Test plan of ELIA

Summary	This document contains a proposal for the Test Plan designed by ELIA in compliance with the criteria specified in Regulation (EU) 2017/2196 and with the provisions in the Federal Grid Code. This document was available for public consultation during the period running from September 15th 2020 until October 15th 2020 and was submitted for approval to the Minister of Energy on October 30th 2020. The minister has approved the Test Plan as per ministerial decree of April 29th 2021.	
Version	1.1	
Date	30-10-2020	
Status	☐ Design	☒ Final version approved by energy minister

Previous versions

Version	Date	Author	Summary of changes
1.0	22-11-2019	ELIA	Comments from the Ministerial Decree of 15/04/2020, the CREG opinion of 11/03/2020 and the comments of various stakeholders.

Related documents

System Defense Plan
Restoration Plan
General conditions to act as Provider of Restoration Services.

Content

1 Introduction

This document contains the Test Plan which defines the equipment and suitability to be tested relevant to the System Defense Plan and Restoration Plan.

The Test Plan has been prepared by ELIA taking into account the requirements of European Commission Regulation (EU) 2017/2196 of November 24, 2017 establishing a grid code for the emergency and restoration of the electricity grid (NC ER) and taking into account other relevant legislation:

- The Royal Decree of April 22, 2019 containing technical regulations for the management of the electricity transmission system and access to it (the Federal Technical Regulations, or FTR for short)
- Regulation (EU) 2016/631 establishing grid connection requirements for electricity generators (NC RFG)
- Regulation (EU) 2016/1388 establishing a grid code for connection of consumers (NC DCC)
- Regulation (EU) 2016/1447 establishing a grid code on requirements for connection to the grid of high-voltage direct current systems and DC-connected power park modules (NC HVDC)

In preparing this Test Plan, ELIA has ensured that:

- the tests do not endanger the operational safety of the transmission system and the interconnected transmission system;
- the tests have minimal impact on system users.

In accordance with Articles 4(2) and (3) and 43(2) of the NC ER and Article 259 of the FTR, ELIA submitted an initial version of the Test Plan to the Minister of Energy for approval on November 22, 2019.

The Minister of Energy had initially given his partial approval to the first version of the test plan as indicated in the Ministerial Decree of April 21, 2020 approving the proposed test plan in accordance with Article 259 of the Royal Decree of April 22, 2019 on technical regulations for the management of the electricity transmission grid and access to it. This partial approval related to part 4.1 of this document regarding the black-start service. The Minister asked ELIA to submit a new Test Plan proposal within six months of the publication of the Decree in the Belgian "StaaTSOlad", i.e. by November 1, 2020 at the latest.

In accordance with Article 7 of the NC ER, ELIA submitted this new test plan proposal for public consultation during a one-month period from Sept. 15, 2020 to Oct. 15, 2020.

Elia has taken into account in this adapted proposal the provisions of the Ministerial Decree of 15 April 2020 as well as CREG's opinion (A)2065 of 11 March 2020 on the first Test Plan proposal as well as the comments received in the public consultation.

The Test Plan refers to the System Defense Plan and Restoration Plan prepared by ELIA in accordance with the NC ER and the FTR, which were approved by the Minister of Energy by ministerial decree on December 19, 2019.

The current version of the test plan was submitted to the Minister of Energy for approval on Oct. 30, 2020.

The Minister of Energy has approved the test plan as indicated in the Ministerial Decree of April 29, 2021 approving the proposal of test plan in accordance with Article 259 of the Royal Decree of April 22, 2019 on technical regulations for the management of the electricity transmission network and access to it. The minister shall hold the system operator to submit a revised test plan to the minister for approval within six months of the approval of a System Defense Plan and Restoration Plan.

2 Legal framework

The proposed test plan was prepared by ELIA in accordance with Article 43 of the NC ER. This proposal was prepared in consultation with following stakeholders:

- the public Distribution System Operators (DSOs), during the specific working groups (AHDR[1]) within Synergrid,
- Significant Grid Users (SGUs) and Restoration Service Providers (RSPs) identified in the System Defense Plan and Restoration Plan, during the working groups (WGSO & EMD[2]) as part of ELIA's users group.

In accordance with Article 43.2 of the NC ER, the test plan includes the equipment and capabilities relevant to the System Defense Plan and Restoration Plan to be tested.

In accordance with Article 43.3 of the NC ER, the test plan shall include the test frequency and conditions in accordance with the minimum requirements defined in Articles 44 to 47 of the NC ER[3] .

The test plan further considers the requirements set forth in the following provisions:

- Articles 48 and 49 of the NC ER;
- Articles 15(5)(a) and (c), 41(2) and 45(5) and (6) of the NC RFG;
- Articles 37(2) and (3), 69(1) and (2), 70(2) and 71(11) of the NC HVDC;
- Articles 19(1) and (2), 35(2), 37(4) and (6), 39(5) and 41(1) of the NC DCC.

The Test Plan follows the **methodology** outlined in the NC RFG, the NC HVDC and the NC DCC for the corresponding suitability tested. However, for SGUs that existed prior to the enactment of these codes, the NC ER provides that the Test Plan must follow the provisions of the national legislation.

Without prejudice to the provisions in Article 43(3) of the NC ER regarding the determination of the **test frequency and conditions** for the compliance tests of the suitability of electricity generation units (art 44), of consumer installations providing demand response (art 45) of suitabilities of HVDC installations (art 46) and of decoupling consumption at low frequencies via relays (art 47), ELIA shall establish the testing frequency and conditions for other equipment and suitabilities relevant to the System Defense Plan and the restoration plan to be tested. In the absence of an outlined **methodology** for testing a particular equipment or aptitude to be tested in the NC RFG, the NC HVDC and the NC DCC or in national legislation, ELIA shall set it out in the test plan in accordance with Article 43(1) and (2) of the NC ER, which states that each TSO shall periodically assess the correct operation of **all equipment and tools** in the System Defense Plan and the restoration plan and record it in a test plan. In accordance with Articles 183 and 184 of the FTR, ELIA has consulted with the affected grid user(s) on the procedure, programming and resources to be used to conduct these tests.

For equipment or tools used in the System Defense Plan or restoration plan that are also frequently used in the normal grid condition, ELIA may assess conformity based on the

[1] AHDR = Afschakel Plan, Restoration Plan, Délestage, Reconstitution
[2] WG SO & EMD = Working Group System Operation and European Market Design.
[3] Since the System Defense Plan does not provide for mitigation measures for defense service providers providing demand response, Article 45 of the NC ER is not applicable in this test plan.

conformity tests and simulations performed in the context of the connection process of the installation to the transmission grid as mentioned in Article 169 paragraph 2 of the FTR and based on correct operation during the normal grid condition.

Neither the System Defense Plan nor the Restoration Plan envisaged that ELIA would impose measures that would exceed the capacities of SGUs designated pursuant to Articles 11(4) and 23(4) of the NC ER as provided in the Connection Contract.

In accordance with Article 43.1 of the NC ER, ELIA may reassess compliance at periodic intervals, such as after a failure, modification or replacement of equipment that may affect the facility's compliance with the requirements of the FTR.

ELIA pursues a balance between, on the one hand, the assurance it wishes to obtain on the correct operation of the equipment or suitability used in the System Defense Plan or restoration plan and, on the other hand, the resources to be used by the corresponding plant owner or operator and the system operator for the preparation, execution and reporting of each test.

Therefore, for frequently used equipment or devices in the normal grid condition, no higher test frequency is specified in this test plan.

In the case of installations providing black-start service, the methodology defined in NC RFG for new installations, does not contain any additional aspects compared to the requirements directly from Article II.4.1 of the General Conditions for Restoration Service Providers.

In the absence of a methodology in the national legislation for the testing of decoupling relays for interrupting consumers at low frequency, ELIA defines in this test plan, the testing conditions and frequencies for existing installations, which do not have to comply with Articles 37(6) and 39(5) of the NC DCC. In accordance with Article 184 of the FTR, ELIA reached an agreement with the relevant grid user, in this case the relevant public DSO, after consultation, on the procedure for conducting the tests of disconnection relays for interrupting consumers at low frequency. This agreement was recorded in the cooperation agreement (SOK) between ELIA and the DSO. If relevant, such agreement between Elia and a CDSO is recorded in the connection agreement between ELIA and the CDSO concerned.

Based on a proposal from ELIA and after an opinion from CREG, the Minister of Energy approves or does not approve the Test Plan, in accordance with Article 259 of the FTR.

In case of conflict between the Test Plan on the one hand and the NC ER and other laws on the other, the latter will prevail.

3 Summary table of equipment and suitability to be tested

In accordance with Article 43(2), of the NC ER, the following table identifies the complete list of equipment and capabilities, both existing and new, relevant to the System Defense Plan and the Restoration Plan, which are included in the test plan with associated test frequency and a reference to the test conditions.

Equipment and capabilities relevant to the System Defense Plan and Restoration Plan to be tested	Relevant to the System Defense Plan or Restoration Plan or general obligation from the NC ER	Periodicity of testing	Comments
RSP that is a PGM and provides a Black-Start service	Restoration Plan	3 years	The test conditions are listed in section 4.1
SGUs designated under Article 11(4) of the NC ER that are not covered by the NC RFG, NC HVDC or NC DCC (existing facilities)	System Defense Plan	Once during the connection process	For installations that need to activate defense or restoration measures at the request of ELIA without a contractual basis, the adequacies were tested during the connection process. ELIA will not impose defense or restoration measures that exceed the capacity of the installation(s) specified in the connection contract, as mentioned in paragraph 8.
SGUs designated pursuant to Article 23(4) of the NC ER that are not covered by the NC RFG, NC HVDC or NC DCC (existing facilities)	Restoration Plan		
The SGUs designated pursuant to Article 11(4) of the NC ER that do fall under the NC RFG, NC HVDC or NC DCC (new installations)	System Defense Plan	Once during the connection process	For installations that need to activate defense or restoration measures at the request of ELIA without a contractual basis, the adequacies were tested during the connection process as described in the NC RFG, NC HVDC or NC DCC. ELIA will not impose defense or restoration measures that exceed the capacity of the plant(s) specified in the connection contract, as stated in paragraph 8.
SGUs designated pursuant to Article 23(4) of the NC ER that do fall under the NC RFG, NC HVDC or NC DCC (new installations)	Restoration Plan		
On installations of the TSOs, public DSOs or CDSO implemented LFDD relays	System Defense Plan	10 years	Test conditions are included in section 7
Communication systems defined in Art. 41 of the NC ER of ELIA, RSPs, public DSOs, CDSO and SGUs identified in the Restoration Plan	General obligation according to NC ER Art. 48(1)	1 year	The test conditions are listed in section 9.1
Reserve power supply of ELIA's communication systems, RSPs, public DSOs, CDSO and SGUs identified in the Restoration Plan	General obligation according to NC ER Art. 48(2)	5 years	The test conditions are listed in section 9.2
Communication systems between TSOs	General obligation according to NC ER Art. 48(3)	Periodicity to be determined by December 18, 2024	Test terms to be determined by December 18, 2024
Communication systems between ELIA and Coreso.	General obligation according to NC ER Art. 49(2)	3 years	The test conditions are listed in section 9.1
Notification system for Emergency ELIA, Blackout ELIA, Grid Restoration ELIA	System Defense Plan and Restoration Plan.	1 year	The test conditions are included in section 9.3

Primary and reserve power supply of the main control center and the reserve control center of ELIA, as provided in Article 42.3 of the NC ER	General obligation according to NC ER Art. 49(2)	1 year	The test conditions are included in section 10.1
Primary and backup data communications from ELIA to substations deemed essential to Restoration Plan procedures	General obligation according to NC ER Art. 49(2)	3 years	Test conditions are listed in Section 9.1 (*).
ELIA backup power sources providing essential services to substations deemed essential to Restoration Plan procedures	General obligation according to NC ER Art. 49(3)	5 years	The test conditions are included in section 10.2 (*)
ELIA transfer procedure for moving main control center to reserve control center	General obligation according to NC ER Art. 49(4)	1 year	The test conditions are included in section 10.3
Signal U-5%	System Defense Plan	5 years	The test conditions are included in section 11.
Synchro coupler	Restoration Plan	During daily operations	Test conditions are listed in Section 12.
The limited frequency sensitive mode for underfrequency and overfrequency of type C and D production plants	System Defense Plan	At least every 10 years or after major changes	Test conditions are listed in Section 4.2.
The limited frequency-sensitive mode for underfrequency and overfrequency of the HVDC systems connecting different synchronous zones.	System Defense Plan	At least every 10 years or after major changes	Test conditions are listed in Section 6.1.
(*) When public DSOs, CDSO or SGUs are involved in these instruments and facilities, they participate in this test.			

Table 1: overview of equipment to be tested and suitability

4 Compliance testing of Power Generating Modules capabilities

Each Restoration Service Provider (RSP) must test its Power Generating Units (PGM) to ensure that they can provide the specified restoration service(s). According to Article 44 of the NC ER, a Test Plan must be prepared for the following services provided by an RSP:

- Black-Start service
- Quick resynchronization service. This service is not included in the System Defense Plan or Restoration Plan (for now). Consequently, there is no corresponding test described in this document. If this service does need to be contracted in the future, a description of this test will be included in the test plan after consultation with the relevant (candidate) providers of this Restoration service and submitted to the Minister for approval after public consultation.

The following capabilities are also used in the System Defense Plan and/or in the Restoration Plan:

- LFSM-U (only for the production units covered by the NC RFG)
- LFSM-O (only for the production units covered by the NC RFG)
- Changing the target value of active power
- Providing additional voltage support by adjusting reactive power
- Frequency control in the case of Restoration

However, these capacities are not contracted by ELIA under the System Defense Plan and/or the Restoration Plan. The modalities of testing with respect to capacities provided by SGUs but not contracted by ELIA are set forth in Section 8.

Other requirements regarding the capacities of production units in the normal or alarm state are outside the scope of this Test Plan, as they fall outside the requirements determined by Art 43.2 of the NC ER.

4.1 Black-Start service

4.1.1 Introduction

Each RSP that is a PGM and provides Black-Start service shall conduct a test of Black-Start capabilities at least every three years according to the minimum requirements set forth in Article 44(1) of the NC ER and Article 45(5) of the NC RFG.

As required by Article 45(5) of the NC RFG, the test examines the technical ability to start up from standstill without any external electrical supply.

However, since the ultimate purpose of the Black-Start service is to energize a dead busbar, to be able to accept active and reactive power, and to resynchronize the grid in island operation with the other part of the transmission system to support grid restoration, ELIA requires that the Restoration Facility demonstrate all of these aspects.

4.1.2 Periodicity of the test

In accordance with Article 44 of the NC ER, a test of Black-Start capabilities should take place at least every three years.

Notwithstanding the previous paragraph, and in order to verify the Restoration Facility's ability to provide Black-Start service, the test must be performed at least once during the term of the contract entered into between the RSP and ELIA.

4.1.3 Description of the test

The test of Black-Start capabilities can take any of the following forms:

- **Test 0:** Inspection of the Black-Start, this includes:
    - An inspection of Black-Start facilities and submission to ELIA representatives of the Black-out and Black-Start procedures to be executed by PGM operators.
    - Explanation of these procedures to ELIA by RSP operators
    - A demonstration of the operation of supporting facilities for "Black-Start" (supporting diesel generators, compressors, supporting steam boilers, etc.).
- **Test 1**: Startup and reconnection:
    - The PGM is shut down, followed by a startup according to the time defined in the “Provisions of the Black Start service” section of the RSP contract.
    - The PGM's support systems are started with an independent electricity source, such as a diesel generator, according to the PGM's "Black-Start Procedure.
    - The PGM is then connected to the transmission system that is already energized.
- **Test 2:**
    - The PGM's supporting systems are powered by an independent energy source.
    - The PGM shall demonstrate the ability to restore voltage to a transmission system main busbar with zero voltage. The PGM shall be able to regulate the voltage on the main busbar at the reference values 0.9 p.u., 1 p.u. (voltage base p.u.: rated voltage of the main busbar of the transmission system).
- **Test 3:**
    - In addition to the performance required in Test 2, the PGM must demonstrate the exchange of reactive power with the transmission system when the TSO switches inductive or capacitive elements to the system in islanding mode. The TSO may request to demonstrate exchanges of reactive power up to the limits of the section "Conditions to participate in Black-Start Service" in the RSP contract.
- **Test 4:**
    - In addition to the performance required in Test 3, the PGM must demonstrate the ability to inject active power into the system in island

operation when the TSO turns on blocks of active power (MW). The TSO may request to demonstrate exchanges of active power up to the limits of the section "Conditions to participate in Black-Start Service" in the RSP contract.

ELIA will require by default the performance of a test 4 of the Black-Start capabilities. However, if due to special circumstances (e.g. unavailable test load, potential negative impact on the transmission system) a test 4 cannot be performed, ELIA may decide, in consultation with the RSP, to perform another of the tests described above.

Apart from the triennial periodic test, ELIA reserves the right to require the RSP to perform the above-mentioned tests on an interim basis, if ELIA deems it necessary.

ELIA will justify and communicate to the RSP the reason for an interim test.

4.1.4 Passing criteria

The test of Black-Start capabilities is considered successful when it meets the conditions determined by ELIA according to Article 43(5) of the NC ER.

4.1.5 Organization and preparation of the test

ELIA and the RSP shall prepare the test according to the minimum requirements set forth in Article 44.1 of the NC ER, except for the unscheduled tests set forth in Section 4.1.6 of this Test Plan.

The RSP and ELIA shall take all measures to minimize the commercial impact of implementing a planned test of Black-Start capabilities for both parties.

The date of testing of the Black-Start Capabilities (Test Date) shall be decided jointly by ELIA and the RSP. The Test Date must be chosen in a period beginning three months before the Reference Date and ending three months after the Reference Date. The Reference Date is the date furthest in the future between:

- the effective date of the RSP contract plus six months;
- the date of the previous testing of the Black-Start capabilities for the same Restoration Facility plus three years.

If ELIA and the RSP do not agree on the Test Date within 30 calendar days of the start of consultation, ELIA will unilaterally impose a Test Date, unless the RSP can prove that doing so would seriously damage its assets and that other and equally effective test periods are possible.

In accordance with Article 4(8) of the NC ER, the RSP may file a complaint against a TSO in connection with ELIA's decision and may refer the complaint to the CREG, which acts as the dispute resolution authority and takes a decision within two months of receiving the complaint. This period can be extended by two months if the CREG requests additional information. The extended period can be further extended with the agreement of the complainant. The CREG's decision is binding unless and until revoked on appeal.

Testing of Black-Start capabilities shall be conducted in accordance with the Black-out and Black-Start procedures of the RSP and relevant procedures of ELIA.

The RSP shall provide ELIA with the following documents prior to the execution of each test of the Black-Start Capabilities, or upon ELIA's request:

- "Blackout procedure" as defined in Article II.1 of the RSP contract;

- "Black-Start Procedure" as defined in Article II.1 of the RSP contract;
- Synoptic diagram of plants.

ELIA shall have the right to attend the testing of the Black-Start capabilities. To this end, the RSP guarantees ELIA access to the premises of the Restoration Facility.

If the test of the Black-Start capabilities fails, ELIA undertakes to cooperate, where possible, in organizing a new test of the Black-Start capabilities, within two months of receiving the RSP's request.

4.1.6 Unscheduled test

Notwithstanding the preceding paragraphs and to verify that the Restoration Facility is truly capable of providing Black-Start Service, ELIA shall have the right to conduct a test of the Black-Start Capabilities as described in paragraph 4.1.3 of this Test Plan, without warning from or consultation with the RSP.

ELIA may conduct such unscheduled tests only if the Restoration Facility is available (according to the definition of unavailability in Article II.4.6 of the RSP Contract), its production program is zero (based on the CIPU nominations sent by the Provider) and it is not participating in the supply of other reserves at that time. ELIA has the right to conduct such tests for each Restoration Facility at least once during the term of the RSP Contract.

4.1.7 Test Reports

ELIA, assisted by the RSP, shall prepare a report of each completed test.

The RSP provides ELIA with access to all test reports and important information about past and current internal testing at the Restoration Facility.

4.1.8 First test of a new Restoration facility

Any Restoration Facility for which no Black-Start service contract existed in the year preceding the year in which the RSP contract was entered into or any Restoration Facility that has not passed a test in the past three years must pass a test of Black-Start capabilities as soon as possible and before the end of the first year of the RSP contract.

4.2 Limited frequency sensitive mode for over and under frequency

4.2.1 Introduction

Type B, C and D manufacturing facilities that must comply with the NC RFG must have the limited frequency sensitive mode for over-frequency.

This means an operating mode that results in a reduction of active power output in response to a change in system frequency above a certain value.

Type C and D manufacturing facilities that must comply with the NC RFG must have the limited frequency sensitive mode for under-frequency.

This means an operating mode that results in an increase in the release of active power in response to a change in system frequency below a certain value.

ELIA's System Defense Plan includes measures that invoke the limited frequency sensitive mode for over- and under-frequency of Type C and D generation facilities that must comply with the NC RFG.

Since the correct operation of this operating mode is an important measure to prevent the grid frequency from further derailing in the emergency state, and since this mode is not used during normal operation, this operating mode will be tested not only during the connection process, but also periodically during the life of the production plant.

4.2.2 Periodicity of the test

A test will be realized at least every 10 years or when the installation is substantially modified or if ELIA can prove on the basis of measurements that the LFSM O/U is not functioning correctly in accordance with the settings indicated in the connection contract.

4.2.3 Description of the test

The production unit is connected to the transmission grid, distribution grid, closed distribution grid or relevant grid during the test.

A dead band of 200 mHz around the normal mains frequency is set on the power-frequency control of the production plant.

An artificially composed alternative frequency signal is injected at the input of the power-frequency controller of the generation plant (further referred to as "the injected frequency"), where normally the actual grid frequency is made available to the controller.

LFSM-O test:

The injected active power of the generation unit is set at 100% of the maximum value or the maximum available active power for generation units operating on renewable energy (such as wind farms, for example), at the normal grid frequency.

An alternate frequency signal is then injected according to the profile shown in Figure 1:

Starting from a frequency of 50.0 Hz, a frequency step of +500 mHz is injected, maintained for 40 seconds, followed by a progressive decrease in frequency to 50.0 Hz over a period of 30 seconds.

Half a minute later, a frequency step of +1500 mHz is injected, maintained for 40 seconds, followed by a progressive decrease in frequency to 50.0 Hz over a period of 30 seconds.

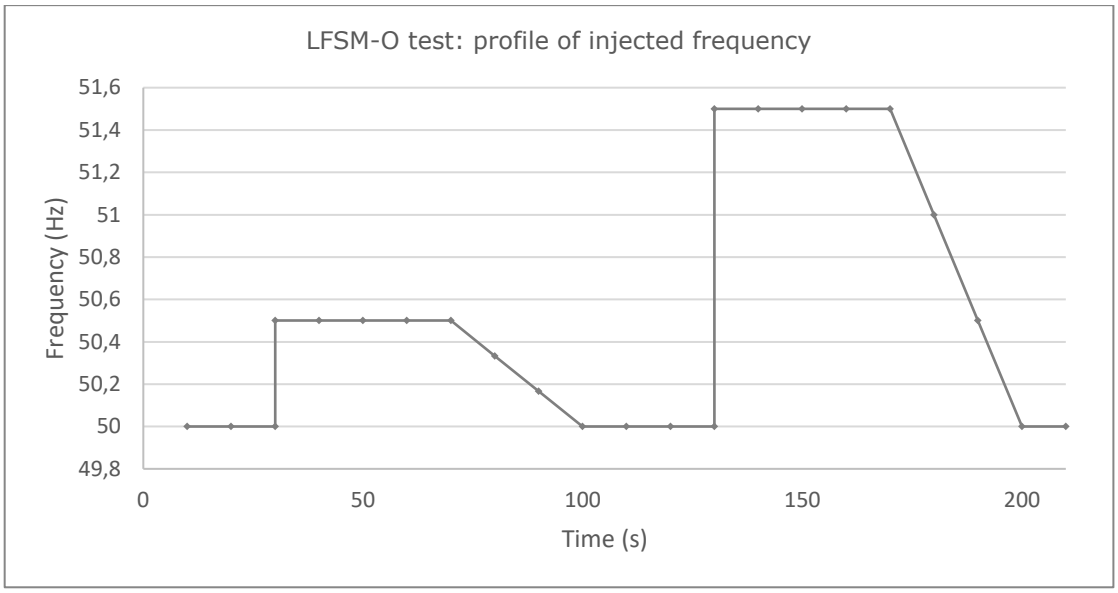

Figure 1: profile of injected frequency in an LFSM-O test.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values, presented in the form curves as a function of time will be included in the test report.

Scenarios	Td [s]	Tsr [s]	Ts [s]	P max [MW]	P av [MW]	ΔP meas [MW]	ΔP exp [MW]
50.5 Hz step							
51.5 Hz step							

Table 2: measurement results of the LFSM-O test.

The quantities listed in Table 2 are defined as follows, as shown in Figure 2:

- Dead time (**Td**): the time between sudden change in injected frequency until the active power of the production unit begins to change;
- Step response time (**Tsr**): the time between sudden change in injected frequency until the active power first reaches the tolerance limit, equal to 5% of the initial value of the active power;
- Setup time (**Ts**): the time between sudden change in injected frequency until the active power remains further within the tolerance limit, equal to 5% of the initial value of the active power.
- **P max**: the maximum active power the production unit can produce.
- **P av**: the available active power is the maximum active power made available by the driving energy source at the relevant time.
- **ΔP meas**: the difference between the measured final and initial values of active power at steady state.
- **ΔP exp**: the difference between the pre-calculated final and initial steady-state active power value.

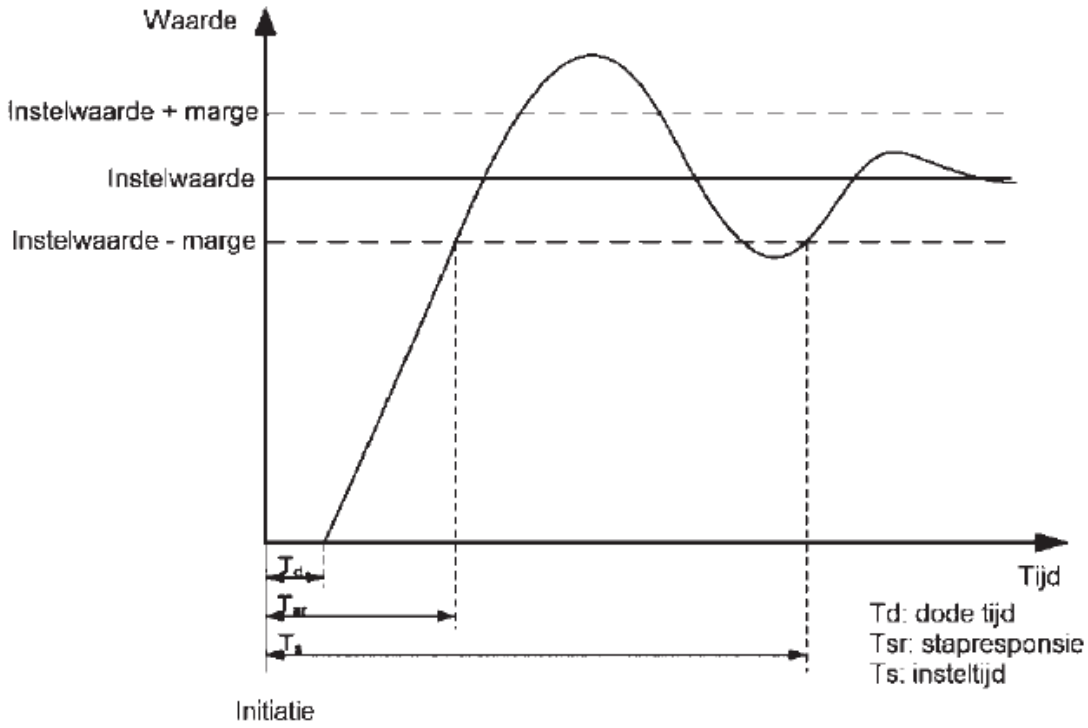

Figure 2: example of a step response illustrating the parameters to be observed

LFSM-U test:

The injected active power of the production unit is set to an initial value that depends on the injected frequency profile as shown in the following formula:

$$P_{begin} = P_{max} - 100.\frac{|\Delta f| - |\Delta f1|}{fn}.\frac{Pref}{s[\%]}$$

Pmax: the maximum active power the production unit can produce.

Δf : the frequency step being injected

Δf1: 200 mHz, the insensitivity zone within which the LFSM-U operating mode is not active.

fn: 50 Hz, the normal mains frequency

s[%]: the set statiek: 5% or if otherwise specified in the connection contract, a value chosen between 2% and 12%

Pref: the maximum active power Pmax, which the generation unit can produce or the maximum available active power for generation units operating on renewable energy (such as wind farms, for example)

Example:

Suppose one wants to test a frequency step of -1500 mHz on a 400 MW production unit, one should set the injected active power of the production unit at the beginning of the test as follows:

$$P_{begin} = 400\,MW - 100.\frac{1500\,mHz - 200\,mHz}{50000\,mHz}.\frac{400\,MW}{5} = 400MW - 208MW = 192\,MW$$

An alternate frequency signal is then injected according to the profile shown in Figure 3:

Starting from a frequency of 50.0 Hz, a frequency step of -500 mHz is injected, maintained for 40 seconds, followed by a progressive increase in frequency to 50.0 Hz over a period of 30 seconds.

Half a minute later, a frequency step of -1500 mHz is injected, maintained for 40 seconds, followed by a progressive increase in frequency to 50.0 Hz over a period of 30 seconds:

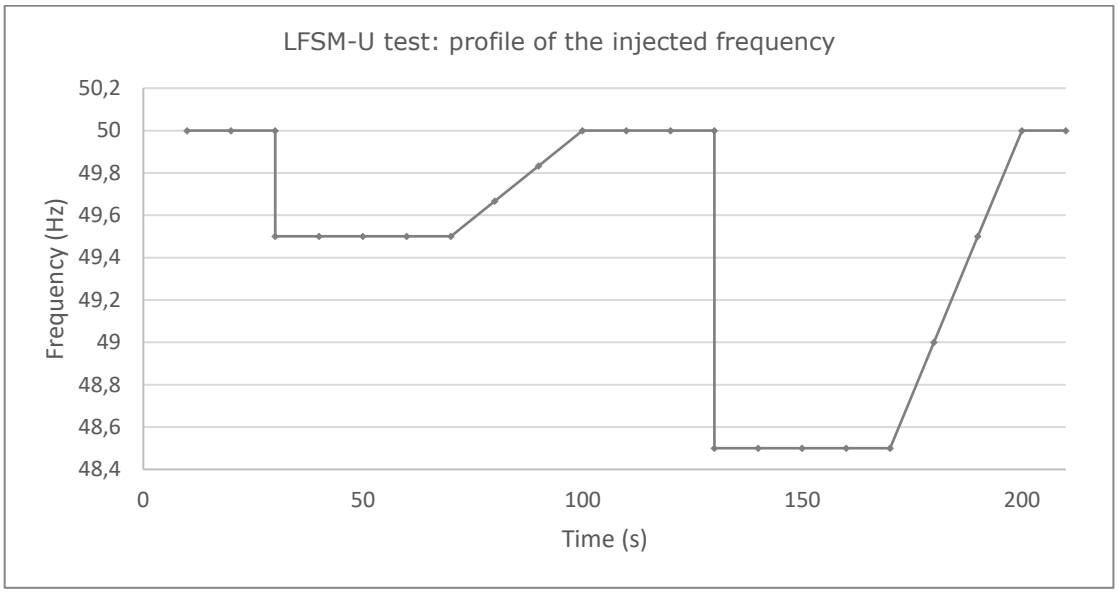

Figure 3: profile of injected frequency in an LFSM-U test.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values presented in the form curves as a function of time will be included in the test report.

4.2.4 Passing Criteria LFSM-O Test.

The LFSM-O test is passed if the following criteria are met, without prejudice to those listed in Article 88(1) of the FTR:

- The injected power of the production unit at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 50.20 Hz.
- As soon as the injected frequency rises above 50.20 Hz, the LFSM-O mode is automatically activated.
- As soon as the injected frequency increases further from 50.20 Hz to 51.00 Hz, the injected power of the production unit at the connection point decreases according to the statism specified in the connection contract (between 2% and 12%) or until the minimum control level of the production unit is reached.
- Once the minimum control level of the production unit is reached, the operating mode will be maintained at the same level (no further decrease in power with further frequency increase)
- The production unit is capable of stable operation in the LFSM-O operating mode.

- When LFSM-O is active, the LFSM-O reference value takes precedence over all other working power reference values.

4.2.5 Passing Criteria LFSM-U Test.

The LFSM-U test is passed if the following criteria are met, without prejudice to those listed in Article 88(2) of the FTR:

- The injected power of the production unit at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 49.80 Hz.
- As soon as the injected frequency falls below 49.80 Hz, the LFSM-U mode is automatically activated.
- As soon as the injected frequency decreases further from 49.80 Hz to 49.00 Hz, the injected power of the production unit at the connection point increases according to the statism specified in the connection contract (between 2% and 12%) or until the maximum control level of the production unit is reached.
- The production unit is capable of stable operation in LFSM-U operating mode.
- When LFSM-U is active, the LFSM-U reference value takes precedence over all other working power reference values.

4.2.6 Organization and preparation of the test

ELIA will inform the relevant system operator and the operator or owner of the generation unit sufficiently in advance to prepare the LFSM-O and LFSM-U tests according to the provisions of Article 4.2.3 of this Test Plan. These parties will take all measures to ensure safety during the execution of the planned tests and minimize the commercial impact for all parties.

The test date (Test Date) shall be decided jointly by ELIA, the relevant grid operator and the operator of the generating unit. If all parties do not agree on the Test Date within 30 calendar days from the start of consultation, ELIA unilaterally imposes a Test Date, unless the relevant grid operator or the operator of the generation unit can prove that this would seriously damage its assets and that other and equally effective test periods are possible.

Article 4, paragraph 8 of the NC ER applies in case of complaints and dispute resolution.

ELIA has the right to attend the LFSM-O/U test. To this end, the operator of the generation unit and, if necessary, the relevant system operator shall guarantee that ELIA has access to the generation unit.

If the LFSM-O/U test fails, ELIA, the operator of the generation unit and the relevant system operator undertake to cooperate, where possible, in the organization of a new LFSM-O/U test, within two months of the failed test.

4.2.7 Test report

The operator of the generation unit, assisted by ELIA and the relevant system operator, shall prepare a report of each completed test.

The test report contains the measurements of the injected fr equence, the active power at the output of the generation unit and the active power injected by the generation unit at the connection point (provided by ELIA), with a sufficiently high resolution.

5 Compliance testing of demand facilities

As part of the System Defense Plan and the Restoration Plan, ELIA may require demand facilities to implement the instructions contained in the System Defense Plan or the Restoration Plan.

However, these instructions cover capacities not necessarily contracted by ELIA under the System Defense Plan or the Restoration Plan. The modalities of testing with respect to capacities provided by SGUs and not contracted by ELIA are set forth in Section 8.

Notwithstanding that Article 43(3) of the NCER provides that the test plan shall establish the test frequency and conditions in accordance with the compliance testing of demand facilities providing demand response services described in Article 45, they are not included in this test plan, as the System Defense Plan does not include measures implemented by defense service providers providing demand response services.

If these defense services would be contracted in the future, a prior description of this test will be included in the test plan after consultation with the relevant (prospective) providers of these defense services and submitted to the Minister for approval after public consultation.

6 Compliance testing of HVDC- installations

Under the System Defense Plan and Restoration Plan, ELIA may require the HVDC facilities to carry out certain instructions contained in the System Defense Plan or Restoration Plan.

However, these instructions cover capacities not contracted by ELIA under the System Defense Plan or Restoration Plan.

The modalities of testing with respect to capacities provided by SGUs and not contracted by ELIA are set forth in Section 8.

Testing of the LFSM-O/U measures is performed periodically and is therefore described separately in this section.

6.1 Limited frequency sensitive mode for over and under frequency

6.1.1 Introduction

Since the correct operation of the frequency-sensitive over- and under-frequency mode is an important measure to prevent the grid frequency from further derailing in the emergency state, and since this mode is not used during normal operation, this mode of operation will be tested not only during the connection process, but also periodically during the lifetime of the HVDC installation.

For HVDC plants connecting two different synchronous zones[4] a test of the limited frequency sensitive mode for over and under frequency will be performed.

6.1.2 Periodicity of the test

At least every 10 years or when the installation is substantially changed or if ELIA can prove on the basis of measurements that the LFSM O/U is not functioning correctly in accordance with the settings indicated in the connection contract

6.1.3 Description of the test

During the test, the HVDC plant is connected at both ends to the corresponding transmission grids belonging to two different synchronous zones.

A dead band of 200 mHz around the normal grid frequency is set on the power-frequency control of the HVDC plant on the Belgian side.

An artificially composed alternative frequency signal is injected at the input of the power-frequency control of the HVDC plant on the Belgian side (further referred to as "the injected frequency"), where normally the actual grid frequency is made available to the controller.

LFSM-O test in import mode (if applicable to the installation):

The active power injected by the HVDC plant on the Belgian side is set at 100% of the maximum value, at the normal grid frequency.

[4] For HVDC installations belonging to the same synchronous zone, the LFSM O/U is not applicable

An alternative frequency signal is then injected according to the profile shown in Figure 1 in § 4.2.3.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values presented in the form curves as a function of time will be included in the test report.

LFSM-O test in export mode (if applicable to the installation):

The active power extracted by the HVDC plant on the Belgian side is set to an initial value that depends on the injected frequency profile as shown in the following formula, whose parameters are defined in §4.2.3:

$$P_{begin} = P_{max} - 100.\frac{|\Delta f| - |\Delta f1|}{fn}.\frac{Pref}{s[\%]}$$

Example: for an HVDC plant with a maximum power of 1000 MW, the initial value of active power should be set as follows, for a test using a frequency step of 1500 mHz:

$$P_{begin} = 1000\ MW - 100.\frac{1500\ mHz - 200\ mHz}{50000\ mHz}.\frac{1000\ MW}{5} = 1000MW - 520MW = 480\ MW$$

An alternative frequency signal is then injected according to the profile shown in Figure 1 in § 4.2.3.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values presented in the form curves as a function of time will be included in the test report.

LFSM-U test in import mode (if applicable to the installation):

The active power injected by the HVDC plant on the Belgian side is set to an initial value that depends on the injected frequency profile as shown in the following formula, whose parameters are defined in §4.2.3:

$$P_{begin} = P_{max} - 100.\frac{|\Delta f| - |\Delta f1|}{fn}.\frac{Pref}{s[\%]}$$

An alternative frequency signal is then injected according to the profile shown in Figure 3 in § 4.2.3.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values presented in the form curves as a function of time will be included in the test report.

LFSM-U test in export mode (if applicable to the installation):

The active power extracted by the HVDC plant on the Belgian side is set to 100% of the maximum value, at the normal grid frequency.

An alternative frequency signal is then injected according to the profile shown in Figure 3 in § 4.2.3.

The measurement results will be listed (as illustrated in Table 2) and along with the measured values presented in the form curves as a function of time will be included in the test report.

6.1.4 Passing criteria LFSM-O test in import mode

The LFSM-O test in import mode is passed if the following criteria are met, without prejudice to those listed in Article 102(5) of the FTR:

- The injected power of the HVDC system at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 50.20 Hz.
- As soon as the injected frequency rises above 50.20 Hz, the LFSM-O mode is automatically activated. The initial delay of the power-frequency response does not exceed 2 seconds.
- As soon as the injected frequency increases further from 50.20 Hz to 51.00 Hz, the injected power of the HVDC plant at the connection point decreases according to the statism specified in the connection contract (between 2% and 12%) or until 0 MW is reached.
- The HVDC plant is capable of stable operation in the LFSM-O operating mode.
- When LFSM-O is active, the LFSM-O reference value takes precedence over all other working power reference values.

6.1.5 Passing criteria LFSM-O test in export mode.

The LFSM-O test in export mode is passed if the following criteria are met, without prejudice to the criteria listed in Article 102(5) of the FTR:

- The active power extracted from the ELIA grid by the HVDC plant at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 50.20 Hz.
- As soon as the injected frequency rises above 50.20 Hz, the LFSM-O mode is automatically activated. The initial delay of the power-frequency response does not exceed 2 seconds.
- As soon as the injected frequency increases further from 50.20 Hz to 51.00 Hz, active power withdrawn from the ELIA grid by the HVDC plant at the connection point increases according to the statism specified in the connection contract (between 2% and 12%) or until the maximum control level of the HVDC plant is reached.
- The HVDC plant is capable of stable operation in the LFSM-O operating mode.
- When LFSM-O is active, the LFSM-O reference value takes precedence over all other working power reference values.

6.1.6 Passing criteria LFSM-U test in import mode.

The LFSM-U test in import mode is passed if the following criteria are met, without prejudice to those listed in Article 102(5) of the FTR::

- The injected power of the HVDC system at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 49.80 Hz.
- As soon as the injected frequency falls below 49.80 Hz, the LFSM-U mode is automatically activated. The initial delay of the power-frequency response does not exceed 2 seconds.
- As soon as the injected frequency drops further from 49.80 Hz to 49.00 Hz, the injected power of the HVDC plant at the connection point increases according to the statism specified in the connection contract (between 2% and 12%) or until the maximum control level of the HVDC plant is reached.
- The HVDC plant is capable of stable operation in the LFSM-U operating mode.
- When LFSM-U is active, the LFSM-U reference value takes precedence over all other working power reference values.

6.1.7 Passing criteria LFSM-U test in export mode.

The LFSM-U test in export mode is passed if the following criteria are met, without prejudice to those listed in Article 102(5) of the FTR::

- The active power extracted from the ELIA grid by the HVDC plant at the connection point remains constant as long as the injected frequency is between 50.00 Hz and 49.80 Hz.
- As soon as the injected frequency falls below 49.80 Hz, the LFSM-U mode is automatically activated. The initial delay of the power-frequency response does not exceed 2 seconds.
- As soon as the injected frequency drops further from 49.80 Hz to 49.00 Hz, active power withdrawn from the ELIA grid by the HVDC plant at the connection point decreases according to the statism specified in the connection contract (between 2% and 12%) or until 0 MW is reached.
- The HVDC plant is capable of stable operation in the LFSM-U operating mode.
- When LFSM-U is active, the LFSM-U reference value takes precedence over all other working power reference values.

6.1.8 Organization and preparation of the test

ELIA, the relevant system operator of the transmission system to which the other end of the HVDC facility is connected and the operator of the HVDC facility shall prepare the test according to the provisions of Article 6.1 of this Test Plan, taking all measures to minimize the commercial impact of conducting a planned test for all parties.

The date on which the test will take place (Test Date) will be decided jointly by the three aforementioned parties.

ELIA shall have the right to attend the LFSM-O/U test. To this end, the operator of the HVDC facility warrants that ELIA has access to the HVDC facility.

If the LFSM-O/U test fails, three aforementioned parties undertake to cooperate, where possible, in organizing a new LFSM-O/U test, within two months of the failed test.

6.1.9 Test report

The operator of the HVDC plant, assisted by ELIA and the relevant system operator of the transmission system to which the other end of the HVDC plant is connected, shall prepare a report of each completed test.

The test report contains the measurements of the injected frequency, the active power exchanged between the HVDC installation and the connection point with the transmission grid on the Belgian side, with a sufficiently high resolution.

7 Compliance test of low frequency demand disconnection (LFDD) via relay

7.1 Introduction

Each TSO, public DSO and CDSO shall conduct tests on the decoupling of demand at low-frequencys via relays in its facility in accordance with the minimum requirements established in Article 47 of the NC ER and in accordance with the methodology established in Article 37(6) and Article 39(5) of the NC DCC for facilities required to comply with the NC DCC.

In the absence of a methodology in the national legislation for testing relays for interrupting "existing" demand facilities at low-frequencies, ELIA defines in this test plan, the test conditions and frequencies for existing demand facilities, which do not have to comply with Articles 37(6) and 39(5) of the NC DCC.

ELIA is authorized to do so, in accordance with Article 43(1) and (2) of the NC ER, which states that each TSO shall periodically review the proper operation of **all equipment and tools** in the System Defense Plan and restoration plan and specify this in a test plan.

In accordance with Article 184 of the FTR, ELIA reached an agreement with the grid user concerned, in this case the public DSO concerned, after consultation, on the procedure described in this chapter for conducting the tests of relays for interrupting consumers at low frequency. This agreement was recorded in the SOK between ELIA and the DSO. If relevant, such agreement between Elia and a relevant CDSO is recorded in the connection agreement between ELIA and the CDSO.

As stated in Article 37(6) and Article 39(5) of the NC DCC, that test of the LFDD relays must demonstrate that the transmission-connected distribution facility/demand facility is technically capable of operation at a nominal AC supply voltage specified by ELIA.

ELIA provides three tests to assess compliance of LFDD relays on **both existing and new** TSO, public DSO or CDSO facilities.

1. A **qualification test performed** prior to installation of the LFDD relay.
2. A **commissioning test performed at least** when installing a new LFDD relay.
3. A **periodic test performed** at least every 10 years if the relay has not been tested during that period.

Each party shall bear its own personnel costs and any other costs for conducting the test on its facilities.

7.2 Qualifying test

Before a new type of LFDD relay is installed, it will be subjected to a qualification test. This qualification test will assess whether the LFDD relay meets the specifications as stated by the manufacturer. The test will be performed before the LFDD relays are installed.

The following characteristics are tested:

- Measurement of threshold accuracy
- Measurement of relay operating time in the event of a sudden frequency drop

- Measurement of relay operating time in frequency drop with different rates of change (ramps)
- Blocking the frequency function with minimum voltage
- Control of relay behavior in the presence of harmonics and a CAB control signal
- Control of relay behavior in the event of a sudden vector jump
- Control of relay behavior at unbalanced voltage
- Checking the anti-aliasing filtering of the relay
- Control of behavior when injecting records in 'Comtrade' format
- Checking the operation of the LEDs
- Checking the initialization time
- Checking the bounce response of the relay trip contacts
- Control of operation time response when one or two phase ground voltages are lost

7.3 Commissioning test

The commissioning test verifies the compliance of newly installed LFDD relays using a frequency drop test.

The commissioning test is carried out after the installation of a new LFDD relay on an existing or new consumer system.

External frequency signals are injected into the LFDD relay to verify that the shutdown command is correctly sent and received by the relevant interrupters or interface cabinet, within the acceptable response time.

The commissioning test is considered successful if:

- The measured response time is less than 150 ms, as stated in Article 19(1)(c) of the NC DCC. The response time refers to the operating time of the LFDD relay including the time for measurement and calculation of the relay. The interrupter opening time is not counted in the response time.
- No bounce phenomenon was observed (making and breaking contact repeatedly over a short period of a few seconds to end in a given, closed or open, position)

7.4 Periodic test

The periodic test verifies the compliance of already installed LFDD relays using a frequency drop test. A distinction is made for installations covered by the NC DCC (new installations) and those not covered by the NC DCC (existing installations):

For facilities that do fall under the NC DCC, the periodic test is considered passed if:

- The measured response time is less than 150 ms, as stated in Article 19(1)(c) of the NC DCC. The response time refers to the operating time of the LFDD relay including the time for measurement and calculation of the relay. The interrupter opening time is not counted in the response time.

- No bounce phenomenon was observed (making and breaking contact repeatedly over a short period of a few seconds to end in a given, closed or open, position).

For facilities not covered by the NC DCC, the periodic test is considered passed if:

- The measured response time, as defined above, is lower than the maximum value used during the commissioning test of the corresponding relay.
- No bounce phenomenon was observed (making and breaking contact repeatedly over a short period of a few seconds to end in a given, closed or open, position).

The owner of the equipment must conduct a periodic test at least every 10 years. The TSO and the relevant public DSO and/or CDSO should coordinate the organization of this test.

If a frequency drop test was performed on the relay in a maintenance context, the 10-year period begins on the date of the performance of that test.

8 Compliance testing for SGUs without a contract for defense or restoration services

Chapter 4 of both the System Defense Plan and the Restoration Plan contains a list of SGUs designated pursuant to Article 11(4) and Article 23(4) of the NC ER, whose capacities may be used by ELIA to implement defense and/or restoration measures, without the need for a contract between ELIA and the person responsible for these facilities for the provision of these services.

For the designated SGUs not covered by the NC RfG, NC HVDC or NC DCC (existing plants) that are required to activate defense or restoration measures at the request of ELIA without a contractual basis, the adequacies were tested in the past during the compliance verification and periodic compliance check described in the connection contract.

The testing modalities are described in the connection contract and its annexes as mentioned in Article 169 paragraph 2 of the FTR. ELIA's requests when the grid is in a state of emergency or in a state of blackout or Restoration will not go against the capacities tested during the connection process and will take into account the technical limits specified in the connection contract.

For those designated SGUs that do fall under the NC RfG, NC HVDC or NC DCC and are required to activate defense or restoration measures at the request of ELIA without a contractual basis, the adequacies specified in the aforementioned grid codes will be tested during the connection process.

ELIA will not impose defense or restoration measures that exceed the capacity of the installation(s) specified in the connection contract.

The capabilities of a facility that will be utilized for defense and Restoration services include:

- The injection or decrease of active and reactive power across the entire operating domain of the plant.
- Remaining connected to the grid as long as the grid frequency and voltage at the tie point remain within the limits specified in the FTR.
- Disconnecting the installation from the grid as soon as the criteria for disconnection are met.

Since these capacities of a plant, whose compliance was verified during the connection process, are assumed to be able to be utilized to provide defense or restoration measures during the plant's lifetime, no additional tests are specified in this Test Plan to verify these capacities repeatedly, with the exception of the LFSM-O/U operating mode, as specified in Sections 4.2 and 6.1.

In the event that the installations are substantially modified, the grid user must notify ELIA and ELIA will assess whether new tests are required.

In accordance with Article 183 of the FTR, for reasons related to the security, reliability or efficiency of the transmission system, the transmission system operator may at any time verify the conformity of the connection and of a transmission system user's facilities. For this purpose, in case of suspicion that the installations of the transmission system user do not comply with the conformity, the transmission system operator may perform tests on these installations itself or have them performed by the transmission system user.

Cost sharing for these tests shall be regulated in accordance with Article 185 of the FTR.

9 Testing of communication systems (NC ER art 48)

9.1 Testing of voice communication devices

The SGUs designated under Article 23(4) of the NC ER, which are included in the Restoration Plan as well as each public DSO, each Restoration service provider, Coreso[5] and ELIA test the communication systems defined in Article 41 of the NC ER at least every year.

These are voice communication systems with sufficient backup equipment and backup power sources so that at least 24 hours of Restoration Plan information can be exchanged if the external power supply fails completely or the individual equipment of the voice communication system fails.

ELIA uses voice-over-IP telephone connections connected to ELIA's internal data communication network for voice communication applications between ELIA's various sites such as posts (including posts considered essential to the Restoration Plan), control centers, service centers, administrative sites, etc. All public DSOs, Coreso, all Restoration service providers and some SGUs also have one or more voice-over-IP telephone connections connected to ELIA's internal data communications network. In the coming years, the remaining SGUs will be invited by ELIA to establish such voice communication links.

ELIA will a priori use its internal Datacom network for voice communications between its own sites, so this system will be tested on an ongoing basis.

At least once a year, at pre-arranged times, a voice communications test will be organized between ELIA operators in the control centers, on the one hand, and the operations manager of each public DSO, Coreso, each Restoration service provider and designated SGUs that has a voice-over-IP telephone connection connected to ELIA's internal data communications network, on the other hand.

ELIA records the time of such test, indicating whether the test was passed or failed.

VOIP telephone connections in ELIA stations are regularly tested in real situation to communicate with ELIA dispatching. In case of communication failures, an analysis will be made to determine the causes of the failure and appropriate measures will be taken to restore communication.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

9.2 Testing the backup power supply of voice communication systems

The SGUs designated pursuant to Article 23(4) of the NC ER, included in the Restoration Plan as well as each public DSO, each Restoration service provider and ELIA shall test the backup power supply of the communication systems defined in Article 41 of the NC ER at least every five years.

Each named entity performs a test in which the power supply of all active and passive components involved in the voice link is disconnected from the external mains supply and taken over by a backup power supply. The correct operation of the voice communication link

[5] Coreso is the regional security coordinator (RSC)

is also tested in this process. Each named entity records the time of such test, indicating whether the test was successful or not.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

9.3 Tests on notifications Emergency ELIA , Blackout ELIA, Grid Restoration ELIA

In accordance with Article 40.2 of the NC ER, ELIA must notify its stakeholders of the system state if it is in an emergency, blackout or Restoration state. In order to accomplish this, ELIA has provided a system that uses multiple communication channels to send subsequent notification signals:

- Emergency ELIA
- Blackout ELIA
- Grid Restoration ELIA

The test is designed to:

- Verifying that the system is working correctly
- Make the various parties using the service aware of its existence
- Keep the contact database current

9.3.1 Sending notifications via text message or e-mail

The sending of notifications via text or e-mail is tested every year. During a test, only one of the three notifications will be tested. The other notifications will be tested in subsequent test periods.

The tests are organized as follows:

- ELIA will send an SMS/e-mail to all parties using SMS or e-mail to notify the time period when the system will be tested.
- ELIA sends the notification. The message explicitly states that it is a test.

The test of the system is considered successful when:

- ELIA does not receive a "delivery failure."
- No party using the service contacts ELIA to report that they did not receive the text message or email.

If the test is not a complete success (only some of the actors did not receive notification), the parties using the service and ELIA will verify that the contact information was correctly entered into the database.

If the test fails (no party received the notification), ELIA will analyze its system in depth to identify the cause of the problem and will take the necessary measures to resolve the issue.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

9.3.2 Transmission of notifications via a SCADA signal

The transmission of notifications via a SCADA signal is tested every month. During a test, only one of the three notifications will be tested. The other notifications will be tested in subsequent test periods.

The tests are organized as follows:

- ELIA will alert SCADA users a month in advance via e-mail about the exact period of the test.
- ELIA sends the notification. During the test, the same SCADA signal as in a real situation is used.
- The SCADA stakeholder automatically sends a response upon receipt of the notification
- The SCADA stakeholder manually acknowledges receipt of the notification by sending the corresponding signal

The test is considered successful when all SCADA stakeholders have automatically and manually acknowledged receipt of the notification.

If the test is not a complete success (only some of the actors did not receive a notification), ELIA will call the SCADA stakeholders who did not acknowledge receipt of the notification within five minutes to clarify the problem and take necessary action.

If the test fails (no party received the notification), ELIA will analyze its system in depth to identify the cause of the problem and will take the necessary measures to resolve the issue.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

10 Testing of tools and facilities (NC ER Art. 49)

10.1 Testing of main and backup power sources for ELIA's main and backup control centers

ELIA tests at least annually the adequacy of the main and backup power sources for the control centers in Schaarbeek, Merksem and Créalys, which also act as each other's backup control centers.

ELIA has an internal procedure for testing the emergency generators of the control centers in Schaarbeek, Merksem and Créalys. This procedure can be viewed by the competent authorities upon request to ELIA, but is not submitted for approval together with this Test Plan.

ELIA will bear the cost of the test.

10.2 Tests related to substations deemed essential to Restoration Plan procedures

The Restoration Plan contains a list of substations deemed essential to the Restoration Plan procedures that are expected to remain operational for at least 24 hours if the primary power supply fails.

Some substations are already equipped and some will be equipped in the coming years with an emergency diesel or battery with an autonomy of at least 24h. ELIA organizes a startup test of these emergency diesels every month. In order not to unnecessarily compromise grid safety, ELIA limits itself to carrying out a startup test of the diesels, with the substation's auxiliary supplies remaining powered in the normal way.

ELIA will bear the cost of the test.

10.3 Testing on moving the main control center to the backup control center

ELIA has an internal procedure for moving from the main control center to the backup control center. This procedure can be viewed by the competent authorities upon request to ELIA, but is not submitted for approval along with this Test Plan.

This procedure is applied by each operator of the main control center at least once a year. ELIA records the time of such tests, indicating whether or not the test was passed.

ELIA will bear the cost of the test.

11 Testing the defense measure "U-5%"

11.1.1 Introduction

The "Control Load" measure is included in the System Defense Plan (Section 7.4) with the intention of reducing the voltage on the secondary side of distribution transformers by 5%,

in order to briefly reduce the consumption of active power[6] in distribution networks, with limited impact on the end user.

In the absence of a methodology in the national legislation and in the NC DCC for testing the measure "Control Load" on demand facilities, ELIA determines in this test plan, the test conditions and frequency.

ELIA is authorized to do so, in accordance with Article 43(1) and (2) of the NC ER, which states that each TSO shall periodically review the proper operation of **all equipment and tools** in the System Defense Plan and restoration plan and record this in a test plan.

In accordance with Article 184 of the FTR, ELIA reached an agreement with the relevant network user, in this case the relevant public DSO, after consultation, on the procedure described in this chapter for the implementation of the tests of the measure "Control load". This agreement was recorded in the SOK between ELIA and the DSO. If relevant, such agreement between Elia and a CDSO is recorded in the Connection Agreement between ELIA and the CDSO concerned.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

11.1.2 Periodicity of the test

This "Load Control" measure is tested every five years on a clearly defined item of the grid, in consultation between ELIA and the relevant DSOs and, if relevant, the relevant CDSOs.

11.1.3 Description of the test

Before starting the test, the active power on the secondary side of the transformer(s) shall be measured at a sufficiently high resolution for at least 30 minutes. Taking into account the continuous variations of the power, a reference value is calculated from this.

The signal is tested as follows:

1. ELIA and the relevant DSO or the relevant CDSO, if relevant, select the transformer substation affected by the U-5% signal. Preferably, a substation is selected from which mainly domestic consumers are fed, where the load is resistive in nature.
2. ELIA and the affected DSO or the affected CDSO, if relevant, reconfigure the signal U-5% used for the test to perform the test only at the affected transformation station.
3. ELIA shall activate the test signal at the time previously defined by ELIA and the DSO or CDSO concerned, if relevant.
4. ELIA and the DSO or CDSO involved, if relevant, shall restore the original configuration.

11.1.4 Passing criteria of the test

For a primarily resistive load, active power is expected to decrease by 9% when the voltage decreases by 5%. In practice, the load is not purely resistive and not completely constant during the duration of the test.

The test is considered successful if the instruction given through ELIA's management system leads to an adjustment of tap positions of the distribution transformer(s) concerned in the

[6] The active power consumption of asynchronous motor load will remain quasi constant if the voltage drops by 5%.

right direction so that a clear load drop compared to the reference value can be observed in the first five minutes after activation of the U-5% signal.

If multiple test on different substations over time show that the impact on active power is less than 5%, this defense action should be questioned.

12 Testing provisions for automatic resynchronization

During system restoration, as soon as two asynchronous zones can be resynchronized the synchronization leader will select a substation equipped with an asynchronous coupler, as described in section 10.1 of the restoration plan. Proper operation of an asynchronous coupler is important so as not to delay grid restoration.

ELIA assesses the conformity of the automatic resynchronization facility. There are four tests to assess the conformity of automatic resynchronization facilities:

- A **qualification test** that takes place before the equipment is ordered from the supplier to verify that the quality and performance do match what ELIA expects from this equipment;
- A **pre-FAT test performed** at the factory by the supplier to verify that the equipment to be delivered does indeed meet the specifications provided by ELIA;
- A **FAT test** performed by ELIA to confirm the results of the pre-FAT test performed by the supplier.
- An **actual no-load test** performed by ELIA when the facility is connected to verify that the facility is connected correctly.

The following is a non-exhaustive list of the components tested:

- Measurement as appropriate of the on and off values
- Measurement of delays
- Checking the indicator lights
- Control of the alarms specific to the relay (such as the alarm faulty power supply, the alarm faulty relay, mains imbalance ...)

Facilities for automatic resynchronization are also regularly used during any restoration of transformer voltage after a planned or unplanned power outage. These devices are also monitored continuously. In the event of a failure, an alarm is triggered.

In the event of an alarm indicating a malfunction or a detected malfunction, ELIA performs an in-depth analysis to identify the cause of the problem and restoration or replace the faulty equipment.

Each party shall bear its own personnel costs and any other costs of conducting the test on its facilities.

13 Definitions and acronyms

Black-start capabilities: 'black-start capabilities' as defined in Article 2(45) of the NC RFG, namely "the ability of an power generating module to restore after a total shutdown, using a dedicated emergency power supply without any supply of electrical energy from outside the generating plant."

CAB = Central remote control: a signal with a frequency above 50 Hz sent by DSOs over the distribution network to control certain demand facilities (street lighting, accumulation heating,...) or to send specific signals (change day/night tariff).

CDSO= Closed Distribution System Operator.

CE 11 AHDR: Working group of Synergrid: 'Comité Electrique 11 Disconnect, Rebuild, Délestage, Reconstruction'

CIPU = Coordination of the Injection of Production Units Contract: "The Coordination of the Injection of Production Units Contract entered into with ELIA, or the regulated contract(s) replacing the CIPU Contract, in accordance with the provisions of Article 4 and Article 377 of the FTR.

CREG = Commission for the Regulation of Electricity and Gas

DSO = distribution system operator. When this document refers to a DSO, it means the operator of a public distribution system. To avoid misunderstanding, a CDSO is not to be understood in this document as a subset of DSOs. Requirements for CDSOs are explicitly stated.

DSP = Defense Service Provider: "defense service provider" as defined in Article 3(1) of the NC ER, namely a "legal entity with a legal or contractual obligation to provide a service that contributes to one or more measures of the System Defense Plan.

FTR = Federal Technical Regulation: the Royal Decree of April 22, 2019 on technical regulations for the management of the electricity transmission grid and access to it.

FRR = Frequency Restoration Reserves: operational reserves to restore frequency and system imbalance to their normal value. Central control. Automatic or manual activation within 15 minutes

Houseload operation: "Houseload operation" as defined in Article 2, Section 44 of the NC RFG, namely "the operation that ensures that power generation units can meet their own energy needs when a system failure results in the disconnection of the power generation units from the system and switch to operation on their own auxiliaries.

Island operation means "island operation" as defined in Article 2, Section 43 of the NC RFG, namely "the independent operation of an entire network or part of a network that is isolated after being disconnected from the interconnected system, with at least one power generation unit or HVDC system supplying power to this network and regulating frequency and voltage.

LAN = Local Area Network

LFC zone: Load Frequency Control zone. For Belgium, this is ELIA's control zone.

LFDD = Low Frequency Demand Disconnection (low frequency automatic demand disconnection control).

LFSM-O =Limited Frequency Sensitive Mode - Overfrequency: limited frequency sensitive mode for overfrequency, means an operating mode for power generation modules or HVDC systems that results in a reduction of active power output in response to a change in system frequency above a certain value.

LFSM-U =Limited Frequency Sensitive Mode - Underfrequency: limited frequency sensitive mode for underfrequency, means an operating mode for power generation modules or HVDC systems that results in an increase in active power output in response to a change in system frequency below a certain value.

Minister of Energy: The minister or secretary of state with responsibility for energy matters.

NCC = National Control **Center**

NC DCC = Network Code Demand Connection. COMMISSION REGULATION (EU) 2016/1388 of 17 August 2016 establishing a network code for consumer connection

NC ER = Network Code Emergency and Restoration. COMMISSION REGULATION (EU) 2017/2196 of November 24, 2017 establishing a Network Code for Emergency and Restoration of the Electricity Grid.

NC HVDC = Network Code HVDC: COMMISSION REGULATION (EU) 2016/1447 of 26 August 2016 establishing a network code on requirements for grid connection of high-voltage direct current systems and DC-connected power park modules

NC RfG = Network Code Requirements for Generators: COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 adopting a network code on requirements for connection of electricity generators to the grid.

PGM = Power Generating Module (power generation unit).

RCC = Regional Control **Center**

Restoration Facility: electricity generating facility with one or more PGMs connected to the same transmission system connection point capable of providing a specified Restoration Service.

Restoration Plan means "Restoration Plan" as defined in Article 3(5) of the NC ER, namely "all technical and organizational measures necessary to restore the normal state of the system.

RSP= Restoration Service Provider: "restoration service provider" as defined in Article 3(2) of the NC ER, namely "legal entity with a legal or contractual obligation to provide a service that contributes to one or more measures of the restoration plan.

RSP Contract: contract between ELIA and a Restoration Service Provider providing Restoration Service under the General Terms and Conditions to act as Restoration Service Provider.

SCADA = Supervisory Control and Data Acquisition

SGU = Significant Grid User.

SOGL = System Operations Guideline. European Commission Regulation (EU) 2017/1485 of August 2, 2017 establishing guidelines on electricity transmission system operation.

Synergrid: Federation of gas and electricity transmission and distribution system operators.

TSO = Transmission System Operator: the transmission system operator operates the high-voltage grid and is responsible for the transmission of electricity. Electricity is transmitted through the high-voltage grid from generators to distribution system operators and large industrial consumers. To perform these tasks, the transmission system operator is also responsible for operating the system. Here, the transmission system operator is the entity responsible for providing access to the grid, monitoring flows and ensuring the uninterrupted management of the balance between generation and consumption.

T&C RSP = Terms and Conditions to act as Restoration Services Provider.