Eskom	Standard	Transmission System Operator

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Content

1. Introduction

Ancillary Services are procured to ensure the safe and reliable operation of the power system under all system conditions. In the unlikely event of a regional or national blackout, System Restoration services are required to return the power system from an emergency condition back to normal operations. To ensure that the service providers who enable these services are continually able to do so, there are criteria for testing, certification, and performance monitoring that must be met. These requirements go beyond what is reflected in the Ancillary Services Technical Requirements and speak to what is required in terms of capability testing and required performance levels on an ongoing basis.

2. Supporting Clauses

2.1 Scope

2.1.1 Purpose

The purpose of this document is to outline the procedure and requirements for testing, certification, and performance monitoring of black-start, self-start, and unit islanding (known collectively as System Restoration) service providers that are or will be contracted to provide these services to the System Operator.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited, its divisions, subsidiaries, entities wherein Eskom has a controlling interest, as well as all independent power producers connected to the South African interconnected power system.

2.1.3 Effective date

This document is effective from the date of authorisation.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems

[2] The South African Grid Code - Network Code

[3] The South African Grid Code – System Operation Code

[4] Ancillary Services Technical Requirements (240-159838031)

2.3 Definitions

Term	Definition
Base-load black-start facility	A power station or facility where emergency start-up equipment is part of a base-load power station to enable black-start capability and the restoration process
Base-load power station	A power station that is designed to operate continuously at a steady load 24-hours a day
Black-start	As per the SA Grid Code, this is the ability of power station or facility to: a) Start-up without an off-site supply, b) Energise a defined portion of the TS, c) Supply load, d) Act as a start-up supply for other capacity to be synchronised as part of a process of restoring the power system
Black-start support station	A base-load non-black-start power station that is dedicated as one of the first stations that will receive start-up power from a peaking black-start facility in a blackout
Emergency start-up equipment	Small-scale generating capacity that serves as a “kickstarter” to provide cranking power for on-site generating unit(s) at a black-start or self-start facility (e.g., diesel generator set)
Mid-merit power station	A power station that is designed to operate in direct response to changing demand and can be shut down or significantly curtailed over off-peak periods.
Peaking black-start facility	A power station or facility where emergency start-up equipment is part of a peaking or mid-merit power station, and that station is in close electrical proximity[1] to a black-start support station to enable black-start capability and the restoration process
Peaking power station	A power station that is designed to operate during peak periods or when the system is under duress
SCO	A specialised mode of operation whereby certain generators can be decoupled from the prime mover and operate as a motor while injecting/absorbing reactive power dynamically, as required by the power system
Self-start	As per the SA Grid Code, this is the ability of a power station or facility to: a) Start-up without an off-site supply, b) Energise a defined portion of the TS, c) Supply load
Self-start facility	A power station or facility where emergency start-up equipment is part of a peaking or mid-merit power station, but that station is undersized and/or too remote to enable black-start
System Restoration	The process of restoring the power system following a blackout, which is where all generators have either tripped or islanded, and all connected customers have lost supply

[1] In this context, electrical proximity is a function of the reactive power capability of the generating unit(s) at the facility, the surrounding transmission network, and the length of path to the black-start support station. These parameters will differ per facility and will be analysed by the System Operator prior to considering black-start certification for a particular facility.

System Restoration Plan	The confidential document that details the guidelines for National Control staff to implement the System Restoration process using System Restoration service providers
System Restoration Services	As per the SA Grid Code, System Restoration services are the group of services that are expected to respond to a national or regional blackout and restore the power system to pre-contingency conditions. Service providers shall be able to establish a grid without external support and enable the restoration of generation capacity and/or load. System restoration services shall consist of black-start, self-start and unit islanding.
Unit islanding	As per the SA Grid Code, this is the ability of a generating unit, loaded to any load up to MCR, to: a) Suddenly disconnect from the TS by opening the HV circuit breaker, b) control all necessary critical parameters to a sufficient degree to maintain the alternator at speed and excited, c) supply its own auxiliaries for at least two hours, allowing the unit to re-synchronise to the TS

2.4 Abbreviations

Abbreviation	Explanation
AS	Ancillary Services (department within the System Operator)
ASTR	Ancillary Services Technical Requirements
AVR	Automatic Voltage Regulator
DC	Direct Current
FACTS	Flexible Alternating Current Transmission System
GCR	Grid Code Requirement
HV	High Voltage
Hz	Hertz
IPS	Interconnected Power System
kV	Kilovolt
kW	Kilowatt
MCR	Maximum Continuous Rating
MVAr	Mega Volt-Ampere Reactive
MW	Megawatt
NC	National Control
OEM	Original Equipment Manufacturer
rpm	Revolutions per minutes
SAGC	South African Grid Code
SCO	Synchronous Condenser Operation
SO	System Operator
STERF	Short-Term Energy Review Forum

Abbreviation	Explanation
TS	Transmission System

2.5 Roles and Responsibilities

2.5.1 National Control, System Operator

National Control (NC) is responsible for the operation and management of the South African interconnected power system under normal and emergency conditions. In a blackout situation, NC will determine when and which of the available system restoration facilities will energise the surrounding transmission and/or distribution network. NC is also responsible for the ownership and implementation of the system restoration plan and will issue all required instructions for recovering and restoring the South African interconnected power system following a blackout, as per the system restoration plan.

2.5.2 Ancillary Services, System Operator

The Ancillary Services (AS) function of the System Operator (SO) is responsible for managing the testing, certification, budgeting, contracting and compensation for all system restoration providers, as well as defining technical requirements and minimum standards applicable to all service providers. AS is also responsible for providing a support function to NC regarding real-time availability and performance of system restoration facilities and units, under normal and emergency conditions.

2.5.3 Service Providers

Service providers are responsible for supplying, maintaining, and operating their respective system restoration units or facilities. Service providers are also responsible for performing and reporting on monthly routine tests of emergency start-up equipment, as well as mandatory capability tests as required by the South African Grid Code (SAGC) and this standard. Service providers are also responsible for responding upon instruction from NC to emergency conditions as required for system restoration purposes.

2.6 Process for Monitoring

Refer to document content.

2.7 Related/Supporting Documents

Not applicable.

3. System Restoration Certification and Performance Monitoring Requirements

The requirements detailed in this document refer specifically to the AS testing[2], certification, and performance monitoring processes with regards to System Restoration. These should be read in conjunction with the Ancillary Services Technical Requirements (ASTR) [4] and the SAGC for a wider view of what is required from provisional and contracted service providers for the individual System Restoration services.

3.1 Unit Islanding

Unit islanding is a critical emergency response mechanism and is the first means of reacting to a blackout, as it is an automatic response capability of certain generating units. This means that a stable islanded unit can begin the restoration of the local transmission system (TS), generation, and load as soon as NC gives the instructions to do so.

In a blackout scenario, there are two main reasons why the unit islanding capability is crucial:

a. for assisting in restoring the network by providing start-up power for tripped generators and restoring customer load,

b. for the provision of hot generating units that are ready to be synchronised (if they cannot play a primary role in the load or generation restoration process).

For these reasons, it is crucial that unit islanding capability is periodically tested and verified per contracted unit to ensure that the system restoration capability of these units is not compromised.

3.1.1 Minimum Unit Islanding Test and Certification Requirements

For either test scope defined in 3.1.1.1 and 3.1.1.2, the unit islanding test must meet the following minimum requirements:

(1) Within 60 days prior to performing an islanding test, a successful physical over-speed test shall be performed on the unit in question

(2) Immediately prior to performing the islanding test, the overspeed protection shall be tested by oil injection or other appropriate simulation and all steam valves stroke checked (where applicable and where this facility is available)

(3) The function of the bled steam non-return valves shall be confirmed before an islanding test is performed (where applicable)

(4) The Automatic Voltage Regulator (AVR) of the unit in question shall be fully commissioned and able to operate in Automatic mode during the test

(5) The power station or facility shall ensure the availability of detailed procedures to ensure the safety of personnel and plant during the tests. These procedures shall include details such as the required level and number of staff, limits, and special precautions necessary for the test. Copies of these procedures shall be made available to the SO upon request.

[2] It should be noted that for all services, the total costs of tests for initial certification will be for the account of the power station

(6) The islanding test shall be performed as if under normal operating conditions i.e., all plant shall remain in normal operating status and configuration (including control systems, protection, and safety devices). No extra plant should be added or removed, and no special modifications should be implemented prior to or during the test for the purpose of ensuring a successful test.

(7) The power station or facility shall notify the SO of their intention to perform an islanding test at least three (3) working days prior to requesting a test outage. Following the approval of the test outage, the power station or facility shall notify AS of the approved date and time for the islanding test at least three (3) working days prior to the approved test date.

(8) Islanding tests shall be carried out by authorised power station staff, assisted as required by contractors, or as stipulated in the applicable contracts/agreements in the case of new plant

(9) During the test period itself, all operating in the first two minutes following initiation of the test shall be noted and the SO informed for approval. All further operating throughout the ensuing test period shall also be noted for reporting purposes.

(10) At the time of opening the high voltage (HV) circuit breaker, the generator load shall be at the required percentage of MCR for the specific test being conducted (see 3.1.1.1 and 3.1.1.2)

(11) Upon opening the HV circuit breaker to initiate the test, the turbo-generator shall supply its own auxiliary load for the prescribed minimum period for the specific test being conducted without tripping the unit at any time (see 3.1.1.1 and 3.1.1.2). After islanding, the unit shall successfully re-synchronise onto the TS and load back up to contracted output without tripping (unless otherwise instructed by NC)

(12) The maximum turbine speed recorded during an islanding test shall not exceed 106% of rated speed

(13) After completion of the test, the power station or facility shall ensure that AS receives a completed certification template detailing all required test data in 1-second resolution (see Appendix C for details of required data). This completed certification template shall be submitted within six (6) weeks of test completion.

(14) In the absence of a completed template, an official power station or facility report shall also be acceptable provided it covers all necessary details. This includes required parameters defined in the certification template over the course of the test and in particular, the trend of the unit generated active power over the full duration of the islanding test (including at least 10 minutes prior to islanding and then loading up to contracted output after resynchronisation to the TS). AS shall then independently verify the test performance to determine if the test was successful as per the required test scope

(15) If a test is deemed successful, AS shall issue a certificate to the power station or facility for the unit in question which will be valid for six (6) years from the date of the test. If the test is unsuccessful, AS shall officially inform the power station or facility of the test result in writing and a re-test will be required for the unit in question within ninety (90) days

3.1.1.1 Prototype Test Requirements

(1) All new power stations or facilities comprised of turbo generator units of the required threshold rating who do not have black-start or self-start capabilities[3] shall perform one successful unit islanding test on one typical unit[4] from 100% of MCR.

(2) This specific test (referred to as the Prototype Test as per GCR2 of the SAGC) requires that the unit controls all necessary critical parameters to maintain the alternator at speed while supplying its own auxiliaries for a minimum period of two (2) hours.

(3) After the two-hour islanded period, the unit shall successfully resynchronise to the TS and load back up to contracted output without tripping.

3.1.1.2 Routine Test Requirements

(1) Currently contracted unit islanding turbo generator units or subsequent units at new power stations or facilities (where all units share the same design and a prototype test has been completed on one unit as per 3.1.1.1 above), shall demonstrate their ability to island by performing a Routine Test as per GCR2 of the SAGC.

(2) The routine test requires the unit to island from at least 60% of MCR, control all necessary critical parameters to maintain the alternator at speed while supplying its own auxiliaries for a minimum period of twenty (20) minutes, giving the assurance that the unit would have remained stable for a minimum of 2 hours if required.

(3) After the twenty-minute islanded period, the unit shall successfully resynchronise to the TS and load back up to contracted output without tripping.

(4) For recertification of a unit, a routine test shall be performed at least once every six years or after any modifications to the plant that directly affect unit islanding capability – such modifications shall be officially communicated to AS prior to commencement, and include a test plan for unit islanding.

3.1.2 Certification based on network fault/incident

If a fault on the Interconnected Power System (IPS) results in the HV circuit breaker of a turbo generator unit opening (due to automatic protection) and causes that unit to island successfully, then this incident can be used to potentially certify (or recertify) that unit. For this to happen, the incident and unit performance shall still meet the minimum certification criteria detailed in 3.1.1.1 or 3.1.1.2 above (as applicable to the certification status of the unit in question). Following the incident, the station shall submit a completed certification template detailing all required incident data to AS within six (6) weeks of the incident for evaluation. In the absence of this template, a power station or facility report shall also be acceptable provided it covers all relevant details as per 3.1.1 (14) above.

[3] Contracted black-start or self-start facilities can elect to provide unit islanding from the generating units at their facility if they choose to do so (and if agreed with the SO). However, as per the SAGC, generating units at these facilities are not obliged to provide unit islanding.

[4] A typical unit refers to a turbo generator unit at a power station where the station is populated by identical units. In cases where there are more than one design or type of unit present at a station, one prototype test is required per design or type.

If the incident and unit performance meet all required criteria, AS shall issue a certificate to the power station or facility for the applicable unit which will be valid for six (6) years from the date of the incident. If the required criteria are not met despite the unit islanding successfully, AS shall officially inform the power station or facility of the assessment and the existing certification date and status will remain in place. If during the assessment, it is observed that the unit tripped during the observed islanding period where the unit should have reasonably been expected to sustain the islanding condition, then the unit shall be required to re-test (see 3.1.5 c below).

3.1.3 Exemption from performing the capability test

In the event that a power station or facility is unable to perform a required unit islanding test for a particular turbo generator unit due to a technical constraint, the power station or facility shall be required to inform AS of the relevant details and impact on required testing. If the constraint is a long-term problem with no prospect of resolution within a reasonable timeframe (i.e., longer than twelve (12) months) then the unit certification in question shall expire and will be eligible for decertification. If applicable, the power station or facility will be advised to follow the NERSA governance process to apply for a temporary or permanent exemption from testing for the expired unit.

If the constraint is a short-to-midterm problem that can be resolved within twelve (12) months, then the power station or facility shall be required to formally request a testing waiver from AS. This request shall be submitted in the form of a letter signed by the relevant senior management of the power station or facility and shall detail the defects that preclude the power station or facility from testing the required unit within the normal timeframe and shall also provide a commitment date for when the unit can be expected to carry out the required capability test. AS shall assess the testing waiver request and provide a written response within three (3) working days.

If all submitted details are found to be acceptable and reasonable, the requested waiver shall be granted from AS for the period up to the agreed upon commitment date. If any concerns are found in the testing waiver request (that are not able to be resolved in further written correspondence between AS and the power station or facility), then AS shall reject the testing waiver request, and the existing certification date will remain in place with decertification (as per 3.1.5 a) as the next step in the process.

This testing waiver shall also be issued if the required outage for the test is not granted from the Eskom Short-Term Energy Review Forum (STERF)[5] due to system generation constraints. As this scenario is outside of the control of the power station or facility, they shall not be negatively impacted by this (in terms of performance monitoring). However, it is the responsibility of the power station or facility to apply for the required outage within the six-yearly testing timeframe and if this outage is not granted, to then notify AS via a testing waiver request. As part of the request, the power station or facility shall provide details of when the outage was requested as well as the date(s) of the STERF meeting(s) where the outage request was not granted.

[5] The Short-Term Energy Review Forum (STERF) is an Eskom committee comprised of Generation and Transmission members that meets weekly to assess the state of the power system and take decisions on outage management based on the state of affected plant, the required outage time, and the resultant effect on the power system.

It must be noted that rolling waivers will not be granted in perpetuity for a particular unit if it is apparent that the reason(s) for requesting the waiver have not been resolved. In such scenarios where continual waivers are requested for a particular unit and test commitment dates have slipped to the point where the original test date has lapsed by more than twelve (12) months, then the unit in question will be decertified as per 3.1.5 below and if applicable, the power station or facility shall be advised to apply for a permanent or temporary exemption via the NERSA exemption process.

3.1.4 Certification of a Generating Unit

Upon successfully meeting the requirements in 3.1.1.1 or 3.1.1.2 above (as applicable to the certification status of the turbo generator unit in question), AS shall issue a unit islanding certificate for the turbo generator unit to the relevant senior management of the power station or facility. This certificate shall be valid for six years from the date of the test or incident and the unit shall reflect as certified in all performance monitoring reporting from AS within the six-year period. A template of a certification letter is included in Appendix A.

3.1.5 Decertification of a Generating Unit

Decertification is a process whereby the AS certificate for a particular service is withdrawn due to the terms of service provision being violated to a prespecified extent. The following conditions are scenarios that shall render a turbo generator unit to be eligible for decertification (A template of the decertification letter is included in Appendix B):

a. If the six-year interval on a unit's certificate has elapsed, the unit shall automatically be regarded as expired. If the power station or facility makes no attempt to test or is explicitly not granted an approval for a testing waiver from AS for the expired unit as per 3.1.3 above within ninety (90) days following certificate expiry, then that unit shall be eligible for decertification.

b. If a unit conducts an unsuccessful test in terms of the requirements in 3.1.1 above, the power station or facility shall be afforded the opportunity to perform a second test within ninety (90) days of the initial test. Should the second test also be unsuccessful, the unit shall be eligible for decertification until the power station or facility can prove (via capability testing) that the unit is capable of islanding.

c. If a unit does not island successfully during an actual incident as per 3.1.2 above, a full report shall be submitted to AS indicating the reason(s) for not islanding successfully. If such a unit is certified for islanding and should reasonably have been expected to island successfully during the actual incident, AS shall then request the unit to be re-tested within ninety (90) days. If the required re-test is then unsuccessful, then that unit shall be eligible for decertification until the power station can or facility can prove (via capability testing) that the unit is capable of islanding.

3.1.6 Performance Monitoring

Performance monitoring of unit islanding for a power station or facility shall be managed on two fronts:

(1) Certification status

(2) Daily availability of unit islanding capability

3.1.6.1 Certification status

AS shall maintain a running count of the number of units certified for unit islanding at a power station or facility versus the number of units contracted for unit islanding at the power station or facility – the ratio between these two measures shall be reported at the end of every month as part of a performance factor. This measure is intended to drive a proactive approach to testing, which is the most veritable measure of unit islanding capability. In months where a capability test is conducted (or a qualifying network incident occurs), the success of these tests or incidents shall factor into the performance of the power station or facility.

(1) If a capability test(s) was conducted during the month or if a network fault(s) occurred which triggered automatic unit islanding on unit(s) at the power station or facility:

Monthly Performance = (0.3 X Certified Units / Contracted Units) + (0.4 X Successful Tests and Incidents / Attempted Tests and Incidents) + (0.3 X Monthly Station Availability)

(2) If no capability tests were conducted during the month and no real unit islanding operation was triggered:

Monthly Performance = (0.5 X Certified Units / Contracted Units) + (0.5 X Monthly Station Availability)

3.1.6.2 Daily availability of unit islanding capability

Power stations or facilities shall be required to make daily Ancillary Services Declarations to the SO for all contracted AS provided. For unit islanding, the power station or facility shall be required to assess the health of the fundamental plant and/or systems that enable unit islanding capability and to make a daily declaration of the availability of unit islanding capability of each contracted unit based on the current plant status (A template of the Ancillary Services Declaration is included in Appendix L). This daily availability shall be averaged on a monthly basis to formulate a monthly availability per unit, which shall then be averaged across all contracted units at the power station or facility to give a station-level monthly availability that shall factor into the monthly performance score, as shown in 3.1.6.1 above.

Monthly Unit Availability = Average of daily declared unit availability status per month

Monthly Station Availability = (Monthly Unit 1 availability + …. + Monthly Unit n availability) / Contracted Units

3.2 Black-start

Black-start is the most fundamental response mechanism in the event of a blackout as it requires no external support and can be reattempted multiple times if unsuccessful (dependant on material supplies). By contrast, unit islanding can only be utilised once per online turbo generator unit i.e., once an islanded unit trips in a blackout, it will remain offline and require start-up power from another source. However, a black-start facility with sufficient emergency and primary fuel, can provide multiple consecutive start-ups, which increases the probability of starting the generation and load restoration process successfully. This means that even a singular black-start facility has the capability to start the process of restoring the entire power system.

Therefore, testing this crucial facility-level capability is vital for the resilience of the South African power system, and monitoring the ongoing availability and performance of black-start facilities is imperative for providing assurance that the SO has the necessary resources on hand to restore the power system at any given time in the unlikely event of a blackout.

3.2.1 Minimum Black-Start Test and Certification Requirements

(1) Each contracted or prospective black-start facility shall complete a successful black-start test, that shall then be repeated every 3 years – the scope of the tests shall alternate between a full or partial test (as defined in the SAGC) per testing cycle.

(2) For both scopes, the test shall be planned and led by the SO, in conjunction with all relevant stakeholders and representatives, i.e. the black-start facility, the relevant transmission grid, other power stations (if required), the associated distribution network (if required), customers and customer representatives (if required), etc.

(3) The test shall be planned and executed in line with an approved test procedure by the SO, agreed upon by all stakeholders prior to test execution.

(4) The black-start facility shall have and maintain an internal site-specific black-start procedure(s) that details all required operations, timing, and staff logistics required to perform a black-start under test and blackout conditions, including considerations for safety of personnel and plant during black-start operations. This procedure(s) shall include details such as the required level and number of staff, limits, and special precautions necessary for the test. Where applicable, this procedure(s) shall be integrated with the overall test procedure that is drafted by the SO, as per 3.2.1 (3).

(5) The test shall be overseen and witnessed by representatives from the SO, in addition to NC staff who will issue all official instructions related to test operations. The test can be witnessed at National Control, the black-start facility or other key areas identified during the planning of the test.

(6) Black-start test operations shall be carried out by authorised staff, assisted as required by contractors, or as stipulated in the applicable contracts/agreements in the case of new facilities.

(7) All time limits and milestone requirements as detailed in 3.2.3 and 3.2.4 are required to be met for the test to be deemed successful.

(8) After completion of the test, the power station shall ensure that AS receives an official station report within six (6) weeks of completion of the black-start test that includes all details as listed in Appendix G

(9) AS shall independently verify the test performance to determine if the test was successful as per the required test scope

(10) If a test is deemed successful, AS shall issue a certificate to the facility which will be valid for three (3) years from the date of the test. If the test is unsuccessful, AS shall officially inform the facility of the test result in writing and a re-test shall be required for the facility as soon as practically possible (taking into account the constraints of all required areas).

3.2.2 Role of Black-Start Support Stations

Peaking black-start facilities require a designated black-start support station to enable a full restoration of the power system. This is because peaking and mid-merit power stations are not designed to generate power continuously for multiple days on end, as will be required during initial restoration. Moreover, the maximum primary fuel level at peaking and mid-merit power stations is typically not sufficient to last for a multi-day continuous restoration process (without necessary pumping or refuelling that will require the black-start facility generator(s) to come to a standstill). For this reason, a dedicated base-load power station (known as a black-start support station) must be available to take power from a peaking black-start facility to enable the restoration process to proceed continuously – even when the black-start facility is taken offline.

Expanding on this, it is important to maintain the minimum primary fuel requirements for black-starting at peaking black-start facilities in the event that an initial attempt(s) at restoration is unsuccessful, and a subsequent black-start(s) is required. Thus, exhausting the primary fuel storage at a peaking black-start facility to sustain an island instead of holding back sufficient capacity for a further emergency condition can potentially lead to a disastrous outcome. Therefore, the role of the black-start support station becomes critical, as it will allow the peaking black-start facility to be taken offline and conserve/replenish fuel levels while continuing the restoration process as required.

For this reason, the SO does not consider a peaking black-start facility in isolation but rather, as an operating set comprised of:

- The peaking or mid-merit power station (which provides the initial start-up power for the island, the black-start support station, other generation, and continuous black-starting capability if required)
- The black-start support station (which sustains the island on a prolonged basis and provides start-up power for further generation to be synchronised, with or without the peaking black-start facility)

3.2.3 Partial Test Scope

3.2.3.1 Base-load black-start facility

(1) A minimum of one base-load generating units at the black-start facility shall be shut down and isolated from the IPS (simulated blackout).

(2) A defined portion of the TS (agreed in test planning) shall also be shut down and isolated from the IPS – the minimum requirement for this purpose is the HV busbar on site, which is the designated starting point for the outgoing TS per facility[6]. This can be extended to transmission line(s), transformer(s), and substation(s) along the associated cranking path from the black-start facility, if agreed during test planning

(3) The generating unit shall be started up independently from on-site emergency start-up equipment (e.g., a separate diesel generator set) within 4 hours, which is from the start-up of the emergency plant to the closing of the generator HV breaker (to energise the dead HV bus-bar)

(4) The generating unit shall energise the defined portion of the TS that was shut down and isolated without tripping

(5) If this configuration (with the black-start facility and energised transmission equipment) can be maintained stably for a short, predefined period (≤ 20 minutes) to take measurements (e.g., frequency, voltage, active power, reactive power, etc.) and observe the stability of the test island, and all time constraints have been adhered to, then the test shall be considered successful

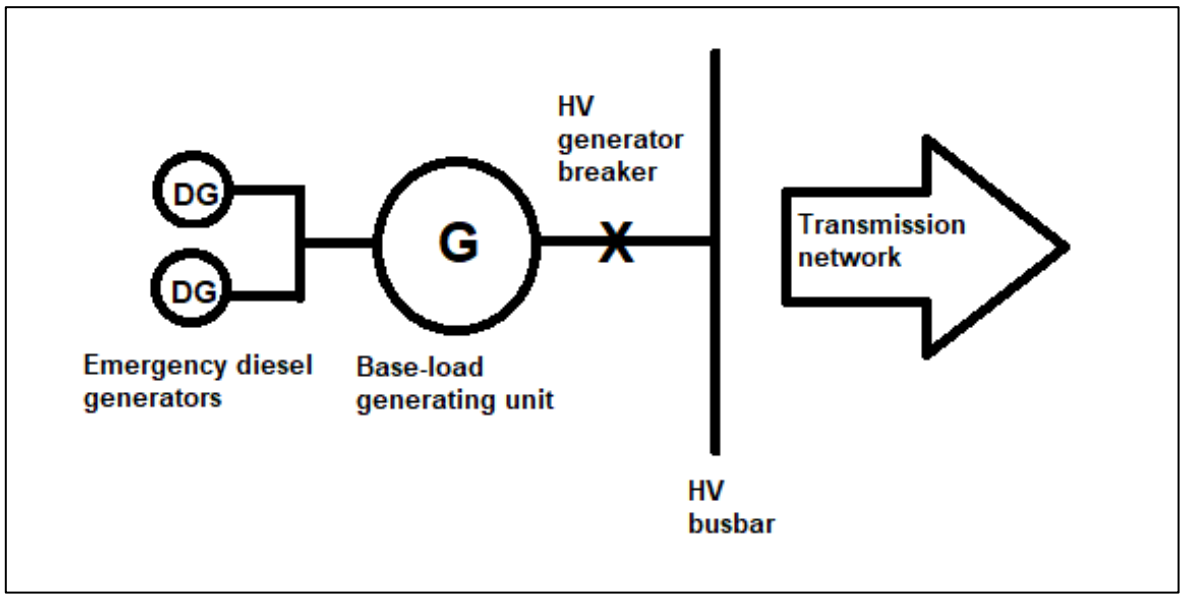

Figure 1 - Example of a partial black-start test network for a base-load black-start facility

[6] This bus-bar may also belong to the respective Transmission Grid, depending on the individual plant owner.

3.2.3.2 Peaking black-start facility

(1) A minimum of two (2) generating units at the peaking black-start facility shall be shut down and isolated from the IPS (simulated blackout). In the event that sectionalising of specific units for test purposes and normal production is not possible (e.g., shared waterways at a pumped storage or hydro station), then the entire station shall be shut down and isolated from the IPS and units not involved in the test shall be kept at standstill for the duration of the test

(2) A designated generating unit at a black-start support station (agreed in test planning) shall also be shut down and isolated from the IPS

(3) A defined portion of the TS (agreed in test planning) shall also be shut down and isolated from the IPS. This shall include the designated path (i.e., transmission lines, transformers, substations) from the black-start facility up to the black-start support station

(4) All required generating units at the peaking black-start facility shall be started up independently from on-site emergency start-up equipment (e.g., a separate diesel generator set) within 2 hours, which is measured from the start-up of the emergency plant to the start-up of the last generating unit

(5) One generating unit shall be dedicated in Generating mode, and (if required) the additional unit(s) shall be dedicated in SCO mode (or other similar reactive power compensation modes). In cases where SCO or other operating modes are not applicable, then any additional voltage control mechanisms that are contracted as part of the facility (e.g., FACTS devices, synchronous condensers, etc.) shall be kept available for the same purpose

(6) The peaking black-start facility shall energise the path from the peaking black-start facility up to the black-start support station without tripping

(7) The start-up power for the designated black-start support test unit that was shut down and isolated shall be supplied by the peaking black-start facility

(8) The black-start support test unit shall be able to start-up and synchronise to the test island created by the black-start facility within four (4) hours (which is measured from back energisation to synchronisation).

(9) If this configuration (with the peaking black-start facility in synchronism with the black-start support test unit via the energised TS) can be maintained stably for a short, predefined period (≤ 20 minutes) to take measurements (e.g., frequency, voltage, active power, reactive power, etc.) and observe the stability of the test island, and all time constraints have been adhered to, then the test shall be considered successful

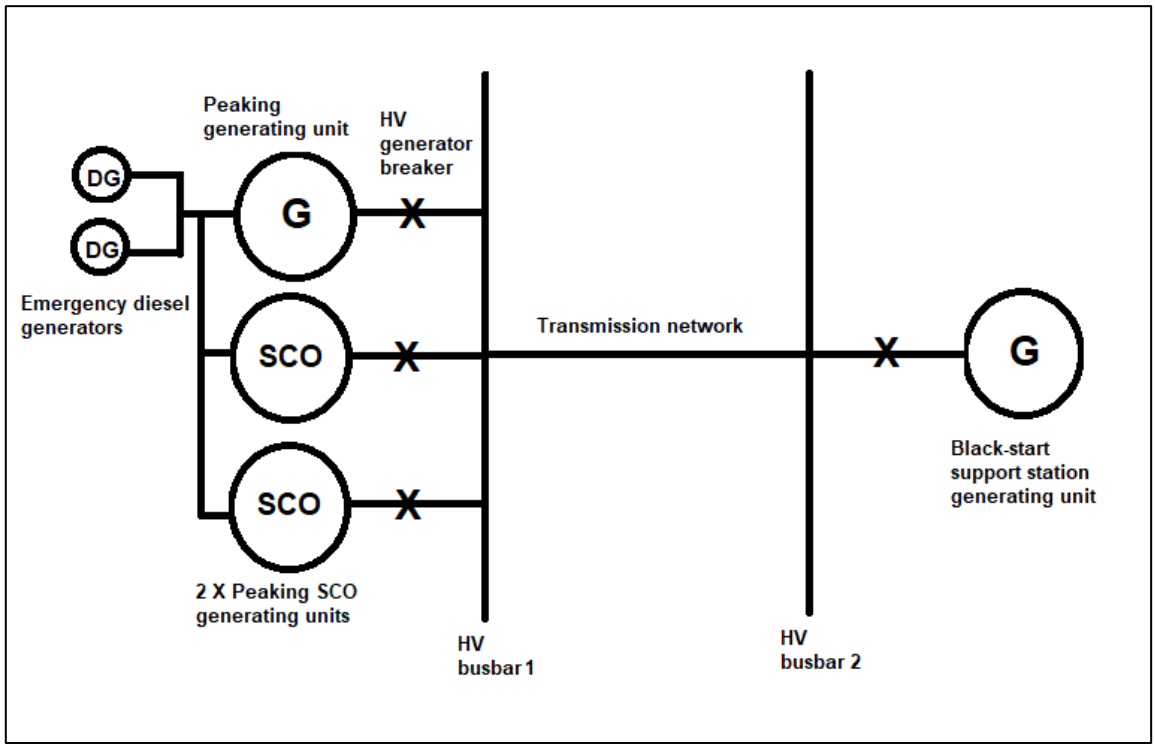

Figure 2 - Example of a partial black-start test network for a peaking black-start facility

3.2.4 Full Test Scope

3.2.4.1 Base-load black-start facility

(1) A minimum of one base-load generating units at the black-start facility shall be shut down and isolated from the IPS (simulated blackout).

(2) A designated customer load (agreed in test planning) shall also be shut down and isolated from the IPS. The timing of this step in the test sequence shall be managed to minimise customer impact

(3) A defined portion of the TS (agreed in test planning) shall also be shut down and isolated from the IPS. This shall include the designated path (i.e., transmission lines, transformers, substations) from the black-start facility up to the designated customer load[7]

(4) The generating unit shall be started up independently from an on-site emergency start-up equipment (e.g., a separate diesel generator set) within 4 hours, which is from the start-up of the emergency plant to the closing of the generator HV breaker (to energise the dead HV bus-bar)

(5) The black-start facility shall energise the path from the black-start facility up to the designated customer load without tripping

[7] This path may include the Distribution and/or municipal network depending on the point of connection of the selected customer load.

(6) The black-start facility shall energise the customer load either in prepared, discrete load blocks (in the event of aggregated municipal or Distribution load); or by ramping at the same ramp-rate with the customer load (in the event of a single industrial customer load)[8]

(7) If this configuration (with the black-start facility supplying the customer load via the energised TS) can be maintained stably for a short, predefined period (≤ 20 minutes) to take measurements (e.g., frequency, voltage, active power, reactive power, etc.) and observe the stability of the test island, and all time constraints have been adhered to, then the test shall be considered successful

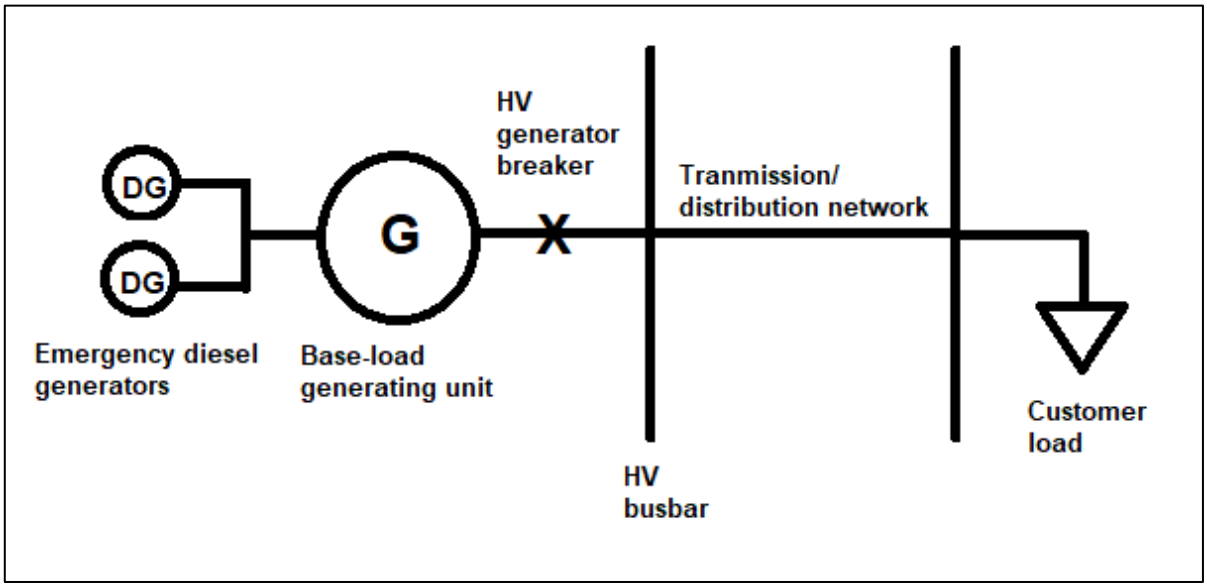

Figure 3 - Example of a full black-start test network for a base-load black-start facility

3.2.4.2 Peaking black-start facility

(1) A minimum of two (2) generating units at the peaking black-start facility shall be shut down and isolated from the IPS (simulated blackout). In the event that sectionalising of specific units for test purposes and normal production is not possible (e.g., shared waterways at a pumped storage or hydro station), then the entire station shall be shut down and isolated from the IPS and units not involved in the test shall be kept at standstill for the duration of the test

(2) A designated generating unit at a black-start support station (agreed in test planning) shall also be shut down and isolated from the IPS

(3) A designated customer load (agreed in test planning) shall also be shut down and isolated from the IPS. The timing of this step in the test sequence shall be managed to minimise customer impact

[8] The black-start facility shall be capable of controlling frequency between 49-51 Hz (as defined in the ASTR) for the test island throughout the test, but particularly during the load pick-up sequence. This will apply equally to 3.2.4.2

(4) A defined portion of the TS (agreed in test planning) shall also be shut down and isolated from the IPS. This shall include the designated path (i.e., transmission lines, transformers, substations) from the black-start facility up to the designated customer load[9], as well as from the black-start facility up to the black-start support station

(5) All required generating units at the black-start facility shall be started up independently from an on-site emergency start-up equipment (e.g., a separate diesel generator set) within 2 hours, which is measured from the start-up of the emergency plant to the start-up of the last generating unit

(6) One generating unit shall be dedicated in Generating mode, and (if required) the additional unit(s) shall be dedicated in SCO mode (or other similar reactive power compensation modes). In cases where SCO or other operating modes are not applicable, then any additional voltage control mechanisms that are contracted as part of the facility (e.g., FACTS devices, synchronous condensers, etc.) shall be kept available for the same purpose

(7) The black-start facility shall energise the path from the black-start facility up to the designated customer load without tripping

(8) The customer load shall be energised from the generators in the test island[10] either in prepared, discrete load blocks (in the event of aggregated municipal or Distribution load); or by ramping at the same ramp-rate with the customer load (in the event of a single industrial customer load)

(9) The black-start facility shall energise the path from the black-start facility up to the black-start support station without tripping

(10) The start-up power for the designated black-start support test unit that was shut down and isolated shall be supplied by the black-start facility

(11) The black-start support test unit shall be able to start-up and synchronise to the test island created by the black-start facility within four (4) hours (which is measured from back energisation to synchronisation)

(12) If this configuration (with the customer load being shared between the black-start facility in synchronism with the black-start support test unit via the energised TS) can be maintained stably for a short, predefined period (≤ 20 minutes) to take measurements (e.g., frequency, voltage, active power, reactive power, etc.) and observe the stability of the test island, and all time constraints have been adhered to, then the test shall be considered successful

[9] This path may include the Distribution and/or municipal network depending on the point of connection of the selected customer load.

[10] The sequence of when the black-start support test unit is synchronised into the test island versus when the customer load is energised will be decided in the test planning process based on the type of customer load and the outcome of dynamic frequency stability simulations. It could be the case that all the customer load is picked up from the black-start facility itself prior to synchronisation of the black-start support test unit; or that the black-start support test unit is synchronised to the black-start facility first and the customer load pick-up is then shared between the generators.

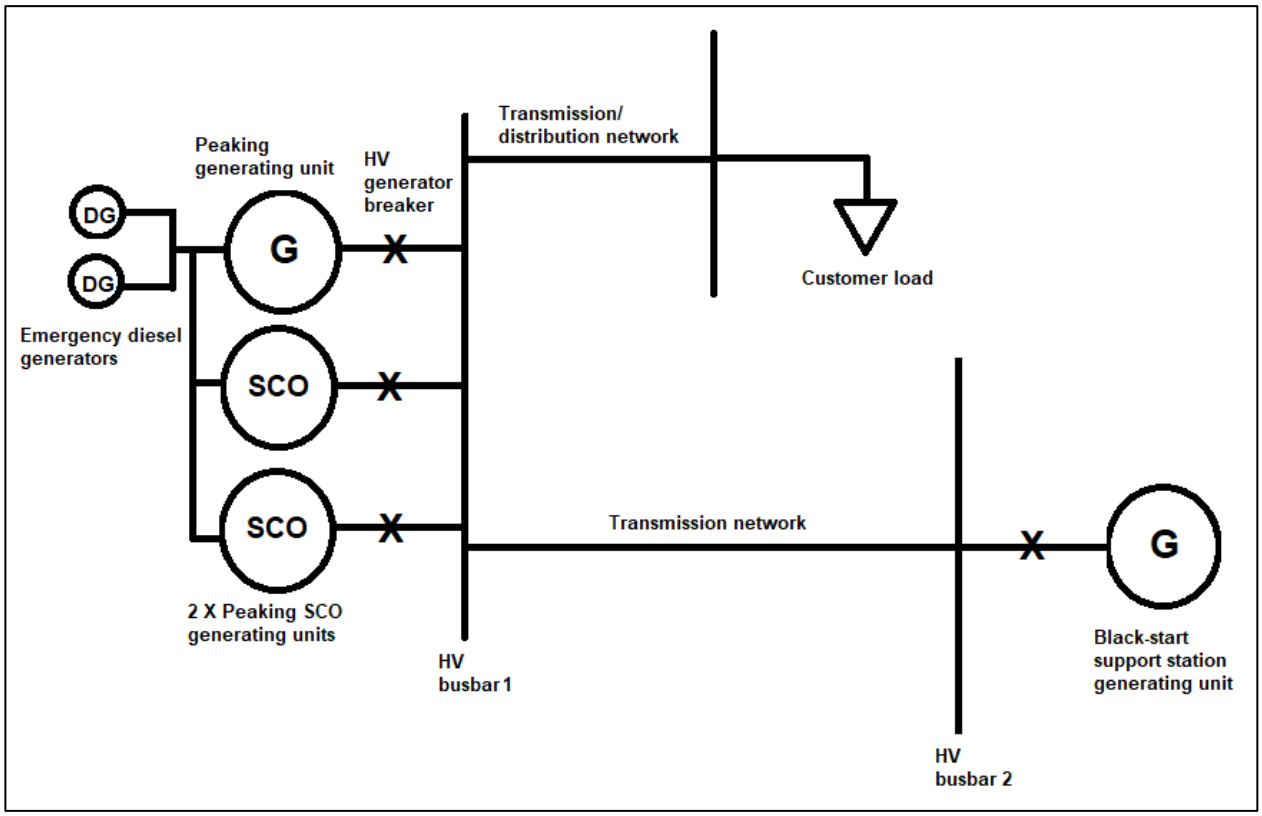

Figure 4 - Example of a full black-start test network for a peaking black-start facility

3.2.5 Certification of a Facility

Upon successfully meeting the requirements in 3.2.3 or 3.2.4 above, AS shall issue a black-start certificate for the facility to the relevant senior management of the power station or facility. This certificate shall be valid for three (3) years from the date of the test and the facility shall reflect as certified in all performance monitoring reporting from AS within the three-year period. A template of a certification letter is included in Appendix D.

3.2.6 Decertification of a Facility

Decertification is a process whereby the AS certificate for a particular service is withdrawn due to the terms of service provision being violated to a prespecified extent.

The key factor for evaluating whether a facility is eligible for black-start decertification is based on facility availability, given the criticality of this service to the resilience of the power system. If the performance of a black-start facility deteriorates to the point where a facility is operationally unavailable for ninety (90) consecutive days, then the facility shall be deemed to be in a Default State.

A Default State is a temporary classification prior to proceeding with decertification of black-start facilities, due to the importance of this service. (A template of a Default State notification letter is included in Appendix E)

If the facility remains in a Default State for a further ninety (90) consecutive days without restoring their operational availability (i.e., one-hundred-and-eighty (180) total consecutive days unavailable), then the facility will be eligible for decertification. The facility will remain decertified until such time that a successful capability test is completed for recertification. (A template of the decertification letter is included in Appendix F).

3.2.7 Performance Monitoring

Performance monitoring of black-start facilities shall be managed on three different fronts:

(1) Certification status

(2) Successful completion of monthly testing

(3) Facility availability

Based on this, the monthly performance of a black-start facility shall be calculated as follows:

Monthly Performance = (0.2 X Certification Score) + (0.4 X Monthly Testing Score) + (0.4 X Monthly Availability Score)

3.2.7.1 Certification status

AS shall maintain a record of the facility certification status based on SAGC capability testing. A certification score will be allocated to the status, which will factor into the overall performance score of the facility.

Certification Score	Label	Description
1	Valid	Valid certificate
0.5	Lapsed	Lapsed certificate
0	Expired	Expired certificate

The “Lapsed” classification is a specialised category created due to the specialised logistics required in planning and executing a black-start test, which is different from other Ancillary Service capability tests. Ideally, once a black-start facility has passed its certification expiry date without successfully completing a required black-start test, then that facility certification would automatically reflect as expired (as would be the case for other services).

However, it is not always possible to conduct the required black-start test within the required testing window (e.g., due to power system constraints, transmission system outages, unavailability of customer load, unavailability of black-start support station units, etc.). Facility certification can also lapse due to failed test(s) attempted within the required timeframe where the root cause for failure is outside of the black-start facility itself (e.g., transmission/distribution system failure, black-start support station start-up defects, customer load defects, etc.).

Therefore, the “Lapsed” classification caters specifically to lapsed black-start certification dates that are completely outside the control of the black-start facility. However, if a test fails or cannot be executed due to defects/constraints at the black-start facility itself (which then causes the black-start certification to expire[11]), then this will reflect as an expired certificate.

3.2.7.2 Successful completion of monthly testing

Periodic compliance monitoring tests shall be performed on all black-start facilities. This will comprise of weekly/monthly test runs of the emergency start-up equipment (e.g., diesel generator set) located at black-start facilities to ensure their continued operability and availability at all times. The specific monthly testing requirements per black-start facility will be detailed in the respective stations’ Ancillary Service Agreements or Power Purchase Agreements.

The contractual testing regimen must be in line with SO requirements and OEM specifications for the different emergency start-up equipment per facility. The standard SO testing regimen is a minimum of two successful one-hour base-load test runs of emergency start-up equipment to be completed per month, per machine (or as per OEM monthly testing requirements, whichever is more onerous). The monthly test score shall be calculated as follows:

Monthly Testing Score = (Total successful monthly tests) / (Total contracted monthly tests)

In general, facilities shall perform the contracted level of routine testing of emergency start-up equipment and the associated monthly testing score shall be given by the ratio of successful monthly tests vs. contracted monthly tests. A monthly test report shall be completed by the facility that includes all details as listed in Appendix G. This report is to be sent to AS within one week of the end of the month. If a routine test(s) is failed or if a machine(s) is unavailable for part or all of a month, the facility shall detail the reasons for this in the monthly test report and endeavour to resolve the defects within two (2) weeks (or as soon as practically possible) and provide written feedback to AS regarding the progress thereof (including in the next monthly test report).

The facility shall also perform all necessary tests (periodic or otherwise) on emergency start-up equipment and associated systems to meet OEM requirements.

3.2.7.3 Facility availability

For a facility to be considered operationally available for black-start, there are fundamental criteria that shall be met. These criteria speak directly to the mechanism of starting up that facility from a blackout condition. The following availability requirements shall apply to both types of black-start facilities:

(1) The required level of operational availability for a black-start facility is 90% of the year (and month)

[11] This would also apply if a certification were lapsed due to external reasons, but a new defect at the black-start facility then causes a planned capability test to fail or be cancelled. This would result in classification changing from “Lapsed” to “Expired”.

(2) Facilities shall ensure that sufficient emergency fuel (75% of bulk tank level) is always kept available for up to three consecutive black-start attempts using the on-site emergency start-up equipment. The monthly availability score for a facility will be scaled by the bulk tank minimum monthly level if this level falls below 75%:

Bulk Tank Minimum Monthly Level	Monthly Fuel Tank Scaling Factor
>= 75%	1
< 75%	Bulk Fuel Tank Minimum Monthly Level / 100

(3) Facilities shall be capable of making daily Ancillary Services Declarations[12] with regards to:

a. Emergency start-up equipment availability

Confirmation of daily availability of required emergency start-up equipment that enables the black-start service

b. Generating units availability

Confirmation of daily availability of at least one generating unit (to be used in Generating mode) to be started independently from emergency start-up equipment

c. Reactive power operating modes (e.g., SCO) availability (if required)

Confirmation of daily availability of the contracted number of additional generating units to be started independently in a reactive power compensation mode from emergency start-up equipment. These unit(s) must be in addition to the designated Generating mode unit.

d. Additional reactive power control plant availability (if required)

Confirmation of daily availability of any additional voltage control plant that is contracted as part of the black-start capability of the facility.

A template of the Ancillary Services Declaration is included in Appendix L.

3.2.7.3.1 Base-load black-start facility

For a base-load black-start facility to be considered operationally available, there shall be operable emergency start-up equipment that is available with adequate emergency fuel/power (as per 3.2.7.3 (2)) to perform a black-start and provide the required start-up power for an on-site base-load generating unit. As such, there shall also be at least one operable base-load generating unit available that can be energised from the emergency start-up equipment. The monthly availability indicator for a base-load facility shall be given as follows:

[12] These declarations shall be aggregated each month to formulate a percentage availability of each listed measure that will be measured against the 90% availability requirement.

Monthly Availability Indicator	Description
1	If (Emergency start-up equipment availability >= 90%) **AND** (Generating units availability >= 90%)
0	If (Emergency start-up equipment availability < 90%) **OR** (Generating units availability < 90%)

Thus, the monthly availability score for a base-load facility shall be calculated in the following way:

Monthly Availability Score = (Monthly Availability Indicator) X (Monthly Fuel Tank Scaling Factor)

3.2.7.3.2 Peaking black-start facility

For a peaking black-start facility to be considered operationally available, there shall be operable emergency start-up equipment that is available with adequate fuel/power (as per 3.2.7.3 (2)) to perform a black-start and provide the required start-up power for an on-site peaking or mid-merit generating unit. As with a base-load facility, there shall be at least one operable on-site peaking or mid-merit generating unit available that can be energised from the emergency start-up equipment. However, for a peaking black-start facility, there may[13] also be a requirement that additional peaking or mid-merit generating unit(s) shall be available in SCO mode (or other similar reactive power compensation modes) to support the reactive power requirements of the initial restoration process, including sufficient margin for N-1 compliance. In cases where SCO or other operating modes are not applicable, then any additional voltage control mechanisms that are contracted as part of the facility shall be kept available for the same purpose. The monthly availability indicator for a peaking black-start facility shall be given as follows:

Monthly Availability Indicator	Description
1	If (Emergency start-up equipment availability >= 90%) **AND** (Generating units availability >= 90%) **AND** (Reactive power operating modes availability **OR** Additional reactive power control plant availability >= 90%)
0	If (Emergency start-up equipment availability < 90%) **OR** (Generating units availability < 90%) **OR** (Reactive power operating modes availability **OR** Additional reactive power control plant availability < 90%)

Thus, the monthly availability score for a peaking facility shall be calculated in the following way:

Monthly Availability Score = (Monthly Availability Indicator) X (Monthly Fuel Tank Scaling Factor)

[13] The requirement for reactive power support from SCO units (or other means of reactive support within the facility) shall be determined based on the location and machine ratings of the facility, considering the cranking path(s) associated with the facility in question.

3.3 Self-start

Self-start is the newest System Restoration service and is intended as a support function to the role of black-start and unit islanding facilities. While black-start and unit islanding facilities are required to provide cranking power for other generators, self-start facilities are only required to supply local load in a microgrid. While historically this was viewed as having limited value in a South African restoration process (due to potential fuel constraints), planning for the future power system (with increasing numbers of diverse energy sources) has shown that there is potential scope for the establishment of microgrids which can supply remote customers who would otherwise have been without power while waiting for the restoration process to reach their area.

Further to this, these microgrids have the potential to provide the frequency and voltage reference needed for inverter-based resources such as renewables and battery energy storage systems to connect to. This introduces a further benefit by unlocking untapped generation potential which would otherwise remain offline until the larger, overall restoration process had progressed to that area. This is a new area of system restoration planning that is being explored given the projected increase of inverter-based resources on the power system in the near future.

For these reasons, testing this new facility-level capability is important for the future of the South African power system, and monitoring the ongoing availability and performance of self-start facilities will be vital for providing assurance that the SO has adequate resources at their disposal to supplement the system restoration process in the unlikely event of a blackout.

3.3.1 Minimum Self-Start Test and Certification Requirements

(1) Each contracted or prospective self-start facility shall complete a successful routine self-start test (as defined in the SAGC), that shall then be repeated every 3 years.

(2) The test shall be planned and led by the SO, in conjunction with all relevant stakeholders and representatives, i.e. the self-start facility, the relevant transmission grid, the associated distribution network (if required), customers and customer representatives.

(3) The test shall be planned and executed in line with an approved test procedure by the SO, agreed upon by all stakeholders prior to test execution.

(4) The self-start facility shall have and maintain an internal site-specific self-start procedure(s) that details all required operations, timing, and staff logistics required to perform a self-start under test and blackout conditions, including considerations for safety of personnel and plant during self-start operations. This procedure(s) shall include details such as the required level and number of staff, limits, and special precautions necessary for the test. Where applicable, this procedure(s) shall be integrated with the overall test procedure that is drafted by the SO, as per 3.3.1 (3).

(5) The test shall be overseen and witnessed by representatives from the SO, in addition to NC staff who will issue all official instructions related to test operations. The test can be witnessed at National Control, the self-start facility or other key areas identified during the planning of the test.

(6) Self-start test operations shall be carried out by authorised staff, assisted as required by contractors, or as stipulated in the applicable contracts/agreements in the case of new facilities

(7) All time limits and milestone requirements as detailed in 3.3.1.1 are required to be met for the test to be deemed successful.

(8) After completion of the test, the power station or facility shall ensure that AS receives an official test report within six (6) weeks of completion of the self-start test that includes all details as listed in Appendix K.

(9) AS shall independently verify the test performance to determine if the test was successful as per the required test scope

(10) If a test is deemed successful, AS shall issue a certificate to the facility which will be valid for three (3) years from the date of the test. If the test is unsuccessful, AS shall officially inform the facility of the test result in writing and a re-test shall be required for the facility as soon as practically possible (taking into account the constraints of all required areas)

3.3.1.1 Routine Test Scope

(1) A minimum of two (2) generating units at the self-start facility shall be shut down and isolated from the IPS (simulated blackout). In the event that sectionalising of specific units for test purposes and normal production is not possible (e.g., shared waterways at a pumped storage or hydro station), then the entire station shall be shut down and isolated from the IPS and units not involved in the test shall be kept at standstill for the duration of the test

(2) A designated customer load (agreed in test planning) shall also be shut down and isolated from the IPS. The timing of this step in the test sequence shall be managed to minimise customer impact

(3) A defined portion of the TS (agreed in test planning) shall also be shut down and isolated from the IPS. This shall include the designated path (i.e., transmission lines, transformers, substations) from the self-start facility up to the designated customer load[14]

(4) All required generating units at the self-start facility shall be started up independently from on-site emergency start-up equipment (e.g., a separate diesel generator set) within 2 hours, which is measured from the start-up of the emergency plant to the start-up of the final generating unit

[14] This path may include the Distribution and/or municipal network depending on the point of connection of the selected customer load.

(5) One generating unit shall be dedicated in Generating mode, and (if required) the additional unit(s) shall be dedicated in SCO mode (or other similar reactive power compensation modes). In cases where SCO or other operating modes are not applicable, then any additional voltage control mechanisms that are contracted as part of the facility (e.g., FACTS devices, synchronous condensers, etc.) shall be kept available for the same purpose

(6) The self-start facility shall energise the path from the self-start facility up to the designated customer load without tripping

(7) The customer load shall be energised either in prepared, discrete load blocks (in the event of aggregated municipal or Distribution load); or by ramping at the same ramp-rate with the customer load (in the event of a single industrial customer load)

(8) If this configuration (with the self-start facility supplying the customer load via the energised TS) can be maintained stably for a short, predefined period (≤ 20 minutes) to take measurements (e.g., frequency, voltage, active power, reactive power, etc.) and observe the stability of the test island, and all time constraints have been adhered to, then the test shall be considered successful

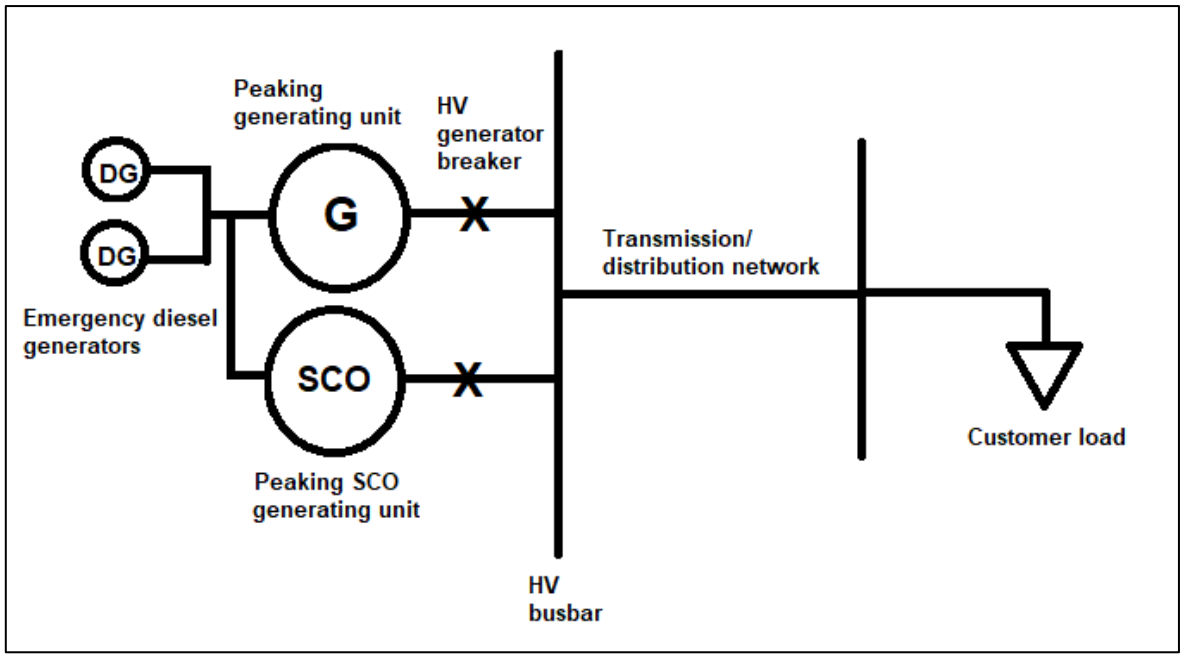

Figure 5 - Example of a routine self-start test network

3.3.2 Certification of a Facility

Upon successfully meeting the requirements in 3.3.1.1 above, AS shall issue a self-start certificate for the facility to the relevant senior management of the power station or facility. This certificate shall be valid for three (3) years from the date of the test and the facility shall reflect as certified in all performance monitoring reporting from AS within the three-year period. A template of a certification letter is included in Appendix H.

3.3.3 Decertification of a Facility

Decertification is a process whereby the AS certificate for a particular service is withdrawn due to the terms of service provision being violated to a prespecified extent.

The key factor for evaluating whether a facility is eligible for self-start decertification is based on facility availability, given the criticality of this service to the resilience of the power system. If the performance of a self-start facility deteriorates to the point where a facility is operationally unavailable for ninety (90) consecutive days, then the facility shall be deemed to be in a Default State.

A Default State is a temporary classification prior to proceeding with decertification of self-start facilities, due to the importance of this service. (A template of a Default State notification letter is included in Appendix I).

If the facility remains in a Default State for a further ninety (90) consecutive without restoring their operational availability (i.e., one-hundred-and-eighty (180) total consecutive days unavailable), then the facility will be eligible for decertification. The facility will remain decertified until such time that a successful capability test is completed for recertification. (A template of the decertification letter is included in Appendix J).

3.3.4 Performance Monitoring

Performance monitoring of self-start facilities shall be managed on three different fronts:

(1) Certification status

(2) Successful completion of monthly testing

(3) Facility availability

Based on this, the monthly performance of a self-start facility shall be calculated as follows:

Monthly Performance = (0.2 X Certification Score) + (0.4 X Monthly Testing Score) + (0.4 X Monthly Availability Score)

3.3.4.1 Certification status

AS shall maintain a record of the facility certification status based on SAGC capability testing. A certification score will be allocated to the status, which will factor into the overall performance score of the facility.

Certification Score	Label	Description
1	Valid	Valid certificate
0.5	Lapsed	Lapsed certificate
0	Expired	Expired certificate

The “Lapsed” classification is a specialised category created due to the specialised logistics required in planning and executing a self-start test. Ideally, once a self-start facility has passed its certification expiry date without successfully completing a required self-start test, then that facility certification would automatically reflect as expired (as would be the case for other services). However, it is not always possible to conduct the required self-start test within the required testing window (e.g., due to power system constraints, transmission/distribution system outages, unavailability of customer load, etc.). Facility certification can also lapse due to failed test(s) attempted within the required timeframe where the root cause for failure is outside of the self-start facility itself (e.g., transmission/distribution system failure, customer load defects, etc.).

Therefore, the “Lapsed” classification caters specifically to lapsed self-start certification dates that are completely outside the control of the self-start facility. However, if a test fails or cannot be executed due to defects/constraints at the self-start facility itself (which then causes the self-start certification to expire[15]), then this will reflect as an expired certificate.

3.3.4.2 Successful completion of monthly testing

Periodic compliance monitoring tests shall be performed on all self-start facilities. This will comprise of weekly/monthly test runs of the emergency start-up equipment (e.g., diesel generator set) located at self-start facilities to ensure their continued operability and availability at all times. The specific monthly testing requirements per self-start facility will be detailed in the respective stations’ Ancillary Service Agreements or Power Purchase Agreements.

The contractual testing regimen must be in line with SO requirements and OEM specifications for the different emergency start-up equipment per facility. The standard SO testing regimen is a minimum of two successful one-hour base-load test runs of emergency start-up equipment to be completed per month, per machine (or as per OEM monthly testing requirements, whichever is more onerous). The monthly test score shall be calculated as follows:

Monthly Testing Score = (Total successful monthly tests) / (Total contracted monthly tests)

In general, facilities shall perform the contracted level of routine testing of emergency start-up equipment and the associated monthly testing score shall be given by the ratio of successful monthly tests versus contracted monthly tests. A monthly test report shall be completed by the facility that includes all details as listed in Appendix K. This report is to be sent to AS within one week of the end of the month. If a routine test(s) is failed or if a machine(s) is unavailable for part or all of a month, the facility shall detail the reasons for this in the monthly test report and endeavour to resolve the defects within two (2) weeks (or as soon as practically possible) and provide written feedback to AS regarding the progress thereof (including in the next monthly test report).

The facility shall also perform all necessary tests (periodic or otherwise) on emergency start-up equipment and associated systems to meet OEM requirements.

[15] This would also apply if a certification were lapsed due to external reasons, but a new defect at the self-start facility then causes a planned capability test to fail or be cancelled. This would result in classification changing from “Lapsed” to “Expired”.

3.3.4.3 Facility availability

For a facility to be considered operationally available for self-start, there are fundamental criteria that shall be met. These criteria speak directly to the mechanism of starting up that facility from a blackout condition. The following availability requirements shall apply to self-start facilities:

(1) The required level of operational availability for a self-start facility is 90% of the year (and month)

(2) Facilities shall ensure that sufficient emergency fuel (75% of bulk tank level) is always kept available for up to three consecutive self-start attempts using the on-site emergency start-up equipment. The monthly availability score for a facility will be scaled by the bulk tank minimum monthly level if this level falls below 75%:

Bulk Tank Minimum Monthly Level	Monthly Fuel Tank Scaling Factor
>= 75%	1
< 75%	Bulk Fuel Tank Minimum Monthly Level / 100

(3) Facilities shall be capable of making daily Ancillary Services Declarations[16] with regards to:

a. Emergency start-up equipment availability

Confirmation of daily availability of required emergency start-up equipment that enables the self-start service

b. Generating units availability

Confirmation of daily availability of at least one generating unit (to be used in Generating mode) to be started independently from emergency start-up equipment

c. Reactive power operating modes (e.g., SCO) availability (if required)

Confirmation of daily availability of the contracted number of additional generating units to be started independently in a reactive power compensation mode from emergency start-up equipment. These unit(s) must be in addition to the designated Generating mode unit.

d. Additional reactive power control plant availability (if required)

Confirmation of daily availability of any additional voltage control plant that is contracted as part of the self-start capability of the facility.

A template of the Ancillary Services Declaration is included in Appendix L.

[16] These declarations shall be aggregated each month to formulate a percentage availability of each listed measure that will be measured against the 90% availability requirement.

For a self-start facility to be considered operationally available, there shall be operable emergency start-up equipment that is available with adequate fuel/power (as per 3.3.4.3 (2)) to perform a self-start and provide the required start-up power for an on-site peaking or mid-merit generating unit. As such, there shall be at least one operable on-site peaking or mid-merit generating unit available that can be energised from the emergency start-up equipment. There may[17] also be a requirement that additional on-site generating unit(s) shall be available in SCO mode (or other similar reactive power compensation modes) to support the reactive power requirements of the initial restoration process, including sufficient margin for N-1 compliance. In cases where SCO or other operating modes are not applicable, then any additional voltage control mechanisms that are contracted as part of the facility shall be kept available for the same purpose. The monthly availability indicator for a self-start facility shall be given as follows:

Monthly Availability Indicator	Description
1	If (Emergency start-up equipment availability >= 90%) **AND** (Generating units availability >= 90%) **AND** (Reactive power operating modes availability **OR** Additional reactive power control plant availability >= 90%)
0	If (Emergency start-up equipment availability < 90%) **OR** (Generating units availability < 90%) **OR** (Reactive power operating modes availability **OR** Additional reactive power control plant availability < 90%)

Resultantly, the monthly availability score for a self-start facility shall be calculated in the following way:

Monthly Availability Score = (Monthly Availability Indicator) X (Monthly Fuel Tank Scaling Factor)

[17] The requirement for reactive power support from SCO units (or other means of reactive support within the facility) shall be determined based on the location and machine ratings of the facility, taking into account the cranking path(s) associated with the facility in question.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Isabel Fick	General Manager, System Operator
Gavin Hurford	National Control Manager, System Operator
Lawrence Padachi	Integrated Power System Reliability Services Manager, System Operator
Phokoane Moshodi	Grid Code Management Manager, System Operator
Siju Joseph	Ancillary Services Manager, System Operator
Louis du Plessis	National Operations Manager, System Operator
Norman Van Der Merwe	Power System Manager, System Operator
Thomas Mugagadeli	Power System Manager, System Operator
Carl Burricks	Power System Manager, System Operator
Eben Fischer	Power System Manager, System Operator
Andre Scholtz	Power System Manager, System Operator
Bonginkosi Sibeko	Chief Engineer, System Operator
Paul Davel	Chief Engineer, System Operator
Shaprin Pillay	Chief Engineer, System Operator
Maite Sako	Chief Engineer, System Operator
Target Mchunu	Chief Engineer, System Operator
Amreen Ismail	Senior Engineer, System Operator
Richard Brayshaw	Senior Engineer, System Operator

5. Revisions

Date	Rev.	Compiler	Remarks
February 2024	1	L. Naidoo	New document

6. Development Team

The following people were involved in the development of this document:

- N/A

7. Acknowledgements

Satish Govender

Marathon Ntusi

Appendix A – UNIT ISLANDING CERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

CERTIFICATION OF POWER STATION UNIT X FOR A SUCCESSFUL ROUTINE/PROTOTYPE UNIT ISLANDING TEST

This letter serves to confirm that **POWER STATION UNIT X** successfully conducted a **ROUTINE/PROTOTYPE** islanding test on **DD MM YYYY**, as per the criteria outlined in GCR2 of the South African Grid Code (Network Code) and 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"*. This Turbo-Generator is hereby certified for unit islanding as stated in the Ancillary Services Purchase Agreement between System Operator and Company Name.

This certificate is valid from the test date of the **DD-MM-YYYY (1)** for a period of 72 months until **DD-MM-YYYY (2)**, at which point a routine test will need be required for recertification.

NB. A further routine test will be required in the event of a generator overhaul or any upgrade/overhaul to the generating unit that will affect unit islanding capability.

Approved by:

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix B – UNIT ISLANDING DECERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

DECERTIFICATION OF POWER STATION UNIT X FOR UNIT ISLANDING

This letter serves to confirm that **POWER STATION UNIT X** has been operationally unavailable to provide unit islanding capability ***(OR)*** has an expired certification for unit islanding for ninety (90) consecutive days from **DD/MM/YY (1) to DD/MM/YY (2)**. Therefore, **POWER STATION UNIT X** is hereby decertified for unit islanding capability as per the requirements of 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"* and as agreed in the Ancillary Services Purchase Agreement between System Operator and Company Name.

This decertification (and any associated implications as detailed in the signed Ancillary Services Purchase Agreement) will remain in place until such time that **POWER STATION** proves that **UNIT X** demonstrates unit islanding capability via the successful execution of a routine unit islanding test.

Approved by:

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix C – UNIT ISLANDING CERTIFICATION REPORT TEMPLATE

SYSTEM OPERATOR

Unit/facility name CERTIFICATION TEST REPORT FOR UNIT ISLANDING

Compiled by	**Functional Responsibility**
Date:	Date:

PUBLIC

1. Basic Information:

Name and Unit		**Test Date**		**Start Time**	
				End Time	

2. Reason for Certification/Decertification:

In line with 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"*, *Unit/facility name* has performed a successful unit islanding test or islanded successfully in response to a real network incident, as required for evaluation of unit islanding capability.

3. Executive Summary of Test *(Which unit was tested? When was the test carried out? How did the unit perform during the test incl. any notable details, figures, etc.?)*

4. Test Results and Acceptance Criteria *(Complete the table with relevant details and responses)*

Unit MCR (MW)			
Last Certification Date			
Type of Test (Prototype/Routine)			
Max. turbine speed recorded (RPM)			
% Of nominal turbine speed			
Initial pre-test load value (MW)			
Average aux. load during islanding test (MW)			
Final post-test load value (MW)			
Frequency (Hz)			
Alternator Voltage (V) before		**Alternator Voltage (V) after**	
Alternator current (A) before		**Alternator current (A) after**	
Exciter Voltage (V) before		**Exciter Voltage (V) after**	
Exciter current (A) before		**Exciter current (A) after**	
Did the unit island successfully for the required minimum time, as per the Grid Code?			
Did the unit successfully resynchronize back to the grid immediately following the test?			
Did the unit load back up to the required contracted load successfully following the test?			
Did the unit meet all Grid Code acceptance criteria for certification?			

5. Unsuccessful Test Details *(If the test was unsuccessful what was the reason for the failure? Has this failure occurred before on this unit? Has this unit failed an islanding test prior to this attempt (for any reason)? What is the plan to rectify the defect that caused the test to fail? When will this repair be complete? When will the test be re-attempted?)*

6. Generator Output Trend *(Please provide a plot of the test unit generator output. This plot should include the entire duration of the test, including at least 10 minutes before the HV breaker is opened and up to the point where the unit has returned to contracted output following the test)*

7. Previous failed tests *(Please provide details of the previous unsuccessful attempts at this test incl. date & time, unit, and the reason for failure)*

Date & Time	Reason for failure

Yours sincerely

_____

Name Surname

GENERAL MANAGER: POWER STATION NAME

COMPANY/DIVISION

Appendix D – BLACK-START CERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

CERTIFICATION OF (POWER STATION NAME) FOR FULL/PARTIAL BLACK START CAPABILITY

This certificate serves to confirm that **POWER STATION NAME** has been tested for **FULL/PARTIAL** black-start capability and has met the requirements of the South African Grid Code and 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"*. The Station is hereby **CERTIFIED** to provide black-start as stated in the Ancillary Services Agreement between the System Operator and Company Name.

This certification is valid from the test date **DD/MM/YY (1)** for 36 months until **DD/MM/YY (2)**, at which point a **FULL/PARTIAL** test will be required for recertification, as per South African Grid Code requirements.

Approved by:

_____

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix E – BLACK-START DEFAULT STATE NOTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

NOTIFICATION OF DEFAULT STATE FOR (POWER STATION NAME) DUE TO BLACK-START UNAVAILABILITY

This letter serves to confirm that **POWER STATION NAME** has been operationally unavailable to provide black-start capability for ninety (90) consecutive days from **DD/MM/YY (1)** to **DD/MM/YY (2)**. In line with the requirements detailed in 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"* and as agreed in the Ancillary Services Purchase Agreement between System Operator and Company Name, **POWER STATION NAME** is now in a Default State for black-start capability.

While in a Default State, contractual implications for **POWER STATION NAME** will be enforced from **DATE** onwards (as detailed in the signed Ancillary Services Purchase Agreement). **POWER STATION NAME** will remain in a Default State until such time that operational availability is restored and confirmed.

If **POWER STATION NAME** remains in a Default State due to continued black-start unavailability for a further ninety (90) consecutive days from **DD/MM/YY (2)** onwards without restoring their operational availability, then the facility will be eligible for decertification.

Approved by:

_____

Name Surname

General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix F – BLACK-START DECERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

DECERTIFICATION OF POWER STATION NAME FOR BLACK-START

This letter serves to confirm that **POWER STATION NAME** has been operationally unavailable to provide black-start capability for one-hundred-and-eighty (180) consecutive days from **DD-MM-YY (1)** to **DD-MM-YY (2)**. This follows from the facility being declared to be in a Default State on **DD-MM-YY (3)** as per the letter sent on **DD-MM-YY (4)**.

In line with the requirements detailed in 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"* and as agreed in the Ancillary Services Purchase Agreement between System Operator and Company Name, **POWER STATION NAME** is hereby decertified for black-start capability.

This decertification (and any associated implications as detailed in the signed Ancillary Services Purchase Agreement) will remain in place until such time that **POWER STATION NAME** demonstrates black-start capability via the successful execution of a partial black-start test.

Approved by:

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix G – BLACK-START TEST REPORT REQUIREMENTS

A. 3-Yearly Capability Test Report

As stated in 3.2.1 (8), the black-start facility shall issue a test report to AS following completion of the black-start test. The details of the report shall include (but is not limited to) the following:

(1) Date and time of test

(2) Agreed scope of work

(3) Test results

(4) Detailed sequence of operational events (with times and sign-off per milestone)

(5) Discussion of results (incl. explanation of any delays or deviation from program, F/V control findings, etc.)

(6) Relevant trends/graphs with associated data in 1-second resolution

a. Emergency plant (e.g., black-start diesel generators) key parameters

I. Turbine speed per machine (rpm)

II. Active power generated per machine (kW or MW as most applicable)

III. Generator terminal voltage per machine (kV)

b. Generating unit(s) key parameters

I. Active power generated and sent out (MW)

II. SCO load per generator (where applicable) (MW)

III. Reactive power injected/absorbed per generator (MVAr)

IV. Generator terminal speed (rpm)

V. Generator frequency (Hz)

VI. Generator terminal voltage (kV)

VII. HV-side generator transformer voltage (kV)

(7) Recommendations (Test outcome, future improvements)

B. Monthly Routine Test Report

As stated in 3.2.7.2, the black-start facility shall issue a monthly test report to AS following completion of routine testing of emergency start-up equipment. The details of the report shall include (but is not limited to) the following:

(1) Date and time of test runs per machine

(2) Monthly percentage availability per machine

(3) Success status of test runs

(4) Fuel consumption per test run per machine

(5) Month-end and monthly minimum bulk fuel tank levels

(6) 1-second resolution data and associated trends during each test run per machine for:

a. Active power generated (MW)

b. Turbine speed (rpm)

c. Generator terminal voltage (kV)

(7) Status of DC system health and other relevant technical indicators

Appendix H – SELF-START CERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

CERTIFICATION OF (POWER STATION NAME) FOR SELF-START CAPABILITY

This certificate serves to confirm that **POWER STATION NAME** has been tested for self-start capability and has met the requirements of the South African Grid Code and 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"*. The Station is hereby **CERTIFIED** to provide self-start as stated in the Ancillary Services Agreement between the System Operator and Company Name.

This certification is valid from the test date **DD/MM/YY (1)** for 36 months until **DD/MM/YY (2)**, at which point a routine test will be required for recertification, as per South African Grid Code requirements.

Approved by:

_____

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix I – SELF-START DEFAULT STATE NOTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

NOTIFICATION OF DEFAULT STATE FOR (POWER STATION NAME) DUE TO SELF-START UNAVAILABILITY

This letter serves to confirm that **POWER STATION NAME** has been operationally unavailable to provide self-start capability for ninety (90) consecutive days from **DD/MM/YY (1)** to **DD/MM/YY (2)**. In line with the requirements detailed in 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"* and as agreed in the Ancillary Services Purchase Agreement between System Operator and Company Name, **POWER STATION NAME** is now in a Default State for self-start capability.

While in a Default State, contractual implications for **POWER STATION NAME** will be enforced from **DATE** onwards (as detailed in the signed Ancillary Services Purchase Agreement). **POWER STATION NAME** will remain in a Default State until such time that operational availability is restored and confirmed.

If **POWER STATION NAME** remains in a Default State due to continued self-start unavailability for a further ninety (90) consecutive days from **DD/MM/YY (2)** onwards without restoring their operational availability, then the facility will be eligible for decertification.

Approved by:

_____

Name Surname

General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix J – SELF-START DECERTIFICATION LETTER

Division/Company Name
General Manager: Name Surname
Address Line 1
Address Line 2
Address Line 3
Postal Code

Date:
dd-mm-yyyy

Enquiries: AS Manager
Tel +27 11 xxx xxxx

Dear Name Surname,

DECERTIFICATION OF POWER STATION NAME FOR SELF-START

This letter serves to confirm that **POWER STATION NAME** has been operationally unavailable to provide self-start capability for one-hundred-and-eighty (180) consecutive days from **DD-MM-YY (1)** to **DD-MM-YY (2)**. This follows from the facility being declared to be in a Default State on **DD-MM-YY (3)** as per the letter sent on **DD-MM-YY (4)**.

In line with the requirements detailed in 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"* and as agreed in the Ancillary Services Purchase Agreement between System Operator and Company Name, **POWER STATION NAME** is hereby decertified for self-start capability.

This decertification (and any associated implications as detailed in the signed Ancillary Services Purchase Agreement) will remain in place until such time that **POWER STATION NAME** demonstrates self-start capability via the successful execution of a routine self-start test.

Approved by:

_____

Name Surname
General Manager: System Operator

TRANSMISSION: SYSTEM OPERATOR

Appendix K – SELF-START TEST REPORT REQUIREMENTS

A. 3-Yearly Capability Test Report

As stated in 3.3.1 (8), the self-start facility shall issue a test report to AS following completion of the self-start test. The details of the report shall include (but is not limited to) the following:

(1) Date and time of test

(2) Agreed scope of work

(3) Test results

(4) Detailed sequence of operational events (with times and sign-off per milestone)

(5) Discussion of results (incl. explanation of any delays or deviation from program, F/V control findings, etc.)

(6) Relevant trends/graphs with associated data in 1-second resolution

a. Emergency plant (e.g., self-start diesel generators) key parameters

I. Turbine speed per machine (rpm)

II. Active power generated per machine (kW or MW as most applicable)

III. Generator terminal voltage per machine (kV)

b. Generating unit(s) key parameters

I. Active power generated and sent out (MW)

II. SCO load per generator (where applicable) (MW)

III. Reactive power injected/absorbed per generator (MVAr)

IV. Generator terminal speed (rpm)

V. Generator frequency (Hz)

VI. Generator terminal voltage (kV)

VII. HV-side generator transformer voltage (kV)

(7) Recommendations (Test outcome, future improvements)

B. Monthly Routine Test Report

As stated in 3.3.4.2, the self-start facility shall issue a monthly test report to AS following completion of routine testing of emergency start-up equipment. The details of the report shall include (but is not limited to) the following:

(1) Date and time of test runs per machine

(2) Monthly percentage availability per machine

(3) Success status of test runs

(4) Fuel consumption per test run per machine

(5) Month-end and monthly minimum bulk fuel tank levels

(6) 1-second resolution data and associated trends during each test run per machine for:

a. Active power generated (MW)

b. Turbine speed (rpm)

c. Generator terminal voltage (kV)

(7) Status of DC system health and other relevant technical indicators

Appendix L – ANCILLARY SERVICES DECLARATION

1. Basic Information

Power Station	POWER STATION NAME	**Declaration Date and Time**	dd/mm/yyyy hh:mm

2. Product

Instantaneous Reserves		Black-start	
Regulating Reserves		Unit Islanding	
Ten-minute Reserves		Voltage Control	
Emergency Level 1		Synchronous Condenser Operation	
Instantaneous Demand Response		Self-start	
Supplemental Demand Response		Constrained Generation	

3. Unit Declaration

	Available (Y/N)	**Validity (hrs)**	**Comment**
Unit 1			
Unit 2			
Unit 3			
Unit n			

4. Facility Declaration (for black-start or self-start facilities)

	Available (Y/N)	**Validity (hrs)**	**Comment**
Emergency start-up equipment			
Generating units			
Reactive power operating modes			
Additional reactive power control plant			

5. Confirmation of Validity

I hereby certify that the declarations provided above are correct at the time of submission and is in keeping with the availability requirements of 559-217028319, *"Certification and Performance Monitoring Standard for System Restoration Services"*. Any change to the availability status declared above will be issued in writing within 24 hours. In the absence of any changes, a new declaration will be issued on **dd/mm/yyyy (2)** at **hh:mm (2)**

Approved by:

_____

Name Surname

Management Designation

Power Station Name