



System Operator for Northern Ireland

Minimum Function Specification

for centrally dispatched

Open Cycle Gas Turbines (OCGT)

OCGT Generation

1.0 Introduction

This Minimum Functional Specification (MFS) is applicable to all Open Cycle generating units connected to the Northern Ireland transmission system that have a power output greater than 5 MW. It does not apply to Combined Cycle units running in Open Cycle mode as these are covered by a separate specification.

Northern Ireland has a small Transmission system with a maximum demand of circa 1900 MW and a minimum demand of 500 MW. With the minimum demand being approximately a quarter of the maximum demand, a situation can occur where a small number of large generators may supply the entire NI system load. There is interconnection to Great Britain via the Moyle Interconnector and also to the ROI transmission system. Although unlikely, it is conceivable that it could run as an island system again during abnormal conditions.

Due to the nature of the NI transmission system i.e. large generating units with relatively low demand, it is possible that the frequency could drop to as low as 47Hz in the event of a large generator fault. This places an extra operational difficulty that other electricity systems would not experience. Within recent years there has been increasing pressure on Governments to replace conventional generation with renewable sources. Due to this there has been a massive penetration of renewable energy sources in NI, and this is expected to continue for a number of years. The Seven Year Generation Capacity Statement 2009-15 assumes that wind generation capacity will exceed 950 MW by 2015. The variability and uncertainty of this type of generation alone, requires that operating the system will become more complex than ever before. It is with complexity in mind that this MFS has been written to ensure that new OCGT plant will be capable

of operating in this new environment, allowing the system operator to manage conventional generation alongside renewable sources. To secure stability and security of supply, generating units connected to the Northern Ireland network will require greater flexibility than previously experienced.

2.0 PLANT CONTROL EQUIPMENT

2.1 General

The Generator will provide models and parameters of all control equipment to the TSO to allow simulation studies to be carried out to demonstrate stable operation of the plant. These should include models and parameters for the generator, excitation control system, power system stabiliser, turbine governor, step-up transformer and tap-changer. Some parameters may be subject to approval by the TSO.

The TSO requires that excitation controllers and governors are dual channel controllers.

The TSO will require commissioning tests to be carried out in line with the appropriate SONI document reference (Guidance for the exchange of data and for testing of new or modified generation connected to the NI Transmission system, 2009, Rev D) to demonstrate grid code compliance with the requirements. The Generator shall supply interim and final Reports within the timelines specified. Prior to these tests satisfactory factory test certification must be submitted to the TSO for its approval.

2.2 Voltage Control

Each generating unit covered by this MFS must be capable of contributing to voltage control by continuous modulation of reactive power. It is expected that those generating units will be fitted with continuously acting, fast response, automatic excitation control systems. It is also expected that the associated generator transformers will be fitted with on-load tap-changers.

a) Excitation Control

The excitation control system should be capable of maintaining, without instability, the generator terminal voltage to within 0.5% of the voltage set-point when the output MVA under steady state conditions is changed from

zero to rated MVA at rated load and frequency. The excitation control system shall be fitted with appropriate excitation limiters and shall be designed in line with best modern practice and comply with relevant international standards. The required transient response of the excitation control system will be defined by the TSO prior to the commissioning tests.

b) Power System Stabiliser

Currently the TSO requires that each generating unit covered by this MFS is fitted with a power system stabiliser (PSS) to enhance the transient performance of the unit to events such as sudden load changes or system short circuits. Whatever design of PSS is employed, the design should ensure that damping torque is improved without a consequent reduction in the available synchronising torque.

After the commissioning tests described in ref (Guidance for the exchange of data and for testing of new or modified generation connected to the NI Transmission system, 2008, Rev D), the TSO will notify the owner whether the PSS is to be in commission or not.

c) On-Load Tap-Changer (OLTC)

The OLTC and the chosen transformer parameters must ensure that the full range of reactive power as required by section 3 of this MFS can be exported or imported over the full range of grid voltage variation. The transformer tapping range and tap step size will be subject to the approval of the TSO.

2.3 Frequency Control

Each generating unit covered by this MFS must be capable of contributing to frequency control between 47Hz and 52Hz (Grid Code CC.S1.5.2) by continuous modulation of active power. The prime mover must be fitted

with a fast acting, proportional speed, governor to provide frequency control under normal operational conditions.

Governors must be designed with a nominal droop of 4% but the droop setting must be capable of continuous adjustment in the range 3% to 8%. Under abnormal conditions, such as when a generating unit becomes islanded but is still supplying customers, the speed governor must be able to control the frequency of the islanded system to below 52 Hz after the transient is over unless this would mean operation at below the minimum stable generation load. (Grid Code CC.S1.5.2).

2.4 Load Control

Where a generating unit is fitted with a unit load controller it must be in operation at all times required by the TSO and in accordance with the settings previously agreed with the TSO. It is important that the action of the load controller does not interfere with the satisfactory provision of response during system frequency events.

3.0 PLANT PERFORMANCE REQUIREMENTS

3.1 Minimum Generation

OCGT units must be capable of continuous stable operation at 10% of the unit MCR with satisfactory emissions.

3.2 Reactive Power Capability

OCGT units must be capable of continuous operation within that shaded part of the generator capability chart (Figure 1) that lies above the Minimum Generation level at all temperatures within the site design temperature range. Units must be capable of providing reactive power under short-term or transient operation in the lower shaded area.

The six corners of the total area are defined as:

At MCR MW	A 0.8 power factor lagging	B 0.95 power factor leading
At 35% MCR MW	C 0.4 power factor lagging	D 0.5 power factor leading
At 0 MW	E the intersection of a vertical line dropped from C to 0 MW	F the intersection of a vertical line dropped from D to 0 MW

Table 1 – Extremes of Power Factor Range

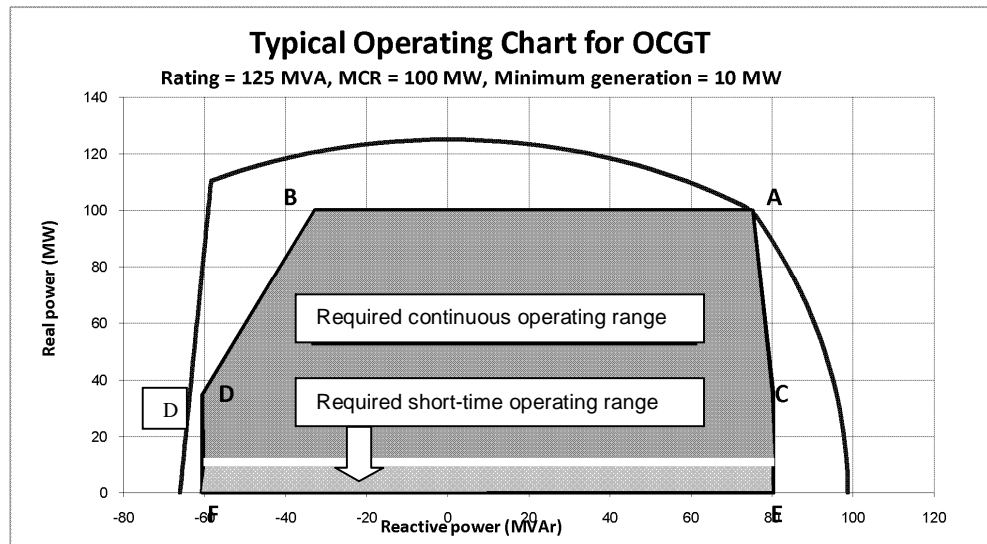


Figure 1 – Capability chart showing required operating range

3.3 Short Circuit Ratio

Generating units should be designed with a short circuit ratio of 0.5 or greater.

3.4 Frequency Response Capability

All generation plant must be capable of automatically providing a change of output in response to rapid changes in system frequency as stated in

the Grid Code (OC1.4.2). Response is required to both falling and rising frequency as a result of a network disturbance. The generator should have a nominal governor droop of 4%. The generating plant must be capable of providing response over four timescales as follows:

	Available in	Sustained to	Expected Response
Initial Response	3 seconds	15 seconds	40% MW response
Primary Response	5 seconds	15 seconds	60% MW response
Secondary Response	15 seconds	90 seconds	100% MW response
Tertiary Response 1	90 seconds	5 minutes	Maintain 100% MW response
Tertiary Response 2	5 minutes	20 minutes	Maintain 100% MW response

Table 2 – Response Timescales

The minimum MW response required from OCGT plant following a 0.5 Hz change in frequency is +18% MCR for a fall in frequency and -10% MCR for an increase in frequency. The response varies with loading according to Figure 2.

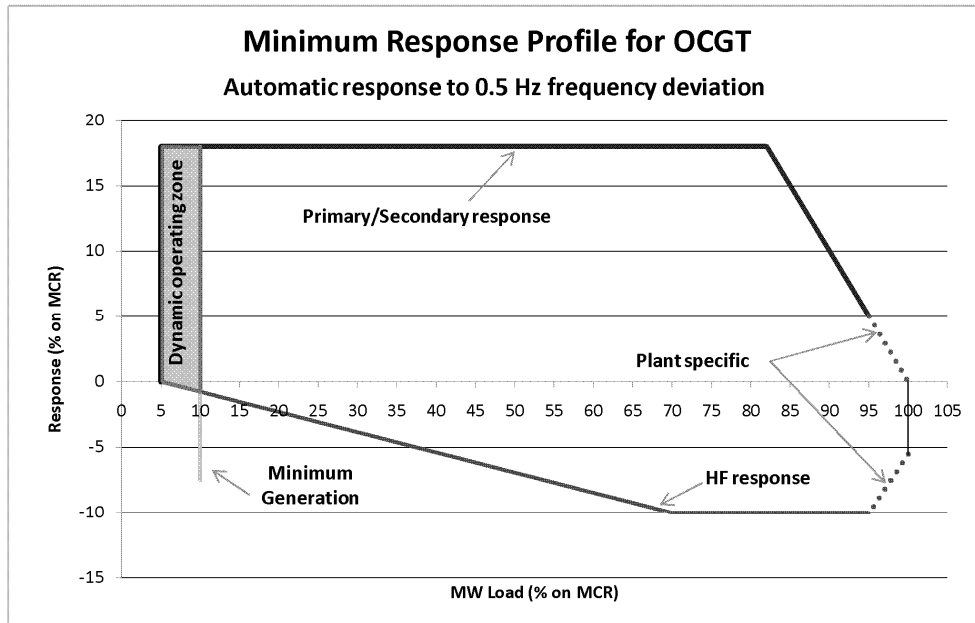


Figure 2 – Minimum Response Profile for OCGT

3.5 Frequency Variation

The NI system frequency can in exceptional circumstances vary between 47 Hz and 52 Hz and all generating plant must be capable of operation in accordance with the table below. In view of the possibility of the NI system operating in island mode, all plant must be able to remain synchronised if the frequency changes up to and including 1.5 Hz/sec.

Between 47.5 Hz and 52 Hz	Continuous stable operation
Between 47 Hz and 47.5 Hz	For a period of at least 20 seconds on each occasion that the frequency is below 47.5 Hz

Table 3 – Expected Frequency Range

Within the frequency range 49.5 Hz to 50.5 Hz there should be no reduction in output on falling frequency. Plant should be appropriately rated to ensure compliance with this requirement. Between 49.5 Hz and 47 Hz the output should not fall at a rate greater than 2%/MCR/Hz.

3.6 Start-up Rates and Ramp Rates

Generating plant may be called upon to provide continuous load cycling or 2-shifting the following requirements apply.

The maximum time to synchronise and the minimum ramp rates expected for OCGT plant are given in Table 5 below. The values given in table 4 include the start-up instruction.

Maximum Time to Synchronise	Ramp Up Rate	Ramp Down Rate
10 minutes	30% MCR/minute	30% MCR/minute

Table 4 – Process Times

The maximum block load to be applied on synchronising must be no more than 10% MCR.

3.7 Load Cycling

The TSO requires that all OCGT plant is capable of ramping between minimum generation and MCR on a continuous basis.

4.0 GENERAL PROVISIONS

All the preceding operating characteristics represent minimum requirements and all plant shall register and perform in a manner giving maximum flexibility of operation appropriate to their type of plant and in accordance with good industry practice.

The provisions of this document should be read in conjunction with the NI Grid Code and in particular the Connection Conditions.

5.0 REFERENCES

- [1] The SONI Grid Code.
- [2] Guidance for the Exchange of Data and for Testing of New or Modified Generation Connected to the NIE System, 2008, Rev D.
- [3] The Seven year generation Capacity Statement 2009-2015.