Approved by Decision No. 53-1/2025 of the Management Board of Elering AS dated 01.07.2025

Requirements for the testing and preparation of a testing plan for the generating units of clients

Valid from 31.07.2025

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1. General part

1.1 This guide establishes the requirements for testing type D generating modules connected to the transmission system operator's power network and provides sample test plans for generating units. The guide shall be applied together with the standard terms and conditions for connecting to the electricity transmission system of Elering AS (hereinafter the Connection Conditions).

2. Testing

2.1 Measurements

2.1.1 Requirements for measurements and metering equipment

2.1.1.1 Measurements must be carried out by a competent measurer, and the measurement results must be demonstrably traceable within the meaning of § 5 of the Metrology Act. The metering equipment to be used must be approved by the transmission system operator before the start of testing.

2.1.1.2 Metering equipment used for power quality measurements must comply with Class A requirements of standard EVS-EN 61000-4-30. The measurement frequency of the equipment must be at least 9.6 kHz.

2.1.1.3 The recording frequency of other metering equipment must be at least 0.1 kHz; however, the exact required recording frequency shall be agreed with the transmission system operator separately for each test during the preparation of the test plan.

2.1.1.4 Measurements must be carried out at the connection point, and only measuring circuits using current and voltage transformers may be used. Measurements via protection circuits are not permitted, except in the case of a fault ride-through (FRT) test.

2.1.1.5 In the case of generating units with synchronous generators, measurements must also be taken in the excitation and stator circuits of the generator and, in the case of mixed installations, also at the generator terminals. In these cases, the metering equipment and principles shall be agreed separately with the transmission system operator.

2.1.1.6 During the testing period, the metering equipment must possess valid calibration certificates. The metering equipment must be independent of other control systems. A single metering equipment must record the process along with the following key parameters of fast processes:

For synchronous power-generating modules:

- 3 phase stator L-N terminal voltages

- 3 phase stator terminal currents
- 3 phase L-N PCC (Point of Common Coupling) voltages
- 3 phase PCC currents
- Active power, PCC MW
- Reactive power, PCC MVar
- Active power MW
- Reactive power MVar
- Generating unit rotor field voltage
- Generating unit rotor field current
- Main exciter field voltage
- Main exciter field current
- AVR reference voltage
- Voltage applied to AVR summing junction (step etc)
- Power system stabiliser output
- DC signal input to AVR Steam Turbine

For the power park module:

- 3 phase L-N PCC voltages
- 3 phase PCC currents
- Active power MW, PCC
- Reactive power MVar, PCC

2.2 Principles for the submission of test results

2.2.1 The following must be submitted with regard to the test results:

2.2.1.1 Information about the testing party;

2.2.1.2 The time and location of the test, as well as the metering equipment used;

2.2.1.3 The location and diagram of the metering equipment connections;

2.2.1.4 The figures presenting the test results must clearly indicate what is intended to be shown. If the purpose of the test is to demonstrate compliance with the Grid Code, the corresponding values must be presented graphically (e.g. control speed, primary control speed and range);

2.2.1.5 A list of data collected manually (e.g. values from the metering device);

2.2.1.6 Metering data in .csv or .txt format;

2.2.1.7 SCADA printouts of the power network status, alarms, and control commands, which may be requested from the transmission system operator, including logs of switching operations from the generating unit's control system;

2.2.1.8 The test report must be submitted in one copy both in paper and digital format;

2.2.1.9 Other relevant data.

2.3 Additional conditions for testing of synchronous power-generating modules

2.3.1 Tests to be conducted prior to synchronisation must be carried out, and the test results must be submitted to the transmission system operator for approval before synchronisation.

2.3.2 The scope of primary control testing shall be agreed in the test plan, depending on the specific characteristics of the generating unit.

2.4 Additional conditions for testing of power park modules

2.4.1 The following events must be recorded during the testing of power park modules:

2.4.2 In the case of wind farms:

2.4.2.1 Disconnection due to excessive wind;

2.4.2.2 Disconnection due to a change in wind direction;

2.4.2.3 Disconnection due to a drop in wind speed;

2.4.2.4 Connection.

2.4.3 In the case of solar plants:

2.4.3.1 Disconnection due to a decrease in solar irradiance;

2.4.3.1 Connection.

2.4.4 Primary control testing

2.4.4.1 The primary control test is not fully described in the test tables, as the exact programme for testing the primary control function depends on the type of generating unit and the logic of the controller (distributed or centralised control).

2.4.5 Simulation of frequency regulator operation using simulated frequency

2.4.5.1 The objective of the tests is to determine the capability to provide frequency containment reserve and to assess the active power response to frequency deviation.

The primary control test is performed in two parts: the first part verifies the provision of frequency containment reserve, and the second part tests primary control with different droop settings and dead zones. Control commands and regulatory parameters are activated from the energy system control centre. Frequency deviation can be induced by changing the frequency setpoint or by simulating an external frequency signal. The external frequency signal may be simulated as either a digital or analogue signal.

2.4.6 Verification of frequency containment reserve

2.4.4 The compliance of the generating unit's primary control with the RfG requirements shall be verified.

2.4.7 Verification of primary control with different dead zones and droop settings

2.4.7.1 In the case of power park modules, the described test may be carried out with limited active power, but the output power of the power park module must be at least one third of its rated active power. The frequency signal to the control system shall be simulated by the client.

2.4.7.2 The test report must indicate the maximum technically feasible output power and the rate of change of active power in response to frequency deviation. The frequency signal must be shown alongside the measurement results. The frequency signal must include rapid changes in frequency (steps of at least 0.1 Hz).

2.4.7.3 Primary control shall be activated from the energy system control centre using different dead zones and droop settings. The purpose is to verify the capability of the control systems and generating units to participate in primary control.

2.4.7.4 Tests must be performed both with primary control enabled and disabled to demonstrate the operation of LFSM-O and LFSM-U.

2.4.7.5 In the case of certain frequency deviations, measurements must be recorded for at least 15 minutes. For each test, the response of the primary control must be recorded for both over- and under-frequency events (i.e. power decrease and increase when frequency deviation exceeds the limits set by the dead zone).

2.4.7.6 The following parameters must be measured at intervals of at least 0.2 seconds:

2.4.7.6.1 Simulated frequency;

2.4.7.6.2 Active power output of the generating unit;

2.4.7.6.3 Maximum possible active power output of the generating unit, in the case of wind power plants connected via inverters, as a function of the measured wind speed;

2.4.7.6.4 Change in active power of the generating unit in response to frequency deviation ($\Delta P/\Delta f$) for droop verification.

2.4.7.7 When performing tests with simulated frequency, the generating unit must comply with the power change rate requirements of the Grid Code, which must also be reflected in the report. The entire frequency containment reserve must be deliverable within 30 seconds.

2.4.7.8 Sample signals for simulated frequency are presented in Figure 3:

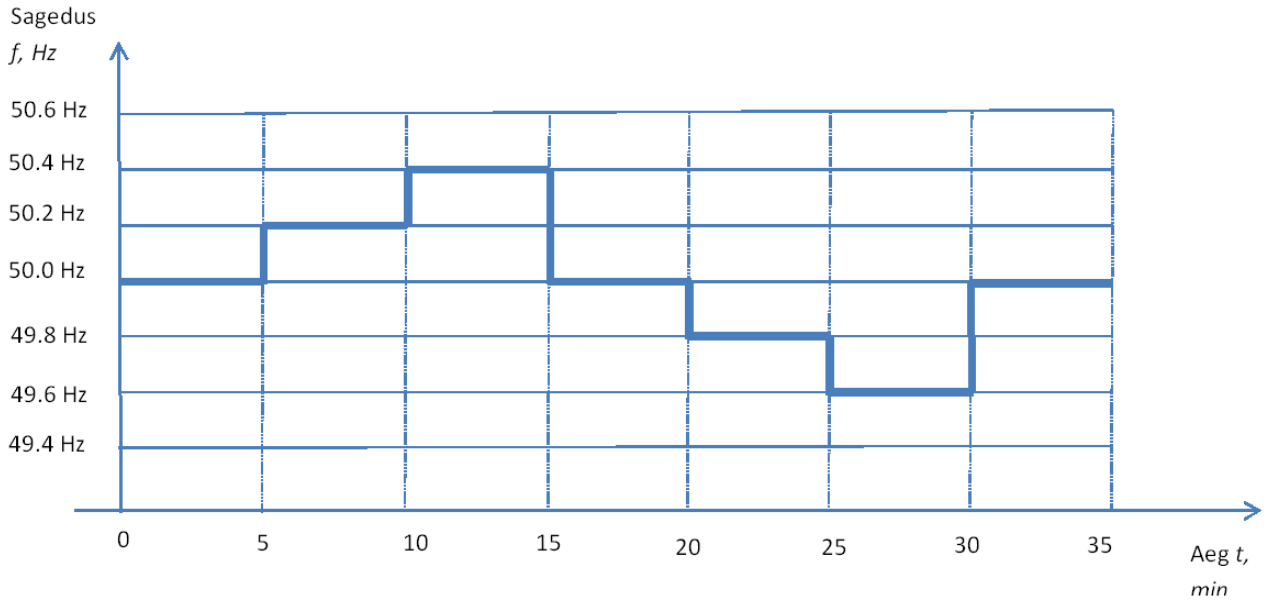

Figure 3. Different levels of simulated frequency signal in the primary control test.

2.5 Technical prequalification requirements for frequency reserves

2.5.1 If desired, the prequalification for frequency reserves may be carried out within the scope of the acceptance tests.

2.5.2 Technical prequalification is a prerequisite for participation in future European energy platforms MARI and PICASSO, as well as for obtaining the right to participate in the future Baltic FCR, aFRR, and mFRR capacity markets.

2.5.3 The data exchange requirements and service agreements necessary for energy and capacity markets will be established upon the launch of the respective markets.

2.5.4 The prequalification process and requirements are available on the Elering website.

2.6 Confirmation by the owner/representative of the generating unit

Based on the power quality measurements, I hereby confirm that the quality indicators …….. (comply / do not comply) with the permissible limit values specified in the tables, and the generating unit …… (does not cause / may cause) disturbances to other clients and electrical equipment connected to the transmission system operator's network.

Date

Generating unit:

Tested part of the generating unit:

W-code of the tested generating unit:

Rated capacity of the tested generating unit: ……. MW; …….MVA

Measurements conducted by:

Measurement period:

Representative of the generating unit:

Signature Date:

CONFIRMATION BY THE TRANSMISSION SYSTEM OPERATOR:

The quality indicators shown in the submitted report … (are / are not) within the permissible limits, and it … (is / is not) permitted to proceed with the execution of test plan items 1–10.

Name of signatory:

Signature: Date:

2.7 Brief report on the quality of electricity

Flicker (95% of measured values over one week)

	Measured	Permissible (110 kV)	Permissible (330 kV)
P_{st}			
P_{lt}			

Harmonics (95% of measured values over one week)

	Measured	Permissible (110 kV)	Permissible (330 kV)
THD U ()			
TDD			

Harmonic order	Measured *Relative voltage u_h, %*	Permissible (110 kV) *Relative voltage u_h, %*	Permissible (330 kV) *Relative voltage u_h, %*
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
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16			
17			
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49			
50			

Asymmetry (95% of values during one week of measurements)

	Measured, %	Permissible (110 kV), %	Permissible (330 kV), %
k_a			

Table of registered overvoltages (entire week of measurement results)

Registered overvoltages	Time	Figure No.	Comment
……	…… (hh.mm.ss – hh.mm.ss, dd.mm.yy)	……	……

2.8 Sample test report

TEST 1: SECONDARY LOAD CONTROL

1.1 Elering test no. correspondence

This test corresponds to or replaces Elering test …….

1.2 Test Conditions

1.3 Test Execution

1.4 Success Criteria

1.5 Comments

1.6 Recorded signals

For example:
VCP, PCP, QCP, P330, Q330, V330, Pref, Qref, OLTC, Vexf, Iexf,
Sampling rate 200 ms (1 s at connection point).

2.9 Acceptance test plan for synchronous power-generating modules

Test 1. Measurements for determination generator parameters (can be replaced with factory acceptant tests)

no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Open Circuit Saturation This test is to measure generators Open Loop Characteristic	Measurement of the steady state variation of generator field current versus generator stator voltage from the minimum achievable generator stator voltage to at least 1.05 p.u. of the rated stator voltage with the generator circuit breaker open.	For machines with brushless exciters the field current measurement shall be the field current of the exciter
2	Saturation factors. This test is to determine the generator saturation factors S1.0 and S1.2	The unit will be brought to synchronous speed and disconnected from the power grid with no field current. The field current will then be increased in steps of 10% until the generator armature voltage reaches 1.2 p.u. of the rated value. The generator armature voltage (Vt), field voltage (Vf) and field current (If) will be recorded, in tabular form, at each step.	
3	Synchronous Machine Impedances and Time Constants Tests that reasonably confirm the d-axis reactances (Xd, X'd, X"d) and time constants (T'do and T"do) of the synchronous generator	For example, recording of terminal voltage and field current following opening of the generator circuit breaker with the generator running at near-zero real power and under-excited so as to absorb substantial reactive power with the excitation system in manual field voltage control Details to be proposed by the manufacturer	
4	Short circuit load test	Details to be proposed by the manufacturer	

Test 2. Power quality measurements

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Power quality measurements	Normal operation of power plant	Measurement period is 7 days. initial conditions determined by Elering

Test 3. Inertia.

Part No	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Inertia. A test that reasonably confirms the inertia constant of the turbine-generator, governor droop and other model parameters	The unit circuit breaker shall be opened to disconnect the unit from grid Details to be proposed by the manufacturer.	• The machine is loaded to a small amount of MW (around 10 - 20% to prevent the interference from protection relay operation) and Mvar value (under-excited condition preferred). • The AVR is set in auto control mode and the governor in speed droop control mode. • The unit circuit breaker input signal to the turbine controller is blocked to defeat the machine speed preset.

Test 4. Generator AVR testing.

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Step change to AVR voltage reference with the generating unit on open circuit	(a) +2.5 % (b) -2.5 % (c) +5.0 % (d) -5.0 % (e) +10.0 % (0,95pu to 1,05 pu) (f) -10.0 % (1,05pu to 0,95 pu)	nominal stator terminal voltage
2	Manual variation of generating unit open circuit voltage	Stator terminal voltage (Ut) (a) increase from 0.5 pu to 1.1 pu (b) decrease from 1.1 pu to 0.5 pu see notes below	• in 0.1 pu step for Ut between 0.5-0.9 pu • in 0.05 pu step for Ut between 0.9-1.1 pu
3	steady state over-excitation limiter (OEL) operation	Mvar outputs at OEL setting slow raising of excitation to just bring OEL into operation. See notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
4	steady state under-excitation limiter (UEL) operation	Mvar outputs at UEL setting slow lowering of excitation to just bring UEL into operation. See notes below	• 100% MW output • 75% MW output • 50% MW output • 25% MW output • min. MW output
5	Step change of Mvar on the transmission system Test conducted by Elering	Switching in and out of: (a) a transformer (b) a reactor (c) a capacitor	• parallel transformers on staggered taps • others as determined by Elering • test with and without PSS

6	**Step change to AVR voltage reference with the generating unit connected to the system.** **(PSS out of service)** **Generating unit output levels:** **(i)50% rated MW, and** **(ii)100% rated MW**	**(a) +1.0 %** **(b) -1.0 %** **(c) +2.5 %** **(d) -2.5 %** **(e) +5.0 %** **(f) -5.0 %** **repeat (e) & (f) twice** **see notes below**	• **nominal stator terminal voltage** • **unity power factor or underexcited operation** • **system base load OR typical conditions at the local equipment and typical electrical connection to the transmission or distribution system** • **tests for (i) must precede tests for (ii)** • **smaller step changes must precede larger step changes**
7	**As for 6 but with the PSS in service**	**Same as in part 6**	**Same as in part 6**
8	**Step change to AVR voltage reference with the generating** **unit connected to the system.** **(PSS out of service)** **System Conditions :** **(i) system minimum load with no other generation on the same bus OR relatively weak connection to the transmission or distribution system, and** **(ii) system maximum load and maximum generation on same bus OR relatively strong connection to the transmission or distribution system**	**(a) +5 %** **(b) -5 %** **repeat (a) & (b)** **twice;** **see note below**	• **nominal stator terminal voltage** • **unity power factor or underexited operation** • **Generating unit output at 100% rated MW**
9	**As for 8 but with the PSS in service**	**Same as in part 8**	**Same as in part 8**

- Tests 1,3 and 4 need not be witnessed by the TSO
- For test 3 a positive step is applied of X% from the sub-OEL value. But for test 4 a -Y% step from the sub-UEL value as shown in Figure 3 is required.

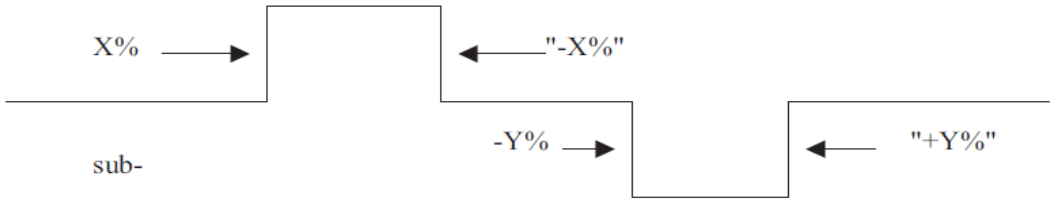

Figure 3. Application of Step Signal

- For tests 6 and 7 care must be taken not to excite large or prolonged oscillations in MW etc. Therefore, smaller step changes must always precede larger step changes to avoid such oscillations.
- The Figure 4 below shows the step changes referred to in the schedule of tests given above. An example is given of a +5% step to the summing junction and then a -5% step. Removal of the +5% ("-5%") step is deemed to be a -5% step. Unless specified otherwise the "-5%" step method shown in Figure 4 is used.

Figure 4. Application of test signal

Test 5 Active and reactive power tests (PQ curve and Q = const)

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	PQ curve measurements	(a) minimum % rated MW a. Q max setpoint b. Q min setpoint (b) 25 % rated MW a. Q max setpoint b. Q min setpoint (c) 50 % rated MW a. Q max setpoint b. Q min setpoint (d) 75% rated MW a. Q max setpoint b. Q min setpoint (e) 100 % rated MW a. Q max setpoint b. Q min setpoint	The min and max Q will be held for 10 minute in each step. Signal from Elering control centre (SCADA if applicable)
2	Q constant	(a) 0 Mvar (b) -1/2Qmax rated Mvar (c) +1/2Qmax rated Mvar	Q will be held for 10 minute in each step. Signal from Elering control centre (SCADA if applicable)
3	Leading and lagging MVar capability at full MW output. System maximum load and maximum generation. Test conducted with as high an ambient temperature as possible.	Generating unit MW and MVar output levels set to 100% of rated values and maintained for one hour both for leading and lagging.	System maximum load and generation Signal from Elering control centre (SCADA if applicable)

Test 6 House load test

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	House load test Remaining load – houseload + load connected directly to power plant Test conducted by Elering	opening of the link to transmission system	• 100% of maximum active power of synchronous generating module • Test duration 6 hour • Resynchronization after 6 hours
2	Islanding of a subsystem consisting of User's generating units plus load with export of power by means of a link to the transmission system. Test conducted by Elering	opening of the link	• 5-10% of generated MW exported by means of the link • 90-95% of generated MW used by the subsystem's load • Each test during 1 hour • Resynchronization

Test 7 Over- and underfrequency

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Overspeed capability to stay in the range of 51.0 to 51,5 Hz for a minimum of 30 minutes	(a) Digital governor: use software, where practical, to put a step in the speed reference of the turbine governor such that the target speed is 51.5Hz (b) Use a manual control to raise speed from 50Hz so as to stay in the 51,0 to 51,5 Hz range for a minimum of 30 min. (c) Where it is practical, use a function generating unit to inject an analogue signal in the appropriate summing junction, so that the turbine stays in the 51,5 Hz range for a minimum of 30 min.	Unsynchronised unit at rated speed and no load
2	Underspeed capability to stay in the range of 48,5 to 47,5Hz for a minimum of 30 minutes	To be proposed by the manufacturer	Unsynchronised unit at rated speed and no load

Test 8 U = constant test

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Testing U constant functionality	(a) XXX kV (b) XXX kV (c) XXX kV Voltage at each step (a)-(c) maintained during 60 minutes	Signal from Elering control centre (SCADA if applicable)

Test 9 Load control (secondary control test)

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Variable frequency injection into the AVR summing junction (with PSS out of service)	0.01-100 rad/sec See notes below	• as determined by Elering
2	Step change to governor/load reference	(a) 2.5 % step increase in MW demand signal (b) 2.5 % decrease in MW demand signal (c) equivalent of 0.05Hz subtracted from the governor speed ref. (d) equivalent of 0.1 Hz added to turbine governor speed reference See notes below	• equipment output at 50-90% of rated MW • others as agreed with Elering
3	Load rejection (real power) Generating unit reactive power output levels: (i) maximum leading Mvar (ii) maximum lagging Mvar	(a) 25 % rated MW (b) 50 % rated MW (c) 100 % rated MW See notes below	• nominal stator terminal voltage • smaller amount must precede larger amount of load rejection • Resynchronization

4	**Load control (active power setpoint test)** **Test conducted by Elering if unit connected under AGC**	**(a) minimum % rated MW** **(b) 50 % rated MW** **(c) 60 % rated** **(d) 70 % rated MW** **(e) 100 % rated MW** **(f) 90 % rated MW** **(g) 80 % rated MW** **(h) 0 MW exported to grid MW** **Power at each step (a)-(h) maintained during 10 minutes** **Signal from Elering control centre (SCADA if applicable)**	**Signal from Elering control centre (SCADA if applicable)**

- For test 1, care has to be taken not to excite electromechanical resonances (eg poorly damped MW swings) if the machine is on line.
- For the tests 2 equipment characteristics may require the changes be varied from the nominal values given. Larger changes may be considered in order to more accurately determine equipment performance.
- For test 3, the instantaneous overspeed protection must be set at an agreed level depending on unit capability

Test 10 Primary control test including LFSM-O and LFSM-U

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	**Testing power plant behaviour in case of frequency changes in grid.**	**(a) 40 % rated MW** **(b) 90 % rated MW** **Frequency steps, droops and deadbands to be determined by Elering**	**Generator need to be synchronized with grid** **Excitation system is in AVR mode and started.** **PSS is in service.** **Generator breaker is closed.** **Signal from Elering control centre (SCADA if applicable)**

Example of Primary control test.

Load generator to 40% of rated active power **XX MW**.

Enable frequency control function in the turbine control system

	Frequency control enabled	Droop (%)	Deadband (mHz)	Frequency step (mHz) (all changes from 50 Hz)	Expected P change (MW)	Duration (after stabilized output), min.
1	Yes	8	100	-80		5
2	Yes	8	100	80		5
3	Yes	8	100	-200		5
4	Yes	8	100	200		15
5	Yes	8	0	-80		5
6	Yes	8	0	80		5
7	Yes	2	100	-80		5
8	Yes	2	100	80		5
9	Yes	2	100	-200		15
10	Yes	2	100	200		5
11	Yes	2	0	-80		5
12	Yes	2	0	80		5
13	No	8	0	-150		5
14	No	8	0	150		5
15	No	8	0	-350		15
16	No	8	0	350		15
17	No	8	0	-500		5
18	No	8	0	500		15
19	No	2	0	-150		5
20	No	2	0	350		5
21	No	2	0	-250		5
22	No	2	0	350		15

Load generator to 90% of rated active power **XX MW**.

	Frequency control enabled	**Droop (%)**	**Deadband (mHz)**	**Frequency step (mHz) (all changes from 50 Hz)**	**Expected P change (MW)**	**Duration (after stabilized output) min.**
1	Yes	8	100	-80		5
2	Yes	8	100	80		5
3	Yes	8	100	-200		5
4	Yes	8	100	200		15
5	Yes	8	0	-80		5
6	Yes	8	0	80		5
7	Yes	2	100	-80		5
8	Yes	2	100	80		5
9	Yes	2	100	-200		15
10	Yes	2	100	200		5
11	Yes	2	0	-80		5
12	Yes	2	0	80		5
13	No	8	0	-150		5
14	No	8	0	150		5
15	No	8	0	-350		15
16	No	8	0	350		5
17	No	8	0	-500		5
18	No	8	0	500		15
19	No	2	0	-150		5
20	No	2	0	150		5
21	No	2	0	-350		5
22	No	2	0	350		15

Test 11 Cold start to maximum rated power

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Cold start to maximum rated power Test conducted by Elering	Initial start order from Elering control centre (SCADA if applicable) Maximum rated power to be maintained during 1 hour Details to be proposed by the manufacturer	At least 24 h shutdown (all primary systems) required before start of the test

Test 12 Testing of aFRR

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Testing automatic Frequency Restoration Reserve Test conducted by Elering	Activation and setpoint signals from Elering control Center.	• Initial generating unit loading as agreed with Elering • Specific testplan in cooperation with Elering

Test 13 Testing of a FACTS/HVDC

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Testing of a FACTS device, if any (SVC, TCR, STATCOM, etc.) This test is performed only when requested by Elering	agreed separately with Elering	• initial conditions determined by Elering

Test 14 Any other test to demonstrate compliance with a declared or registered equipment performance characteristic.

Test No	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Tripping of an adjacent generating unit Test conducted by Elering This test is performed only when requested by Elering	tripping of generating unit(s)	• initial generating unit loadings as agreed by Elering
2	Any other test to demonstrate compliance with a declared or registered equipment performance characteristic.	To be advised	

Test 15 Fault ride-through (FRT) test

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Fault ride-through (FRT) test	To be proposed and conducted by Elering	Up to 250 ms; fault at PCC 2ph-g or 3ph-g; or 1ph-g

Load-Frequency reserve testing, if requested by client

part no.	GENERAL DESCRIPTION	CHANGES APPLIED	TEST CONDITIONS
1	Load-Frequency reserve testing	According to reserve type requirements	According to prequalification requirements

2.10 Test plan for the power park module

START, date: ..... 20..

END, date: …….. 20..

Date

The generating unit's:

Tested part of the generating unit:

W-code of the tested generating unit:

Rated capacity of the tested generating unit: ……. MW; …….MVA

Location of the connection point:

Person responsible for conducting the tests: …… ……

Contact details: tel: ……..

e-mail: …….

Contact person(s) from the transmission system operator during the tests:

Name:

Phone: ..... No.:

e-mail:

Contact details of the transmission system operator's energy system control centre representative:

Name:

Phone: ..... No.:

e-mail:

Approval of the test plan by the transmission system operator:

Name of approver:

Date:

Signature:

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
0.1	**Power quality measurement**	All limitations disabled; the generating unit is operating under normal conditions. NOTICE from the generating unit regarding the start of power quality measurements, which must last at least 7 consecutive days.	Other tests may not be conducted in the generating unit during this period. A written entry is made upon receipt of the NOTICE of measurement start. TEST START	During testing, no adjustments, settings, or manual switching of the generation module on or off shall be performed. Likewise, no other switching operations shall be carried out within the generating unit's electrical installation.			
0.2		At least seven (7) days after p.0.1, a NOTICE regarding the completion of quality measurements by the generating unit shall be provided to the TSO.	A written entry is made upon receipt of the NOTICE. TEST END	The test must measure the accuracy of maintaining reactive power at Q = 0 Mvar.			
Execution of **test plan items 1–10** is permitted only if the quality measurements have been conducted and the summary report submitted by the generating unit has been approved by the transmission system operator. A written notification of this approval must be provided to the energy system control centre and the test operator. A sample of a short report on quality measurements is provided in section 1.7 of this document. The full report of the quality measurements must be included in the final test report. The minimum value of active power required under the initial conditions of tests 1–10 is calculated by taking the 1-minute average of the output power at the connection point.							

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
2	**Emergency reduction of output power**	All power-generating facilities in operation, normal condition . P≥80 % Pn	All limitations disabled / TEST START	Emergency power reduction may be implemented via switching off the generating unit's circuit breakers. The number and scale of limitations (XX) depends on the capacity and configuration of the generating unit. *If the load shedding is performed by operating circuit breakers, the output power limit may be reduced. If the load shedding rate depends on the output power, 80% of the rated power shall be used, or in cases where the output power is within 80%… 60% of the rated power, the test results must be supplemented with a simulation in a calculation model to verify compliance with*			
2.1.		The generating unit produces power for at least 5 minutes at P≥80 % Pn	The generating unit's P emergency power limit 0 % – ON				
2.2.		11 minutes have passed since the order was placed in item 2.1.	THE GENERATING UNIT'S P emergency power limit 0 % – OFF				
2.x.		The generating unit produces power for at least 5 minutes at P≥80 % Pn	THE GENERATING UNIT'S P emergency power limit **XX** % – ON				
2.y.		11 minutes have passed since the order was placed in item 2.x.	THE GENERATING UNIT'S P emergency power limit **XX** % – OFF				

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
2.z.		After item 2.y the generating unit reaches steady-state operation without limitations and provides maximum output power for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
3	**Smooth active power control, secondary control**	All generation units in operation, normal condition, P ≥ 80 % Pn	max allowed P = 100%, TEST START				
3.1.		The power park module produces power for at least 5 minutes at P≥80% P_n	ENTER P regulation rate …… [MW/min] ENTER maximum allowed P = 80% P_n	The reduction and restoration of output power shall be performed using smooth control at the specified rate. During the test, the generating unit must not be switched on or off. The target value must be reached at the connection point based on SCADA commands. Allowed deviation: ±5% of rated power or max 5 MW.			
3.2.		11 minutes have passed since the order was placed in item 3.1.	ENTER maximum allowed P = 60 % P_n				
3.3.		11 minutes have passed since the order was placed in item 3.2.	ENTER maximum allowed P = 40 % P_n				
3.4.		11 minutes have passed since the order was placed in item 3.3.	ENTER maximum allowed P = MIN % P_n				

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
3.5.		11 minutes have passed since the order was placed in item 3.4.	ENTER maximum allowed P = 100 % P_n				
3.6.		After item 3.5 the power park module reaches steady-state operation without limitations and provides maximum output power for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
4	**Reactive power control in U=const mode**	All power-generating facilities in operation, normal condition, P≥50% P_n	All limitations disabled / TEST START	Output power must not be limited. At least 50% of wind turbines must remain in operation at each voltage setpoint P≥50% P_n. Voltage setpoints XXX, YYY, ZZZ will be defined by the control centre. The actual test plan will be adapted to the agreed control signals. At all three stages, the control centre will change the network voltage (e.g. switching reactor or the power transformer's tap changer). These changes and the corresponding behaviour of the generating unit must be shown in the test results report.			
4.1.		The power park module produces power for at least 5 minutes at P≥50% P_n	GENERATING UNIT'S control U=const – ON, setpoint U = **XXX** kV				
4.1.		The power park module produces power for at least 5 minutes at P≥50% P_n After the order of 4.1, minimum 8 hours later	GENERATING UNIT'S control U=const, setpoint U = **YYY** kV				

Item No	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
4.3.		The generating unit produces power for at least 5 minutes at P≥50% P_n After the order of 4.2, minimum 8 hours later	THE GENERATING UNIT'S control U=const, setpoint U = **ZZZ** kV				
4.4.		After the order of 4.3, minimum 8 hours later	THE GENERATING UNIT'S control U=const – OFF				
4.5.		After the order in item 4.4, the generating unit has reached steady state reactive power (Q=0 Mvar) and operates for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
5	**Measurement of P/Q characteristics of generating unit at connection point** **To be continued on this page …**	All generating units in operation, normal condition , P≥80 % Pn	All limitations disabled / TEST START	The reduction and restoration of output power shall be performed using smooth control at the specified rate. During the test, the generating unit must not switch on or off. The actual test plan will be adapted to the agreed control signals.			
5.1.		The generating unit produces power for at least 5 minutes at P≥80% P_n	THE GENERATING UNIT'S control Q=const – ON THE GENERATING UNIT'S setpoint Q ENTER + Q_{MAX}				

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
5.2.	**Measurement of P/Q characteristics of generating unit at connection point**	11 minutes have passed since the order was placed in item 5.1.	THE GENERATING UNIT'S setpoint $Q_{ENTER} - Q_{MAX}$				
5.3.		11 minutes have passed since the order was placed in item 5.2.	ENTER maximum allowed $P = 80\ \% P_n$ THE GENERATING UNIT'S setpoint Q = - Q MA X				
5.4.		11 minutes have passed since the order was placed in item 5.3.	THE GENERATING UNIT'S setpoint $Q_{ENTER} + Q_{MAX}$				
5.5.		11 minutes have passed since the order was placed in item 5.4.	ENTER maximum allowed $P = 70\% P_n$ THE GENERATING UNIT'S setpoint Q = +Q MAX	The reduction and restoration of output power shall be performed using smooth control at the specified rate. During the test, the generating unit must not switch on or off.			
5.6.		11 minutes have passed since the order was placed in item 5.5.	THE GENERATING UNIT'S setpoint Q ENTER - Q MAX				
5.7.		11 minutes have passed since the order was placed in item 5.6.	ENTER maximum allowed $P = 60\% P_n$ THE GENERATING UNIT'S setpoint Q = -Q MAX				
5.8.		11 minutes have passed since the order was placed in item 5.7.	THE GENERATING UNIT'S setpoint Q ENTER +Q MAX				

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
5.9.		11 minutes have passed since the order was placed in item 5.8.	ENTER maximum allowed P = 50% P_n THE GENERATING UNIT'S setpoint Q = +Q MAX				
5.10.		11 minutes have passed since the order was placed in item 5.9.	THE GENERATING UNIT'S setpoint Q ENTER - Q MAX				
5.11.		11 minutes have passed since the order was placed in item 5.10.	ENTER maximum allowed P = 40% P_n THE GENERATING UNIT'S setpoint Q = -Q MAX				
5.12.		11 minutes have passed since the order was placed in item 5.11.	THE GENERATING UNIT'S setpoint Q ENTER +Q MAX				
5.13.		11 minutes have passed since the order was placed in item 5.12.	ENTER maximum allowed P = 30% P_n THE GENERATING UNIT'S setpoint Q = +Q MAX				
5.14.		11 minutes have passed since the order was placed in item 5.13.	THE GENERATING UNIT'S setpoint Q ENTER - Q MAX				
5.15.		11 minutes have passed since the order was placed in item 5.14.	ENTER maximum allowed P = 20% P_n THE GENERATING UNIT'S setpoint Q = -Q MAX				

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM. YYYY]	TIME [HH.MM]
5.16.		11 minutes have passed since the order was placed in item 5.15.	THE GENERATING UNIT'S setpoint Q ENTER + Q_{MAX}				
5.17.		11 minutes have passed since the order was placed in item 5.16.	ENTER maximum allowed P = 100% Pn THE GENERATING UNIT'S setpoint Q = +Q MAX				
5.18.		11 minutes have passed since the order was placed in item 5.17.	THE GENERATING UNIT'S setpoint Q ENTER - Q_{MAX}				
5.19.		11 minutes have passed since the order was placed in item 5.18.	ENTER maximum allowed P = 100% P_n (limit exceeded) THE GENERATING UNIT'Scontrol Q=const - OFF				
5.20.		After the order in item 4.4, the generating unit has reached steady state reactive power (Q=0 Mvar) and operates for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
6	**Reactive power**	All generating units in operation, normal condition , P≥20 % Pn	All limitations disabled / TEST START	No switching of the generating unit may take place during the test.			

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
6.1	**control Q=const**	The generating unit produces power for at least 5 minutes at P≥20% P_n	THE GENERATING UNIT'Scontrol Q=const – ON THE GENERATING UNIT'S setpoint Q ENTER Q = +½ Q MAX	Setpoint tolerance at the connection point: ±10% of P_n The actual test plan will be adapted to the agreed control signals. At all three stages, the control centre will change the network voltage (e.g. switching reactor or the power transformer's tap changer). These changes and the corresponding behaviour of the generating unit must be shown in the test results report.			
6.2		60 minutes have passed since the order was placed in item 6.1.	THE GENERATING UNIT'S setpoint Q ENTER Q = -½ Q MAX				
6.3		60 minutes have passed since the order was placed in item 6.2.	THE GENERATING UNIT'Scontrol Q=const - OFF				
6.4		After the order in item 6.3, the generating unit has reached steady state reactive power (Q=0 Mvar) and operates for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
7	**Short-term disconnection**	All generating units in operation, normal condition , P≥50 % Pn	All limitations disabled / TEST START	All inverters must be operational before switching off the circuit breaker (VL), and must reconnect to the grid			

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
7.1.	**from the grid**	The generating unit produces power for at least 5 minutes at P≥50% P_n	Generating unit's circuit breaker (VL) …… OFF	switching on the circuit breaker.			
7.2		Since item 7.1. in 10 seconds have elapsed.	Generating unit's circuit breaker (VL) …… ON				
7.3		After item 7.2 the generating unit reaches steady-state operation without limitations and provides maximum output power for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							
8	**Short-term disconnection from the grid without central control system**	All power-generating facilities in operation, P≥50 % P_n The generating unit's control computer has previously been taken out of service.	All limitations disabled / TEST START	All inverters must be operational before switching off the circuit breaker (VL), and must reconnect to the grid automatically after switching on the circuit breaker.			
8.1.		The generating unit produces power for at least 5 minutes at P≥50% P_n	Generating unit's circuit breaker (VL) …… OFF				
8.2		Since item 8.1. in 10 seconds 10 elapsed.	Generating unit's circuit breaker (VL) …… ON				
8.3		After item 8.2 the generating unit reaches steady-state operation without limitations and provides maximum output power for 5 minutes.	TEST END				
At least 5 minutes between 2 tests							

Item No.	DESCRIPTION	INITIAL CONDITION / REQUIREMENT	ACTION BY ENERGY SYSTEM CONTROL CENTRE	COMMENT	NOTE [OK/-]	DATE [DD.MM.YYYY]	TIME [HH.MM]
9.1	**Operation without central control system – 24 h**	NOTICE from the generating unit stating that the generating unit's control computer has been taken out of service.	TEST START [No control commands allowed / EJK control centre does not intervene]	No other tests shall be performed on the generation module at the same time.			
9.2		24 hours after receiving the notice as of item 9.1, the generating unit shall issue a new NOTICE indicating that its control computer has been put into operation.	[No control commands allowed during the test / EJK control centre does not intervene] END OF TEST				
At least 5 minutes between 2 tests							
10	**Primary control. Low- and high-frequency operation.**	All power-generating facilities in operation, normal condition, $P \geq 40\% P_n$ Primary control test must be performed in cooperation with the EJK control centre. All control commands and transmission time stamps must be documented in the report.	The activation and setpoint signals for primary control are transmitted by the power system control center.	The detailed test plan must be coordinated in advance with the transmission system operator.			

11	**Automatic frequency restoration reserve (aFRR)**	All power-generating facilities in operation, normal condition, $P \geq 40\% P_n$ The frequency reserve test must be performed in cooperation with the EJK control centre. All control commands and transmission time stamps must be documented in the report.	Activation and setpoint signals for the reserve are provided by the energy system control centre.	The detailed test plan must be coordinated in advance with the transmission system operator.			
12	**Additional tests as required**			Additional tests that demonstrate the technical capability of the generating unit (e.g. testing of FACTS equipment, etc.)			
13	**FAULT RIDE-THROUGH (FRT) test**	The owner of the generating unit shall be notified in advance of the test.		The test is performed by the transmission system operator. Short circuit (fault) duration up to 250 ms; The short-circuit required for the test (1-phase to ground, 2-phase to ground, or 3-phase) shall be performed			
Item No.	**DESCRIPTION**	**INITIAL CONDITION / REQUIREMENT**		**ACTION BY ENERGY SYSTEM CONTROL CENTRE**	**COMMENT**	**NOTE [OK/-]**	**DATE [DD.MM.YYYY]**	**TIME [HH.MM]**
					at the connection point or as close to it as possible.			

	Prequalification for frequency reserves upon client's request		**According to the type of frequency reserve**	**According to the prequalification requirements for frequency reserves**			