Steady-State Reactive Power (SSRP)

System Services Test Procedure

Synchronous Machine

Unit Name

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# Document Version History

Revision 3.0 published 12th November 2019

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Version** | **Date** | **Comment** | **Name** | **Company** |
| 0.1 | Insert Date | Minor version (v0.1) - First submission for review and approval | Insert Name | Unit Company Name |
| 1.0 | Insert Date | Revised to version 1.0 following approval by EirGrid, SONI.  | Insert Name | Unit Company Name |

# Introduction

The Unit shall submit the latest version of this test procedure as published on the EirGrid or SONI websites[[1]](#footnote-2).

All yellow sections shall be filled in before the test procedure will be approved. All grey sections shall be filled in during testing. If any test requirements or steps are unclear, or if there is an issue with meeting any requirements or carrying out any steps, please contact generator\_testing@eirgrid.com or  generator\_testing@soni.ltd.uk as appropriate. Note that additional test sections may be required for units with multiple modes of operation.

On the day of testing, suitably qualified technical personnel are required on site to assist in undertaking the tests. The personnel shall have the ability to:

1. Set up and disconnect the control system and instrumentation as required;
2. Ability to fully understand the Unit’s function and its relationship to the System;
3. Liaise with NCC, CHCC as required;
4. Mitigate issues arising during the test and report on system incidents.

The availability of personnel at NCC, CHCC will be necessary in order to initiate the necessary instructions for the test. NCC, CHCC will determine:

1. If network conditions allow the testing to proceed.
2. Which tests will be carried out
3. When the tests will be carried out.

On completion of this test, the following shall be submitted to generator\_testing@eirgrid.com or  generator\_testing@soni.ltd.uk:

|  |  |
| --- | --- |
| **Submission** | **Timelines**  |
| A scanned copy of the test procedure, as completed and signed on site on the day of testing | 1 working day |
| Test data in CSV or Excel format | 1 working day |
| Test report | 10 working days |

# Abbreviations

NCC National Control Centre

CHCC Castlereagh House Control Centre

SSRP Steady-State Reactive Power

MVAr Mega Volt Ampere – reactive

MW Mega Watt

TSO Transmission System Operator

MEC Maximum Export Capacity

RPM Revolutions per Minute

kV kilovolt

Hz Hertz – unit of frequency

Qrange Maximum MVAr range (from full lagging to full leading) at the generator terminals.

Prange Maximum MW range that unit is capable of providing while also providing reactive power at the terminals.

PMax Maximum MW value that the unit is capable of while also providing reactive power at the generator terminals.

PMin Minimum MW value that the unit is capable of while also providing reactive power at the generator terminals.

QMax Maximum Lagging Mar.

QMin Minimum Leading MVAr

# Unit DATA

|  |  |
| --- | --- |
| Unit test coordinator | Unit to Specify Name, Company and contact details. |
| Unit name | Name:\_\_\_\_\_\_\_\_\_ |
| Unit connection point | HV Bushings of T101 in XX 110kV station |
| Unit connection voltage | \_\_\_\_\_\_\_\_kV |
| Unit fuel type(s)  | Primary:\_\_\_\_\_\_\_\_\_ Secondary:\_\_\_\_\_\_\_\_\_ |
| Operating modes | *e.g.* OCGT, CCGT, Sync Comp *etc*. |
| Registered capacity / (NI) maximum continuous rating | \_\_\_\_\_\_\_\_\_\_\_MW |
| Minimum loadMinimum generation | \_\_\_\_\_\_\_\_\_\_\_MW\_\_\_\_\_\_\_\_\_\_\_MW |
| Contracted MEC | \_\_\_\_\_\_\_\_\_\_\_MW |
| Installed plant | Name: \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_MVA Name: \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_MW |
| House load  | \_\_\_\_\_\_\_\_\_\_\_MW |

Generator shall insert Active and Reactive Power Capability (PQ) chart

The PQ chart shall include the capability of the unit for the applicable voltage range:

For Ireland:

* 400kV system: 350kV to 420kV
* 220kV system: 200kV to 245kV
* 110kV system: 99kV to 123kV

For Northern Ireland:

* 275kV System: 247.5kV to 302.5kV
* 110kV System: 99kV to 121kV

# System Services

The definitions referenced in this document are for indicative purposes only. In the event of inconsistency between the definitions in this document and those in the DS3 System Services Agreement, the definitions in the DS3 System Services Agreement shall prevail.

## Steady-State Reactive Power

SSRP is defined as the dispatchable reactive power range (QRange) in MVAr that can be provided across the full range of active power output (PRange).

## Reactive Power Factor calculation

$$RP Factor= \frac{Active Power Range across which reactive power can be provided \left(P\_{Range}\right)}{Registered Capacity}$$

$$SSRP Volume= Q\_{Range} x RP Factor$$

For dispatchable synchronous condensers and loads RP Factor = 1.



Figure : Example graph showing the P and Q ranges. Min Load is shown as the bottom blue line (Pmin).

# Site safety requirements

The following is required for the EirGrid, SONI witness to attend site:

|  |  |
| --- | --- |
| Personal Protective Equipment Requirements1. Site Safety boots
2. Hard Hat with chin strap
3. Hi Vis
4. Arc Resistive clothing
5. Safety Glasses
6. Gloves
7. Safe Pass
 | 1. Yes / No
2. Yes / No
3. Yes / No
4. Yes / No
5. Yes / No
6. Yes / No
7. Yes / No
 |
| Site Induction requirements | Yes / No (If Yes, Unit to specify how and when the induction shall carried out) |
| Any further information | Unit to specify |

# Test Purpose and pre conditions

## Test Purpose

This test is to demonstrate the capability of the reactive power curve for the unit. The test will verify the following values.

1. PMax, QMax (Lagging)
2. PMax, QMin (Leading)
3. PMin, QMax
4. PMin, QMin
5. Sync Comp mode P, Qmin
6. Sync Comp mode P, Qmax

## Pre Conditions

Should “No” be answered to any of the following, contact the EirGrid, SONI Test Coordinator and agree next steps in advance of making any corrective actions.

|  |  |  |
| --- | --- | --- |
| **No.** | **Conditions** | **Check on day of test** |
| 1 | Test Profiles have been submitted and approved by near time. | Yes/No |
| 2 | Unit Fuel Type: Primary Fuel / Secondary Fuel, Gas / Distillate. | Yes/No |
| 3 | Frequency Response mode On / Off. | Yes/No |
| 4 | Unit is on load and stable in agreement with NCC, CHCC. | Yes/No |
| 5 | Normal start up support auxiliary systems are aligned and in service. | Yes/No |
| 6 | Grid Connected Transformer Tap range | Tap range: \_\_\_\_ to \_\_\_\_ |
| 7 | Size of MVAr step changes agreed with NCC, CHCC Transmission Desk (*e.g.* 5 MVAr) | \_\_\_\_ MVAr |
| 8 | Required signals, as described in section 8 are available. | Yes/No |

# Instrumentation and onsite data trending

All of the following trends shall be recorded by the Unit during the test. Failure to provide any of these trends will result in test cancellation.

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Data Trending and Recording** | **Resolution** | **Check On Day Of Test** |
| 1 | Active power at Connection (MW) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 2 | Reactive power at Connection point (MVAr) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 3 | Active Power at Generator Terminals (MW) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 4 | Reactive Power at Generator Terminals (MVAr) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 5 | Generator Voltage (kV) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 6 | Turbine Speed (RPM) | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 7 | Generator Transformer Tap setting | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 8 | System Voltage  | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 9 | System Frequency | Unit to specify, 1s or as agreed with TSO | Yes/No |
| 10 | Other signals as required by the unit or by generator\_testing@eirgrid.com or  generator\_testing@soni.ltd.uk. | Unit to specify | Yes/No |
| 11 | Alarm/Event page | Screenshot alarms/events for duration of the test.  |
| 12 | Generator Overview Screen | Screenshot at appropriate milestones during the test i.e. Before, during at regular intervals and after test from generator overview page on DCS |
| 13 | EDIL instructions | Screenshot as logged during the test. |

# Test Steps

The sequence of the tests may vary due to system conditions and shall be agreed and updated within the procedure based on EirGrid, SONI feedback as appropriate.

Mode: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (e.g. combined / open half cycle etc.) (Add additional tables as required for each mode)

## Registered Capacity, Maximum MVAr lagging (exporting) (PMax, QMax)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step No.** | **Action** | **Time** | **Comments** |
| 1 | Unit operator begins data recording for all trends listed in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to **Registered Capacity/MCR** via EDIL. |  | Registered Capacity: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to **Registered Capacity/MCR** and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit at Registered Capacity/MCR the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Lagging (exporting) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Max Active Power: \_\_\_\_\_\_Achieved Max Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at Full lagging (exporting) MVARs and Registered Capacity and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs NCC, CHCC that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test.  |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Max Active Power: \_\_\_\_\_\_Achieved Max Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Unit operator ends data recording for all trends noted in section 8. |  |  |

## Registered Capacity, Maximum MVAr Leading (importing), (PMax, QMin)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Unit operator begins data recording for all trends listed in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to **Registered Capacity/MCR** via EDIL. |  | Registered Capacity: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to **Registered Capacity/MCR** and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit at Registered Capacity/MCR the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Leading (importing) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Max Active Power: \_\_\_\_\_\_Achieved Max Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at maximum Leading (importing) MVARs and Registered Capacity/MCR and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs NCC, CHCC that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Max Active Power: \_\_\_\_\_\_Achieved Max Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Unit operator ends data recording for all trends noted in section 8. |  |  |

## Minimum Load/ Minimum Generation (as applicable), Maximum MVAr Lagging (exporting), (PMin, QMax)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Unit operator begins data recording for all trends noted in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to Minimum Load/ Minimum Generation via EDIL. |  | Minimum Load Generation: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to Minimum Load/ Minimum Generation and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit at Minimum Load/ Minimum Generation the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Lagging (exporting) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at maximum Leading (importing) MVARs and Minimum Load/ Minimum Generation and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs NCC, CHCC that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Unit operator ends data recording for all trends noted in section 8. |  |  |

## Minimum Load/ Minimum Generation (as applicable), Maximum MVAr Leading (importing), PMin, QMin

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Unit operator begins data recording for all trends noted in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to Minimum Load/ Minimum Generation via EDIL. |  | Minimum Load Generation: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to Minimum Load/ Minimum Generation and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit at Minimum Load/ Minimum Generation, the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Leading (importing) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at maximum Leading (importing) MVARs and Minimum Load/ Minimum Generation and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs them that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Test step completed. Test ends |  |  |

## Sync Comp Mode (as applicable), Maximum MVAr Leading (importing), QMin

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Unit operator begins data recording for all trends noted in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to synchronise and revert to Sync Comp mode via EDIL. |  | Minimum Load Generation: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to Sync Comp mode and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit in Sync Comp mode, the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Leading (importing) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at maximum Leading (importing) MVARs and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs them that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Test step completed. Test ends |  |  |

## Sync Comp Mode (as applicable), Maximum MVAr Lagging (exporting), QMax

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Unit operator begins data recording for all trends noted in Section 8. |  |  |
| 2 | Unit operator contacts NCC, CHCC and requests permission to begin test and a dispatch instruction to synchronise and revert to Sync Comp mode via EDIL. |  | Minimum Load Generation: \_\_\_\_ MW |
| 3 | Unit operator receives EDIL instruction, dispatches the Unit to Sync Comp mode and allows the Unit to stabilise for 10 mins. |  |  |
| 4 | With the Unit in Sync Comp mode, the Unit operator contacts NCC, CHCC and requests a dispatch instruction via EDIL to the rated Lagging (exporting) MVAr value for the Generator. The Unit Operator shall dispatch the unit as instructed and allow the Unit to stabilise for each change of state. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 5 | With the Unit at maximum Leading (importing) MVARs and the generator thermally stabilised, run for a minimum of 30 minutes. |  | Start time: \_\_\_\_\_End time: \_\_\_\_\_\_ |
| 6 | Unit operator contacts NCC, CHCC and informs them that the test is completed.Unit operator agrees MVAr dispatch with NCC, CHCC before proceeding to the next test. |  | Agreed MVAr steps agreed with NCC, CHCC:\_\_\_\_\_\_\_\_\_\_Achieved Min Active Power: \_\_\_\_\_\_Achieved Min Lagging MVAr: \_\_\_\_\_\_\_\_ |
| 7 | Test step completed. Test ends |  |  |

# Comments and Signoff

|  |
| --- |
| **Comments:**  |
| Unit Witness signoff that this test has been carried out according to the test procedure, above.Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date / Time: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| EirGrid, SONI Witness signoff that this test has been carried out according to the test procedure, above.Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date / Time: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. <http://www.eirgridgroup.com/> or <http://www.soni.ltd.uk/> [↑](#footnote-ref-2)