EXPLANATORY NOTE RELATED TO THE TEST PLAN

15/09/2020

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1. Practical information

On the 22nd of November 2019, a first draft of the test plan was submitted to the Minister of Energy for approval as required by Regulation EU 2017/2196 establishing a network code on electricity emergency and restoration (NC ER).

On the 15th of April 220, the Minister of Energy partially approved the test plan by ministerial decree, namely the part relating to the Black Start tests.

In the same ministerial decree, ELIA was requested to introduce a new adapted version of the rest of the test plan by the 1st of November 2020 at the latest.

This note aims to contextualize this new updated version of the test plan that will be submitted to the Minister of Energy.

At the end of the public consultation on this updated version (from 15 September 2020 to 15 October 2020), all comments will be made public on ELIA's website, with an explanation of how ELIA responded to these remarks or the reasons why they were not considered. ELIA will respect the potential requests of confidentiality and/or anonymity of respondents.

Please note that comments concerning items outside the scope of the documents will not be considered by ELIA.

Questions and / or other remarks concerning the documents concerned can be sent to the following email address: consultations@elia.be.

2. Introduction

Regulation (EU) 2017/2196 establishes requirements for the management, coordination and operation of the network in the European Union in a state of emergency, blackout or restoration (NC ER). These requirements are intended to maintain operational safety and prevent the spread of an incident on the power grid that could result in a widespread failure.

In accordance with this regulation, and Article 259 of the Federal Grid Code (FGC), ELIA submitted a first version of the test plan (in Dutch and French) for approval to the minister of Energy on the 22nd of November 2019.

The Minister of Energy decided to partially approve the test plan, namely the part relating to the black-start tests. This decision was acted in the ministerial decree of the 15th of April 2020 approving the test plan in accordance with Article 259 of the royal decree of April 22nd 2019 establishing a federal grid code for the electricity transport grid operation and the access to it. According to this ministerial decree, ELIA has to submit an updated version 6 months after the publication of the ministerial decree, namely on the 1st of November 2020 at the latest.

Consequently, ELIA adapted the test plan in accordance with the comments of the Minister of Energy in the ministerial decree and the comments of the CREG in its advice (A)2065 of the 11th of March 2020. The section related to the black-start service of power generating units has not been updated as this part has been approved by the Minister of Energy.

ELIA makes this new updated version of the test plan available for public consultation during a period of one month according to Article 7 of Regulation (EU) 2017/2196. The consultation period starts on the 15th of September 2020 and ends on the 15th of October 2020.

In case the System Defence Plan or the Restoration Plan are updated and rely on new services, a new version of the test plan will be submitted for approval.

3. Legal framework

The test plan is elaborated by ELIA, taking into account the prescriptions of Commission Regulation (EU) 2017/2196 of 24 November 2017 establishing a network code on electricity emergency and restoration (NC ER) and taking into account relevant legislation (national federal grid code, (FGC)) as well as possible local specificities and other Network Codes (NC). These other NC are:

- Regulation (EU) 2016/631 establishing a network code on requirements for grid connection of generators (NC RfG);
- Regulation (EU) 2016/1388 establishing a Network Code on Demand Connection (NC DCC);
- Regulation (EU) 2016/1447 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules (NC HVDC).

The test plan follows the methodology laid down in the NC RfG, in the NC HVDC and in the NC DCC for the corresponding tested capability. However, for the SGUs that do not resort under these codes, namely the existing units, the NC ER foresees that the test plan shall follow the provisions of national law.

When no methodology to test equipment or capabilities required in the System Defence Plan and/or Restoration plan is given in the NC RfG, NC DCC, NC HVDC or in the national legislation, ELIA defines the methodology described in the test plan in accordance with article 43(1) and 43(2) of the NC ER. In such cases, Elia and the involved grid users agreed on the procedure, programming and means to be used for the execution of such test(s) in accordance with article 184 of the FGC.

The System Defence Plan and Restoration Plan does not impose requirements that exceed the capabilities of the SGUs identified in Article 11(4) and 23(4) of the NC ER.

The test plan of ELIA identifies equipment and capabilities relevant for the System Defence Plan and the Restoration Plan that have to be tested. The test plan also describes the tests that should be executed for the relevant equipment.

4. Explanation on the test plan

4.1. Introduction

The test plan aims to identify equipment and capabilities relevant for the System Defence Plan and Restoration Plan that have to be tested. Article 43(3) of NC ER gives more details on the test plan's content and stipulates that the test plan shall include the periodicity and conditions for the test outlined in Article 44 to 47 of NC ER. These articles relate to:

- Power Generating Modules delivering black start and/or quick resynchronisation services (Article 44)
- Demand facilities providing demand side response (Article 45)
- HVDC system delivering a black start service (Article 46)
- Low frequency demand disconnection relays (Article 47)

The ministerial decree and the advice of the CREG ask ELIA to provide an exhaustive list of the equipment and capabilities that are used in the System Defence Plan and/or Restoration Plan. Consequently, test description and periodicity have been added for the following equipment and capabilities:

- LFSM-U and LFSM-O for production units and HVDC units
- Communication systems (Article 48 of NC ER)
- Equipment and installations related to the transport grid operation including the transfer procedure from the main and back up control room (Article 49 of NC ER)
- Reduction of active power consumption in distribution systems by reducing the voltage reference value by 5%
- Automatic resynchronisation devices

Besides these equipment and capabilities and according to the ministerial decree and the advice of the CREG, ELIA was asked to provide a test description and a test periodicity for capabilities that might be applied for defence or restoration measures, but which are not necessarily explicitly contracted by ELIA. Many of these capabilities are used in daily operation (change of the active power setpoint, additional voltage/reactive power support …). For such frequently used capabilities, ELIA relies on the compliance tests realized during the commissioning of the units, unless the units are significantly modified or in case ELIA observes indications of non-conformities, in which case an additional test might be imposed. A dedicated paragraph has been added in section 8 of the test plan to comply with this requirement.

4.2. Compliance testing of Power Generating Modules capabilities

According to Article 44 of NC ER, the test plan should contain a test for the following services provided by PGMs, which are RSPs:

- Black start service
- Quick resynchronisation service.

ELIA also proposes a test methodology for LFSM-U and LFSM-O capabilities for transmission connected PGMs of type C and D that resort under the NC RfG because these capabilities are used only in emergency situations.

Other non-contracted capabilities used in daily operations are tested according to the conformity test described in the connection agreement and its appendices.

4.2.1. Black-start services

This section has not been updated as the minister of energy approved it in the ministerial decree of April 15th 2020 on the approval of the test plan proposal according to Article 259 of the Royal Decree of April 22nd 2019 establishing a technical code for the electricity transport grid operation and the access thereto.

4.2.2. Quick resynchronisation services

In the current version of the Restoration Plan, ELIA does not contract quick resynchronisation services. Hence, no test is described for such services in this version of the test plan. However, according to Article 15(5)(c) of NC RfG, PGM of type C & D shall be capable of quick resynchronisation in line with the protection strategy agreed between the relevant system operator, ELIA and the power generating facility.

As this equipment is also used to resynchronize the unit after an outage, there is no need to foresee periodical test in addition to the conformity test specific in the connection contract. Indeed, as this equipment is used in normal operation, a potential defect would be rapidly detected & solved.

If, in the future, ELIA contracts restoration services which are PGM providing a quick resynchronization service, a test procedure will be developed considering the minimal requirements laid down in Article 44(2) of the NC ER, Article 45(6) and Article 15(5)(c) of the NC RfG. In that case, a new version of the test plan will be submitted for approval.

4.2.3. LFSM-O capability of PGM

The LFSM-O is a capability required by the NC RfG. By consequence, the proposed test applies only for new transmission connected PGMs of type C and D. Existing units are therefore not concerned by this test. This capability is not contracted in the framework of the System Defence Plan and/or Restoration Plan. However, as it is used only in emergency situations, a test with a periodicity of 10 years is deemed necessary. In case of important modification of the installation, an additional test can also be required by ELIA.

The proposed test consists of measuring the power output following a steep frequency increase as shown in Figure 1. As an initial condition for the test, the PGM will inject the maximum available power in order to have sufficient power reduction potential for the appropriate reaction to the increased frequency signal.

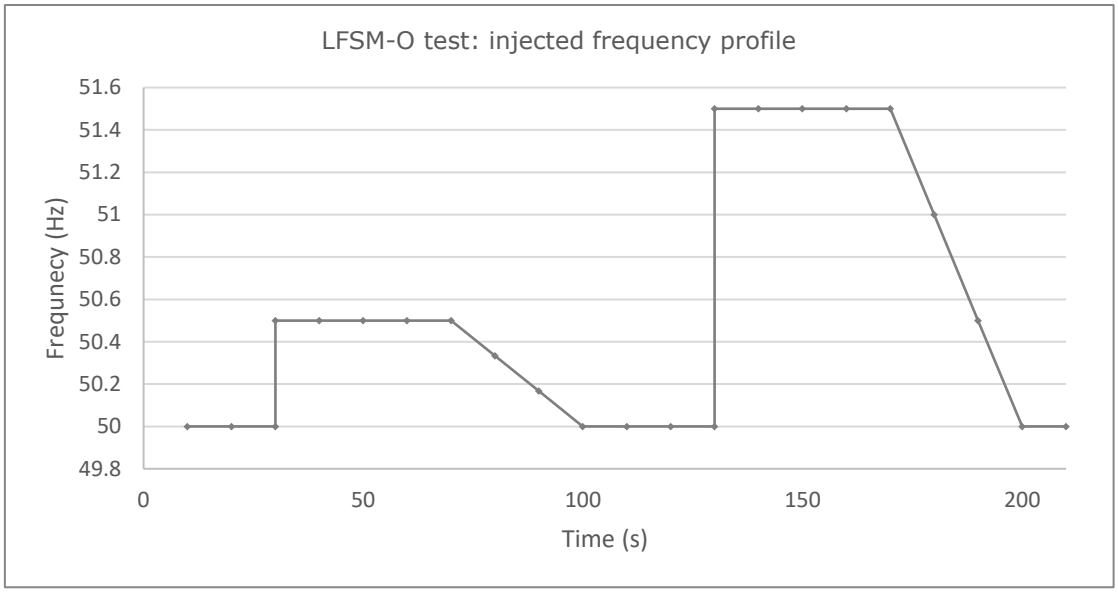

Figure 1: Frequency profile injected during a LFSM-O test

The profile consists of the following steps:

- **A first step to 50.50 Hz during 40 seconds:** The duration of 40 seconds aims to give sufficient time for the injected power of the PGM to stabilize. This first step aims to trigger a moderate reaction and verify that the system works before triggering a larger reaction with a larger frequency increase.
- **A frequency decrease up to 50.00 Hz lasting 30s**: This part aims to observe the answer of the PGM when the frequency decreases and to verify that the LFSM-O is deactivated when the frequency drops below 50.20 Hz.
- **A plateau at 50.00 Hz lasting 30 s:** This plateau ensures that the power injected by the PGM is stabilized before the second step.
- **A second step to 51.50 Hz during 40 seconds**: The duration of 40 seconds aims to give sufficient time for the injected power of the PGM to stabilize. The threshold of 51.50 Hz corresponds to the maximum frequency for which a PGM has to be capable of operating during minimum 30 minutes according to Table 2 of the NC RfG.
- **Another frequency decrease up to 50.00 Hz**: This part aims to observe the response of the PGM when the frequency decreases and to verify that the LFSM-O is deactivated when the frequency drops below 50.20 Hz.

4.2.4. LFSM-U capability of PGM

The LFSM-U is a capability required by the NC RfG. By consequence, the proposed test applies only for new units. This capability is not contracted in the framework of the System Defence Plan and/or Restoration Plan. However, as it is used only in emergency situations, a test with a periodicity of 10 years is deemed necessary. In case of important modification of the installation, an additional test can also be required by ELIA.

The proposed test consists of measuring the power output following a steep frequency decrease as shown in Figure 2.

The initial active power setpoint for the test is defined according to the following formula:

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

Where

Pmax: The maximum active power that the PGM is able to produce

Δf: The injected frequency drop.

Δf1: 200 mHz, the dead band zone in which the LFSM-U is inactive

fn: 50 Hz, the normal grid frequency

s [%]: The given droop value: 5% or, when specified differently in the connection contract, a value chosen between 2% and 12%.

Pref: the maximal active power Pmax that the PGM can produce or the maximum available power for units working based on renewable energy (e.g. wind parks).

This formula ensures that a sufficient margin is available for the LFSM-U test.

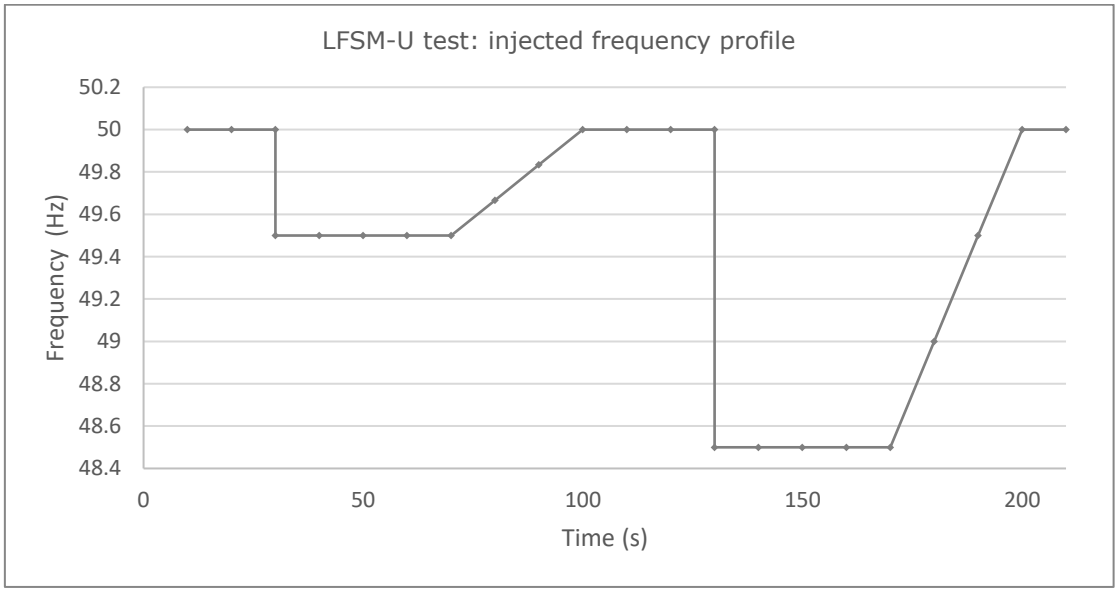

Figure 2 : Frequency profile injected during a LFSM-U test

The profile consists of the following:

- **A first frequency drop to 49.50 Hz during 40 seconds:** The duration of 40 seconds aims to have sufficient time for the injected power of the PGM to stabilize. This first step aims to trigger a moderate reaction and to verify that the system works before triggering a larger reaction with a larger frequency decrease.
- **A frequency increase up to 50.00 Hz lasting 30s**: This part aims to observe the answer of the PGM when the frequency increases and to verify that the LFSM-U is deactivated when the frequency goes beyond 49.80 Hz.
- **A plateau at 50.00 Hz lasting 30 s:** This plateau ensures that the power injected by the PGM is stabilized before the second frequency drop.
- **A second frequency drop to 48.50 Hz during 40 seconds**: The duration of 40 seconds aims to have sufficient time for the injected power of the PGM to stabilize. The threshold of 48.50 Hz is related to one of the second lowest frequency for which

a PGM has to operate during a minimum amount of time according to Table 2 of the NC RfG.

- **Another frequency increase up to 50.00 Hz**: This part aims to observe the response of the PGM when the frequency increases and to verify that the LFSM-U is deactivated when the frequency goes beyond 49.80 Hz.

4.3. Compliance testing of demand facilities providing demand side response

According to Article 45(1) and Article 45(2) of NC ER, Defence Service Provider (DSP) delivering demand response or LFDD shall execute a demand modification test or LFDD test. However, the current version of the System Defence Plan, does not include measures to be executed by DSPs delivering demand response or LFDD. Hence, no test is described for such services in this version of the test plan.

If, in the future, the actions described in the System Defence Plan should rely on actions from DSPs delivering demand side response, a dedicated test will be developed in concertation with the stakeholders and taking into account the minimum requirements laid down in Article 45(1) of the NC ER and Article 41(1) of the NC DCC. In that case, a new version of the test plan will be submitted for approval.

If, in the future, the actions described in the System Defence Plan should rely on actions from DSPs applying LFDD, a dedicated test will be developed in concertation with the stakeholders and taking into account the minimum requirements laid down in Article 45(2) of the NC ER and Article 37(4) of the NC DCC. In that case, a new version of the test plan will be submitted for approval.

Other non-contracted capabilities used in daily operation are tested according to the conformity test described in the connection contract and its appendices.

4.4. Compliance testing of HVDC capabilities

4.4.1. Compliance testing of HVDC system delivering a black-start service

According to Article 46 of NC ER, each RSP which is an HVDC system delivering a black-start service shall execute a black-start capability test. However, in the current version of the Restoration Plan, ELIA does not rely on HVDC systems delivering black-start capabilities. Hence, no test is described for such services in this version of the test plan.

If, in the future, ELIA relies on RSPs which are HVDC systems providing black-start capabilities, a test procedure will be developed on a case-by-case basis, based on the RSP capabilities and considering the minimal requirements laid down in Article 46 of the NC ER, Article 71(11), Article 37(2) and Article 37(3) of the NC HVDC. In that case, a new version of the test plan will be submitted for approval.

4.4.2. LFSM-O test for HVDC units

This test is only applicable for HVDC units subject to the NC HVDC and for HVDC units linking two different synchronous areas. The activation of the LFSM-O for a HVDC unit linking two locations in a same synchronous area would not solve the frequency deviation.

This capability is not contracted in the framework of the System Defence Plan and/or Restoration Plan. However, as it is used only in emergency situations, a test with a periodicity

of 10 years is deemed necessary. In case of important modifications to the installation, an additional test can also be required by ELIA.

The proposed test consists of measuring the power exchange at the Belgian side following a steep frequency increase based on a frequency signal given in Figure 1.

A difference for the initial active power setpoint is made when HVDC units are in import mode or in export mode.

- When in **import mode**, the expected reaction during the LFSM-O test is to decrease the injected active power. The initial active power set point is then set to 100% of the maximum available power to give a sufficient margin to realize the LFSM-U test.
- When in **export mode**, the expected reaction during the LFSM-U test is to increase the active power taken at the Belgian side. The initial active power set point is then set according to the following formula in order to provide a sufficient margin for the test:

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

  The parameters are defined in Section 4.2.4 of this document.

4.4.3. LFSM-U test for HVDC units

This test is only applicable for HVDC units subject to the NC HVDC and for HVDC units linking two different synchronous areas. The activation of the LFSM-U for a HVDC unit linking two locations in a same synchronous area would not solve the frequency deviation.

This capability is not contracted in the framework of the System Defence Plan and/or Restoration Plan. However, as it is used only in emergency situations, a test with a periodicity of 10 years is deemed necessary. In case of an important modification to the installation, an additional test can also be required.

The proposed test consists of measuring the power exchange at the Belgian side following a steep frequency decrease based on a frequency signal given in Figure 2.

A difference for the initial active power setpoint is made when HVDC units are in import mode or in export mode.

- When in **import mode**, the expected reaction during the LFSM-U test is to increase the injected active power. The initial active power setpoint is then according to the following formula in order to provide a sufficient margin for the test:

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

  The parameters are defined in Section 4.2.4 of this document.

- When in **export mode**, the expected reaction during the LFSM-U test is to decrease the active power taken at the Belgian side. The initial active power setpoint is then set to 100% of the available power in order to have a sufficient margin for the LFSM-U test.

4.4.4. Other non-contracted capabilities

Other non-contracted capabilities used in daily operation are tested according to the conformity test described in the connection contract and its appendices.

4.5. Compliance testing of low frequency demand disconnection (LFDD) relays

According to Article 47 of NC ER, each DSO & TSO shall execute testing on LFDD relays implemented on its installation in order to demonstrate the technical capability of the transmission-connected distribution facilities/demand facilities to operate from a nominal AC supply specified by ELIA.

Due to the criticality of such equipment, ELIA tests the equipment at three different moments even if this is not explicitly required in the NC ER:

- Execution of a **qualification test** taking place before the installation of the LFDD relay
- Execution of a **commissioning test** taking place at least when a new LFDD relay is installed
- Execution of a **periodical test** taking place at least every 10 years if the relay has not been tested during this period.

As the NC ER only specifies requirements for a periodical test, the qualification and commissioning tests are not described extensively in this test plan.

There is a distinction between existing demand facilities not subject to the NC DCC and new demand facilities subject to the NC DCC.

Two values are specified for the test of relays on demand facilities subject to the NC DCC:

- A **maximum operating time of 150 ms** as specified in Article 19(1)(c)(ii) of NC DCC
- A **test periodicity of 10 years** based on the qualified lifetime of the relays of 20 years.

For the test of relays on existing demand facilities not subject to the NC DCC:

- The maximum operating time measured during the time should be smaller than the maximum value used during the commissioning of the corresponding relay. No specific value is given for existing units as there is no value is currently mentioned in the national legislation.
- The test periodicity of 10 years remains applicable

4.6. Compliance testing for non-contracted capabilities

In emergency, blackout or restoration situations, ELIA can ask the SGU to activate non-contracted capabilities given in the System Defence Plan and/or Restoration Plan. ELIA does not plan to use capabilities that exceed the capabilities mentioned in the connection contract.

For existing units that are not subject to the NC RfG, the NC DCC or the NC HVDC, the capabilities are tested once, i.e. the conformity test realized during the connection process.

For units subject to the NC RfG, the NC DCC or the NC HVDC, the conformity test realized during the connection process will also be used to assess the compliance of these measures. The conformity test will consider the specific requirements and methodologies provided in the NC RfG, NC DCC and NC HVDC.

Most of these capabilities are used in daily operation. In case of malfunction, the situation will rapidly be detected and solved according to the guidelines and procedures of the corresponding SGU. Hence, no periodic tests in addition to the conformity test is deemed necessary.

An exception is made for the LFSM-O and LFSM-U capabilities that are applicable for units subject to the NC RfG and NC HVDC and which are used only in emergency situations. For these specific capabilities, a specific test is described.

4.7. Compliance testing of communication systems

4.7.1. Voice communication systems

Voice communication systems used to coordinate the actions to be executed during an emergency or restoration situation should be tested.

A distinction is made between voice communication systems used to communicate between ELIA and the SGUs and the voice communication systems used by ELIA to communicate between the dispatching and the substations.

For voice communication systems used for communication between ELIA and the SGUs, a yearly test is foreseen, in accordance with Article 48(1) of the NC ER.

As the voice communication system used to communicate between ELIA's dispatchings and the substations is used in daily operation, no additional periodic test is foreseen.

4.7.2. Back-up power supply of the voice communication system

The back-up power supply of the voice communication system should be tested with a periodicity of 5 years, in accordance with Article 48(2) of NC ER.

4.7.3. System State notification Emergency ELIA, Blackout ELIA and Grid Restoration ELIA

Besides the voice communication system, ELIA also notifies SGUs if the system state is in the Emergency, Blackout or Grid Restoration state through the following communication channels: website, mail, SMS, SCADA.

The test periodicity differs for the test of the SCADA communication channels and the SMS and mail communication channels due to the system's complexity. The monthly test periodicity of the SCADA system is based on the test periodicity of a similar signal currently used by ELIA to alert certain stakeholders.

4.8. Compliance testing of tools and facilities

A test description is given for the following equipment and capabilities belonging to ELIA:

- **Main and back-up power supply of the main and back-up control room**: the test is realized every month according to an internal & confidential procedure.
- **Back-up power supply of critical substations**: The test is limited to the start-up of the back-up power supply. The equipment of the substations remain supplied by the primary power source in order to avoid endangering the grid operation.
- **Transfer procedure from the main to the back-up control room**: the test is realized every year according to an internal & confidential procedure.

Other critical tools and facilities are used in the daily grid operation. In case of malfunction, the system is immediately detected and solved within undue delay.

4.9. Compliance testing of the voltage reference point reduction signal

This signal is tested every 5 years as it requires a strong preparation in close collaboration with the DSO or with the CDSO if relevant.

The test implies to entirely configure a dedicated signal that will test the effect of the voltage reference point reduction signal on one substation only to avoid impacting the entire grid.

4.10. Compliance testing of automatic resynchronisation devices

Automatic resynchronisation devices experience a large set of compliance tests before their commissioning to ensure their proper functioning during their entire lifetime. This equipment are also used in daily operation, after a planned outage for example. Hence, a potential problem would be rapidly detected and solved without undue delay. The regular utilization of the automatic resynchronisation devices provides sufficient confidence to avoid the planning of dedicated periodical tests.