Operational Constraints Update
18/12/2019

Key Updates
• *Constraint Groups (S_NBMIN_MINNI1) and (S_NBMIN_MINNI2) have been removed as they are no longer required*

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Contents

1. Introduction

To enable the efficient and secure operation of the power system, units are scheduled and dispatched to certain levels to prevent equipment overloading, voltages outside limits or system instability.

The process by which the TSOs schedule and dispatch the power system is outlined in the 'Balancing Market Principles Statement'[1]. This includes a description of how the operational constraints outlined in this document are applied.

1.1 Document Objective

The objective of the Operational Constraints Update is to present the key system and generator constraints which are included in the scheduling process. The most common operational constraints that are modelled are:

- North – South tie-line export / import constraint: MWR type
- Moyle import / export constraint: MW type
- Requirement to keep a minimum number of units on in an area: NB type
- Requirement to limit the output of the generators in an area to limit short circuit levels or overloads: MW type or NB type
- Requirement for a minimum output from the generators in an area to support the voltage or to avoid overloads: MW type or NB type
- Requirement to limit the output of stations due to fish spawning: MW type

This document comprises of: (i) **Operational Reserve Requirements**, and (ii) **System Constraints**.

1.2 List of Terms

TCG Type	
MW	Limit MW output of unit or units assigned to a TCG
MWR	Limits (the total MW + Primary Reserve - the area demand) from assigned resources
NB	Limit to the status (On/Off) of the unit or units assigned to a TCG

Limit Flag	
E	Equality Constraint (generation = load)
X	Export Constraint - limit output of a group of units <= max limit
N	Import Constraint - limit output of a group of units >= min limit
B	In-between Constraint; >= min and <= max

[1] https://www.sem-o.com/documents/EirGrid-and-SONI-Balancing-Market-Principles-Statement-V2.0.pdf

2. Operating Reserve Requirements

The following tables show the operating reserve requirements on an all-island basis and in each jurisdiction.

Category	All Island Requirement % Largest In-Feed	Ireland Minimum[1] (MW)	Northern Ireland Minimum (MW)
POR[2]	75%[3] (S_PRM_TOT)	135/ 75 (S_PRM_ROI)	49 (S_PRM_NI)
SOR	75%[4] (S_SEC_TOT)	135/ 75 (S_SEC_ROI)	49 (S_SEC_NI)
TOR1	100% (S_TR1_TOT)	135/ 75 (S_TR1_ROI)	49 (S_TR1_NI)
TOR2	100% (S_TR2_TOT)	135/ 75 (S_TR2_ROI)	49 (S_TR2_NI)

1. Ireland Lower values apply from 00:00 - 07:00 inclusive
2. Minimum values of POR in each jurisdiction must be supplied from regulating sources
3. At times more than 75% POR is held All Island (up to 80%) in order to maintain system security standards based on transient security analysis (this will remain under review by the TSOs).
4. At times more than 75% SOR is held All Island (up to 100%) in order to maintain system security standards based on real-time transient security analysis (this will remain under review by the TSOs).

2.1 Operating Reserve Definitions

Category	Delivered By	Maintained Until
Primary (POR)	5 seconds	15 seconds
Secondary (SOR)	15 seconds	90 seconds
Tertiary 1 (TOR1)	90 seconds	5 minutes
Tertiary 2 (TOR2)	5 minutes	20 minutes

2.2 Source of Reserve

	Ireland	Northern Ireland
Regulating Reserve	Synchronised Generating Units	Synchronised Generating Units
Non or Partially Regulating Reserve	Turlough Hill Units when in pumping mode 23 MW of Response from DSUs EWIC Interconnector (up to 75 MW)[2]	10 MW of battery response 2 MW of Response from DSUs Moyle Interconnector (up to 75 MW)
Negative Reserve (Defined as the MW output of a conventional generator above its minimum load)	100MW (scheduled in MMS)	50MW (scheduled in MMS)

[2] On trial with NGET

3. System Constraints

3.1 Tie Line Limits

Tie line flows in both directions have physical limits, the maximum flow that can be sustained without breaching system security rules (line overloads, voltage limits, system stability etc.) after a credible transmission or generation event. The limits are referred to as the Total Transfer Capacity (TTC) comprising of two values: N-S and S-N. For more information on Inter-Area Flow (North-South Tie Line) Constraints follow link:
https://www.sem-o.com/documents/general-publications/Information_Note_on_Inter-Area_Flow_Constraints.pdf

3.2 Non-Synchronous Generation

To ensure the secure, stable operation of the power system, it is necessary to limit the level of non-synchronous generation of the system. The System Non-Synchronous Penetration (SNSP) is a measure of the non-synchronous generation on the system at an instant in time i.e. the non-synchronous generation and net interconnector imports as a percentage of the demand and net interconnector exports (where "Demand" includes pump storage consumption when in pumping mode).

3.3 Adverse Weather and Increased System Risk

During periods of adverse weather or where there is an increased system risk (e.g. high impact generator or interconnector testing), the TSOs may implement measures to mitigate the consequences of this risk. Such measures may include but not limited to providing additional reserve and running units out of merit.

Any changes to operational constraints will be notified to Participants through a new Weekly Operational Constraints Update

3.4 Permanent System Constraint Tables

The following tables set out the system constraints:

- Active System Wide Constraints;
- Active Northern Ireland Constraints, and
- Active Ireland Constraints.

Note that the limits specified in each table represent the normal intact transmission network limit. These limits may vary from time to time due to changing system conditions.

3.4.1 Active System Wide Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
Inter-Area Flow **(S_MWR_ROI)**	MWR	X:<=	400 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	Ensures that the total MW transferred between Ireland and Northern Ireland does not exceed the operational limits of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements. This is required to ensure the operational limits of the existing North South tie line are respected.
Inter-Area Flow **(S_MWR_NI)**	MWR	X:<=	450 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	Ensures that the total MW transferred between Northern Ireland and Ireland does not exceed the limitations of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements. This is required to ensure the limits of the existing North South tie line are respected.
Non-Synchronous Generation **(S_SNSP_TOT)**		X:<=	65%	Wind, Moyle Interconnector, EWIC Interconnector	Ensures that the SNSP is kept below 65%.
Operational Limit for RoCoF **(S_RoCoF)**		X:<=	0.5 Hz/s	Ireland and Northern Ireland Power Systems	Ensures that RoCoF does not exceed 0.5 Hz/s.
Operational Limit for Inertia **(S_INERTIA_TOT)**		N:>=	23,000MWs	Ireland and Northern Ireland Power Systems	Ensures that all island Inertia does not fall below 23,000 MWs.

3.4.2 Active Northern Ireland Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability **(S_NBMIN_MINNIU)**	NB	N:>=	3 Units at all times	B10, B31, B32, C30, K1, K2	There must be at least 3 machines on-load at all times in Northern Ireland. Required for dynamic stability.
System Stability (S_NBMIN_MINNI3)	NB	N:>=	1 Unit at all times	C30, K1, K2	There must be a least 1 machine on-load at all times in Northern Ireland. Required for dynamic stability.
Replacement Reserve **(S_REP_NI) (S_MWMAX_NI_GT)**	MW	X:<=	272 MW	BGT1, BGT2, CGA, CGT8, EMPOWER , iPOWER, KGT1, KGT2, KGT3, KGT4	Combined MW output of OCGTs and AGUs must be less than 272 MW (out of a total of 397 MW) in Northern Ireland at all times. 125 MW required for replacement reserve. The limit is subject to change based on the availability of the units and transmission constraints that may limit their output.
North West Generation **(S_NBMIN_CPS)**	NB	N:>=	0 or 1 Unit depending on NI system demand	C30	Coolkeeragh C30 must be on load when the NI system demand is at or above 1,550 MW, CGT8 is unavailable and NI wind generation < 450 MW. This demand limit can be raised to 1,608 MW if CGT8 is available. For NI wind generation in excess of 450 MW there is no constraint. This operational constraint is required to ensure voltage stability in the northwest of Northern Ireland and to prevent possible system voltage collapse above the indicated system demand.
Moyle Interconnector **(S_MWMIN_MOYLE) (S_MWMAX_MOYLE)**	MW	B	-380* < MW < 442 -	Moyle Interconnector[3]	It ensures that all flows do not exceed an import of 442MW to Northern Ireland and an export of 380MW* to Scotland (values taken from NI). This is required to ensure that the limits are respected. *Note: Firm export limit on Moyle reduced to 80MW from 10th November 2017. There is an agreed process between Moyle and NGET on releasing additional "non-firm" export capacity when GB system conditions allow.

[3] Combined Ramp Rate of EWIC and Moyle Interconnectors is limited to 10 MW/Min

3.4.3 Active Ireland Constraints

[A] Scenario A: In this scenario if PBA or PBB are operating in combined cycle mode they will be considered as constraint resources

[B] Scenario B: In this scenario if PBA or PBB are operating in open cycle mode they will be considered as constraint resources

Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability **(S_NBMIN_ROImin)**	NB	N:>=	5 Units	AD2, DB1, GI4, HNC, HN2, MP1, MP2, MP3, PBA [A], PBB [A], TB3, TB4, TYC, WG1	There must be at least 5 machines on-load at all times in Ireland. Required for dynamic stability. [A] See Scenario A
Replacement Reserve **(S_REP_ROI)** **(S_MWMAX_ROI_GT)**	MW	X:<=	698 MW [B]	AT1, AT2, AT4, ED3, ED5, NW5, RP1, RP2, TP1, TP3. PBA [B], PBB [B]	Combined MW output of OCGTs must be less than 698 MW (out of a total of 1023 MW) in Ireland at all times. 325 MW required for replacement reserve. The limit is subject to change based on the availability of the units and transmission constraints that may limit their output. [B] See Scenario B
Dublin Generation **(S_NBMIN_DubNB2)**	NB	N:>=	1 Units	DB1, HNC, HN2	There must be at least 1 large generator on-load at all times in the Dublin area. Required for voltage control.
Dublin Generation **(S_NBMIN_Dub_NB)**	NB	N:>=	2 Units	DB1, HNC, HN2, PBA [B], PBB [B]	There must be at least 2 large generators on-load at all times in the Dublin area. Required for voltage control. This assumes EWIC is operational. Note that during an outage of EWIC there must be at least 3 large generators on-load at all times in the Dublin area. [B] See Scenario B
Dublin Generation **(S_NBMIN_DUB_L1)**	NB	N:>=	2 Units if Ireland System Demand >4000MW	DB1, HNC, PBA [B], PBB [B],	Requirement for 2 units to be on load when Ireland System Demand is greater than 4000 MW. This operational constraint is required for load flow control in the Dublin area. This assumes EWIC is operational. [B] See Scenario B

Name	TCG Type	Limit Type	Limit	Resources	Description
Dublin Generation **(S_NBMIN_DUB_L2)**	NB	N:>=	3 Units if Ireland System Demand > 4700 MW	DB1, HNC, HN2, PBA [B], PBB [B]	Requirement for 3 units to be on load when Ireland System Demand is greater than 4700 MW. This operational constraint is required for load flow control in the Dublin area. This assumes EWIC is operational. [B] See Scenario B
South Generation **(S_NBMIN_STHLD1)**	NB	N:>=	1 Unit if Ireland System Demand > 1500 MW	AD2, AT1, AT2, AT4, SK3, SK4, WG1	Requirement for at least one Unit to be on load when Ireland System Demand is greater than 1500 MW. This operational constraint is required for voltage stability in the South.
South Generation **(S_NBMIN_STHLD2)** **(S_NBMIN_STHLD3)**	NB	N:>=	2 Units if Ireland System Demand > 2500 MW	AD2, AT1, AT2, AT4, GI4, SK3, SK4, WG1	Requirement for at least two Units, only one of which can be SK3 or SK4, to be on load when Ireland System Demand is greater than 2500 MW. This operational constraint is required for voltage stability in the South.
South Generation **(S_NBMIN_STHLD2)**	NB	N:>=	3 Units if Ireland System Demand > 3500 MW	AD2, AT1, AT2, AT4, GI4, SK3, SK4, WG1	Requirement for at least three Units to be on load when Ireland System Demand is greater than 3500 MW. This operational constraint is required for voltage stability in the South. Note that when Ireland wind is less than 500 MW one of these Units must be AD2, AT1, AT2, AT4, WG1.
South Generation **(S_NBMIN_STHLD5)**	NB	N:>=	1 Unit if Ireland System Demand > 4200 MW	AD2, GI4, WG1	Requirement for at least one Unit to be on load when Ireland System Demand is greater than 4200 MW. This operational constraint is required for voltage stability in the South.
Cork Generation **(S_MWMIN_CRK_MW)** **(S_MWMAX_CRK_MW)**	MW	B	0 MW <MW< 1100 MW	AD2, AT1, AT2, AT4, WG1	Generation restriction in the Cork area: this will be determined week ahead and available in the Weekly Operational Constraints Update.

Name	TCG Type	Limit Type	Limit	Resources	Description
South Generation **(S_MWMIN_STH_MW)** **(S_MWMAX_STH_MW)**	MW	B	0 MW <MW< 1800 MW	AD2, AT1, AT2, AT4, GI4, WG1	Generation restriction in the Southern Region: this will be determined week ahead and available in the Weekly Operational Constraints Update.
400 kV Network **(S_NBMIN_MP_NB)**	NB	N:>=	1 Unit	MP1, MP3, TYC	There must be at least one unit on load at all times; required to support the 400kV network.
EWIC Interconnector **(S_MWMIN_EWIC)** **(S_MWMAX_EWIC)**	MW	B	-526 <MW< 504	EWIC Interconnector[4]	It ensures that all flows do not exceed an import of 504MW to Ireland and an export of 526MW to GB (values taken from Portan). This is required to ensure that the limits are respected. Current restriction is to mitigate against impact of a high frequency event on the island in the event of a trip on EWIC.
South West Generation **(S_NBMAX_SW_NB)**	NB	N:>=	1 Unit	TB3, TB4	To support South West voltage, at times of very low wind generation output in the south-west, additional generation may be required

[4] Combined Ramp Rates on EWIC and Moyle Interconnectors are limited to 10 MW/Min