration Plan
- Activation of the System Restoration Plan
- Re-energisation of the Power System
- Frequency management and re-synchronisation of the Power System
- Measures of the System Restoration Plan

The measures and remedial actions detailed in this document will be enacted depending on the status of the power system in Northern Ireland at the time of the required action.

This SRP will be drafted with the following technical guidelines taken into account:

The operational security limits set out in accordance with Article 25 of Regulation (EU) 2017/1485¹.

- The behaviour and capability of load and generation within the synchronous area.
- The specific needs of the high priority grid users listed in the Appendix of this plan.
- The characteristics of the transmission system and underlying DSO's.

¹ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN>

3. System Restoration Plan Overview

3.1. Design of the Restoration Plan

3.1.1. Network Code Requirements

The System Restoration Plan has been designed in accordance to the requirements of Article 23 of the Emergency and Restoration Code. This article details the specific requirements of the System Restoration Plan and what should be considered when drafting.

When designing the restoration plan it must take into account:

- The behaviour and capabilities of load and generation
- The specific needs of high priority significant grid users and their terms and conditions for disconnection and re-energisation
- The characteristics of the network and of the underlying DSOs networks

The Restoration Plan shall contain the conditions under which it shall be activated and the instructions to be issued to the TSO. In particular it shall:

- Provide a list of measures to be implemented by the TSO, DSO and SGUs on their installations.
- Provide a list of substations which are essential for its restoration plan procedures.
- The implementation deadlines for each listed measure

The restoration plan shall include at least the following technical and organisational measures:

- Re-energisation procedure;
- Frequency management procedure; and
- Re-synchronisation procedure.

The restoration plan shall have minimal impact of the system users, be economically efficient and only necessary measures shall be activated.

3.1.2. Provision of the Restoration Plan

The design of the System Restoration Plan is set out in SONI Grid Code sections OC7.2 to OC7.5

As per Grid Code section OC7.2 states that the objective of the System Restoration Plan is to:

- Achieve restoration of the total system and enable demand to once again be satisfied in the shortest possible time.
- To achieve re-synchronisation of parts of the transmission system which have ceased to be synchronised with each other
- To ensure communication routes and arrangements are available to senior management of the TSO
- To ensure that the NI System can continue to operate in the event that the TSO Control Centre is incapacitated for any reason

As per Grid Code sections OC7.4.1 to OC7.4.4 regards the design of the System Restoration Plan for a total shutdown or a partial shutdown of the power system. During these periods of total or partial shutdown, licence standards may not be met and the whole or any part of the system may be operated outside of normal voltage and/or frequency standards.

Grid Code section OC7.5 outlines that certain power stations (“Black Start Stations”) are identified under their connection agreement as having an ability for at least one of its CDGUs to Start-Up as soon as possible from Shutdown and to energise a part of the total system to be synchronised to NI System upon instruction from the TSO.

Grid Code section OC7.6.2 states that the recovery from a Total Shutdown or Partial Shutdown require that this OC7 is sufficiently flexible to accommodate the full range of Power Station, Total System characteristics and operational possibilities, and this precludes the setting out of precise chronological sequences.

The overall strategy will, in general, include the overlapping phases of establishment of isolated Power Stations, together with complementary local Demand, termed "Power

Islands", step by step integration of these Power Islands into larger sub-systems and, eventually, complete re-establishment of the Total System.

- For example indicative timings are as follows: Blue Alert SMS sent to Blue Alert distribution list
- Black Start Mobilisation SMS sent to transmission asset owners nominated staff within 2 minutes of the blue alert SMS being sent
- Specific plan formulated by SONI within 15 minutes of establishing the nature of the blackout
- Communications established with Black Start Generating Stations within 15 minutes of the plan formulation
- External supply to primary target generators as specified in the plan within 2 hours of the plan formulation
- Re-synchronisation of separate subsystems within 6 hours of the plan formulation
- Restoration of supply to specified transmission stations within 8 hours of the plan formulation
- Restoration of continuous supply to all remaining 275kV and 110 kV transmission stations within 12 hours of the plan formulation

The high level steps to be included in the development of a restoration plan are:

Step / Tasks	Available Tools & Notes
1. Communication	
Contact Manager of Real Time	CHCC Check lists in back of the PSRP
Issue Blue Alert SMS	SMS System procedure in Appendix 17
Issue Black Start Mobilisation SMS	
Contact DCC	OTN / Satellite phones
Staff the CHCC/ECC – Appoint Control Engineers to manage designated island	Control Engineers, SCADA & Near Time Standby Engineers
Staff the Incident Room (If required)	
2. Establish status of Black Start and Non Black Start Power Stations	
Check EMS to confirm that CHCC Emergency Diesel Generator is online & connected.	Contact SONI SCADA immediately
Contact Black Start Stations - establish time to Black Start	OTN / Satellite phones
Contact generation stations with target generators - establish status, critical time for getting supply and time to re-start once external supply is restored	Refer to reference information in each subsystem PSRP
Prioritise generation stations for supply	
3. Divide transmission system into subsystems	
Check all Circuit Breakers are opened at all transmission substations	Use PSRP as a guide & draw dividing lines on network drawing

Step / Tasks	Available Tools & Notes
Split the transmission system into subsystems	template in PSRP
Clearly delineate between subsystems	
4. Choose Path from Black Start Station to priority Non Black Start Stations	
Check Black Start Mobilisation Substation List – NIE Engineers will confirm substation attendance with CHCC. Contact DCC for additional substation attendance where required.	Substation attendance sheet and BSM Procedure in Appendices
Consult PSRP for preferred route	Identify Transmission & Generation outages that affect restoration path via EMS
Review status of Transmission System	
Coordinate with DCC to ensure route is staffed	As per BSM procedure
Develop a detailed switching plan for each subsystem restoration path.	Refer to the relevant sections of the PSRP for guidance
5. Commence Sub System Restoration & Load Pick-up	
Use soft energisation if available	Black Start Generating Stations
Communicate with DCC when picking up auxiliary load blocks in power stations	DCC should have agreed load blocks prepared
DCC to switch in load to raise total load quantity and stabilise generating units within islands	Communicate with Generators – Ensure Automatic Frequency Response is enabled to provide system stability
When picking up DCC load ensure frequency is high and the voltage drop that will occur on switch in does not cause very low voltages	Frequency overview page on EMS gives frequency at Black Start Stations
Commence DCC load reconnection within the limits of the available generators – keep units part loaded	Priority Loads for reconnection in consultation with DCC
6. Synchronise Sub Systems	
Couple weak subsystems to strong subsystems	
Use Synchronising Points identified in the PSRP if possible	PSRP Appendix 6 – Manual controlled Synchronising facilities
Communicate with NIE field Engineers at substations with synchro scope operations.	NIE will provide confirmation that Engineers are fully trained in manual sync switching
Step down Island Control Engineers as Islands are unified to form one jurisdictional island	
7. Complete Restoration	
Rebuild the system carefully	EMS Contingency Analysis
Avoid overloads or voltage issues	
Cancel Blue Alert Signal once restoration is complete.	

3.2. Activation and Re-energisation of the Restoration Plan

3.2.1. Network Code Requirements

The System Restoration Plan has an activation plan in accordance to the requirements of Article 25 of the Emergency and Restoration Code. This article details the specific requirements of the System Restoration Plan and what should be considered when drafting.

Each TSO shall activate the procedures of its restoration plan in coordination with the DSOs and SGUs identified pursuant to Article 23(4) and with restoration service providers in the following cases:

- When the system is in the emergency state, once the system is stabilised following activation of the measures of the system defence plan; or
- When the system is in the blackout state

During system restoration, each TSO shall identify and monitor:

- Synchronised regions to which its control area belongs and the TSO which it shares this synchronous region with
- The available active power reserves in its control area.

Each DSO and SGU identified and each restoration service provider shall execute without undue delay the restoration plan instructions issued by the TSO, in accordance with the restoration plan procedures.

Each TSO shall activate those procedures of its restoration plan that have a significant cross-border impact in coordination with the impacted TSOs.

The re-energisation procedure shall include measures to:

- Manage voltage and frequency deviations
- Monitor and manage island operation
- Resynchronising island operation areas

When re-energisation is occurring the TSO shall take into account:

- The availability of power sources capable of re-energisation

- The expected duration and risks of possible re-energisation strategies
- The conditions of the power system
- The conditions of directly connected systems, including interconnectors
- High priority significant grid users
- The possibility to combine top-down and bottom-up re-energisation strategies

During re-energisation, the TSO shall, after consultation with DSOs, establish and notify the amount of netted demand to be reconnected on distribution networks.

3.2.2. Provision of the Restoration Plan

The activation of the System Restoration Plan is set out in SONI Grid Code section OC7.4.6.

Grid Code section OC7.4.6.4 states that the TSO's instructions may be to:

- A Black Start Station relating to the commencement of generation
- To a Large Demand Customer with respect to the restoration of Demand
- To the DNO with respect to cooperating in the restoration of Demand on the Distribution System
- To a Generating Plant relating to preparation for commencement of generation once an external power supply has been made available

In each case this may include switching instructions.

Grid Code section OC7.4.6.5 states that:

- The TSO instructions relating to a Black Start will be given in the same format as normal Dispatch Instructions.
- Accordingly, the TSO will, as part of a Black Start, instruct a Generator with a Black Start Station to Start-Up a particular CDGU and confirm to the TSO when this has been achieved.
- Following such confirmation, the TSO will endeavour to stabilise that CDGU by instructing Large Demand Customers to establish appropriate Demand on the Transmission System and/or the DNO to coordinate where possible the establishment of appropriate Demand on the Distribution System,

- Following which the TSO may instruct the Start-Up and Synchronisation of the remaining available CDGUs at that Black Start Station and their loading with appropriate Demand to create a Power Island.

If during this Demand restoration process any CDGU cannot, because of the Demand being experienced, either keep within its Technical Parameters or operate outside its Technical Parameters, the Generator shall inform the TSO and the TSO will, where possible, either instruct Large Demand Customers to alter Demand and/or the DNO to cooperate with altering Demand, or will re-configure the NI System in order to alleviate the problem being experienced by the Generator.

SONI will take such actions as follows;

- Ensure the NIE Black Start Mobilisation members have been instructed to switch off all low frequency and low voltage load shedding facilities and to switch off auto-reclosing facilities on transmission lines
- The transmission system should be re-energised feeder by feeder to limit increments of MVAR's generated
- Only one circuit of a double circuit feeder should be used at the early stages of restoration and except where studies have shown that a problem does not exist, care should be taken when energising a long 275kV or 110kV transmission line, to the end of which an unloaded transformer is connected
- To minimise potential inrush currents, transformers tap changers should be positioned so that the maximum number of turns will be excited in the transformer

Load engineers will use the latest load schedule to decide which loads should be reconnected. At early stages of restoration the stability of the Black Start units is of priority so the load that is being reconnected is selected based on the ability to reconnect very small load blocks with minimal switching. Once additional generators come onto the subsystem, priority loads can be restored.

3.3. Frequency Management and Re-synchronisation

3.3.1. Network Code Requirements

The System Restoration Plan has to manage frequency and the re-synchronisation of the grid in accordance to the requirements of Articles 28-34 of the Emergency and Restoration Code. These article details the specific requirements of the System Restoration Plan and what should be considered when drafting.

The frequency management procedure of the restoration plan shall contain a set of measures aiming at restoring system frequency back to the nominal frequency.

The TSO shall activate its frequency management procedure:

- In preparation of the re-synchronisation procedure
- In case of frequency deviation
- In case of re-energisation

It shall include:

- A list of actions regarding the setting of the load-frequency controller
- The establishment of target frequency in case of bottom-up re-energisation strategy;
- Frequency management after frequency deviation; and
- Frequency management after synchronous area split.
- The determination of the amount of load and generation to be reconnected taking into account the available active power reserves within the synchronised region in order to avoid major frequency deviations.

The re-synchronisation procedure of the restoration plan shall include:

- The measures allowing the TSO to apply a re-synchronisation strategy
- The maximum limits for phase angle, frequency and voltage differences for connecting lines

3.3.2. Provision of the Restoration Plan

The frequency management and re-synchronisation of the System Restoration Plan is set out in SONI Grid Code section OC7.5

Grid Code section OC7.5.1 states that where parts of the Total System have ceased to be Synchronised with each other but there is no Total Shutdown or Partial Shutdown, the TSO will instruct relevant Users to regulate generation or Demand, as the case may be, to enable the De-Synchronised islands to be Re-Synchronised and the TSO will inform those Users when Re-Synchronisation has taken place.

Grid Code section OC7.5.2 states that during a period in which the circumstances described in OC7.5.1 apply, the Licence Standards may not be met and the whole or any part of the Total System may be operated outside normal voltage and/or Frequency standards.

Further, Scheduling and Dispatch in accordance with the principles in the SDCs for determining which CDGUs will be Scheduled and Dispatched may cease and will not be re-implemented until the TSO decides that normal Scheduling and Dispatch procedures can be re-implemented.

The TSO will inform all Generators with Generating Plant when normal Scheduling and Dispatch has been re-implemented.

Grid Code section OC7.5.3 states that in circumstances where the part of the NI System to which Generating Units are connected has become detached from the rest of the NI System and there is no Synchronising system available to facilitate re-synchronisation with the rest of the NI System, then the Generator shall, under the TSO's instructions, ensure that the Generating Units are disconnected and held ready for re-synchronisation upon the TSO's subsequent instructions.

The synchronising of subsystems should only occur when the changes of one subsystem "bringing down" a second subsystem is minimal. Synchronising should only take place where a controlled synchronising facility exists.

4. Article by Article Summary

The following table summarizes the SRP with respect to the relevant articles of the NCER.

Article	Details	SONI Comments
1-3	General Provisions and Definitions	
4	Regulatory Aspects including general principles / transparency; Terms and Conditions Consultation; December 18 th Notification to RAs	This document and related documents comprise the public consultation documents that are being carried out to satisfy the provisions in Article 4 (and 7).
5	Consultation and Coordination	No issues
6	Regional Coordination	Northern Ireland system restoration will be compared with Ireland system restoration to ensure consistency. As not AC connected to GB, Article 6 does not extend to consideration of GB SRP in any detail.
7	Public Consultation	This document and related documents comprise the public consultation documents that are being carried out to satisfy the provisions in Article 7 (and 4).
8	Recovery of Costs	SONI does not anticipate any additional costs stemming from this Regulation.
9	Confidentiality Obligations	Note that only a high level version of the plan has been described in this document, and does not contain any confidential material.
11-22	System Defence Plan	Covered in SDP Document
23	Design of the SRP	Although the SRP has been in existence for many years, the principles set out in this Article strongly align with the design of the current plan. The current plan is being reviewed to further align with the provisions of the NC ER, including for example the concept of bottom-up vs top-down restoration.
24	Implementation of the SRP	No changes expected here, as there is already a plan in operation.
25	Activation of the SRP	Self-explanatory – the SRP is enacted once the system is in a blackout or partial blackout state.
26	Re-energisation Procedure	Bottom-up and top-down approaches – will be spelled out more clearly in

Article	Details	SONI Comments
		next version of SRP.
27	Activation of Re-energisation Procedure	Concerns an assessment of the system state following the blackout event and determining the best course of action. Control engineers are trained to anticipate many different scenarios.
28-31	Frequency Management after Frequency Deviation; Frequency Management after Synchronous Area Split	These Articles are concerned with continental restoration where the actions of TSO can impact on restoration. They do not apply in general to the Ireland / Northern Ireland context where there is a single TSO with two control room's co-ordinating system restoration.
32-34	Resynchronisation Procedure; Resynchronisation Strategy	Although the general principles in these Articles are adhered to, they again relate to continental Europe where several TSO may be attempting to resynchronise areas, and where one TSO needs to be in charge.
35-39	Market Activities	Covered in separate documents
40-42	Information Exchange, Communication Systems, Tools and Facilities	Where applicable, the TSO already has enough information to carry out its function to restore the power system. There are OPTEL and TETRA systems in place in case of problems with communications during a blackout. There is also a backup control room available and regularly tested.
43-52	Compliance Testing and Monitoring	SONI regularly carries out testing of blackstart generation, blackstart procedures, and simulations for Control Centre staff, as well as communications exercises with key stakeholders.