

	Standard	NTCSA/System Operator/Ancillary Services
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Title: **Certification and Performance Monitoring for Generators Capable of Providing Reactive Power Support**

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1. Introduction

This standard details the requirements for certification and performance monitoring of reactive power support services from Generators (including IPPs) on the Interconnected Power System (IPS). These reactive power support services are specified in the Ancillary Services Technical Requirements (ASTR) which is updated yearly, allowing the System Operator to procure those services from various service providers via a contractual agreement. These services are comprised of dynamic voltage control from generating units capable of providing reactive power support. The South African Grid Code (SAGC) requires that the service providers / generators connected to the network, adhere to the stipulated requirements in the codes whilst the System Operator (SO) intends to contract additional reactive power services from capable generators for system voltage control. The service providers shall be required to adhere to the generator voltage control certification and performance requirements stipulated in this standard to ensure SO achieves system reliability targets as defined in the Grid Code.

2. Supporting Clauses

2.1 Scope

This document focuses on testing, certification, de-certification, and performance monitoring for generators capable of providing reactive power support.

2.1.1 Purpose

The aim of this standard is to ensure that transmission busbar voltage levels, reactive power flows and reactive power support from generators are monitored, maintained, and controlled within acceptable limits.

2.1.2 Applicability

This document shall apply throughout National Transmission Company South Africa SOC Ltd, its business units and functional areas, as well as all generators connected or planning to connect to the interconnected power system.

2.1.3 Effective date

This document is effective from date of authorisation.

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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] South African Grid Code (SAGC)
- [2] 240-159838031 Ancillary Services Technical Requirements for 2025/26 – 2029/30
- [3] 240-180300098 Certification and Performance Monitoring for Generators Capable of Operating in a Synchronous Condenser Mode

2.2.2 Informative

- [4] ISO 9001 Quality Management Systems.

2.3 Definitions

Definition	Description
Ancillary Services	As per the SAGC, these are services supplied to the NTCSA by generators, distributors, or end-use customers, necessary for the reliable and secure transport of power from generators to distributors and other customers, as defined in the System Operation Code, section 4.
National Transmission Company	As per the SAGC, this is the South African legal entity licensed to execute the national transmission responsibility. It consists of a System Operator and a national transmission network service provider.
Declared Voltage	Declared by the licensee as the voltage at the point of supply.
Facility	A generation facility which converts primary energy to electrical energy which consists of one or more Power Generating Modules connected to a network at one or more Connection Points.
Generator	As per the SAGC, this is a legal entity licensed to engage in the production of electricity through a unit or power station.
Independent Power Producer	Any undertaking by any person or entity which the government of South Africa does not hold a controlling ownership interest (whether direct or indirect), of new generation capacity at a generation facility following a determination made by the Minister of Energy in terms of section 34(1) of the Act.
Maximum Continuous Rating (MCR)	As per the SAGC, this is the sent-out capacity that a unit is rated to produce continuously under normal conditions.

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Service Provider	A legal entity who contracts to provide ancillary services and operates one or more units or one or more facilities that supply power or capabilities to the Transmission or Distribution System.
System Operator	A legal entity licensed to be responsible for short term reliability of the interconnected power system (IPS), which oversees controlling and operating the transmission system and dispatching generation (or balancing the supply and demand) in real time basis.
Under Voltage Event	An event where the voltage supplied reduces to a value of less than 0,85 p.u. of the standard or declared voltage for more than 3seconds on one or more phases.
Voltage Control	The ability of a power system to maintain steady acceptable voltages at all buses in the system under normal operating conditions and after being subjected to a disturbance.

2.4 Abbreviations

Unit – As defined in the Grid Code

Abbreviation	Explanation
AS	Ancillary Services
ASPR	Ancillary Services Performance Report
ASTR	Ancillary Services Technical Requirement
AVR	Automatic Voltage Regulator
BB	Busbar
CO	Commercial Operation
EMS	Energy Management System
GC	Grid Code
GCM	Grid Code Management
GCR	Grid Code Requirement
IPP	Independent Power Producer
IPS	Interconnected Power System
MCR	Maximum Continuous Rating
MW	Megawatt
NC	National Control
NERSA	National Energy Regulator of South Africa
PCC	Point of Common Coupling
RP	Reactive Power
SAGC	South African Grid Code
SO	System Operator

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Abbreviation	Explanation
SP	Service Provider
TS	Transmission System
VC	Voltage Control

2.5 Roles and Responsibilities

2.5.1 Ancillary Services, System Operator

- The Ancillary Services is responsible for managing the testing, certification, budgeting, contracting and compensation for all contracted service providers, as well as defining technical requirements and minimum standards applicable to all potential service providers.
- Ancillary Services is also responsible for providing a support function to NC regarding real-time availability and performance of generators, under normal and emergency conditions.

2.5.2 National Control, System Operator

- National Control (NC) is responsible for managing the operation of the Power System in a safe, economical and secured manner, while maintaining reliability and quality of supply.
- NC maintains the transmission system voltages within the statutory limits by switching the reactive power equipment and utilising generators to support the system.

2.5.3 National Control System Support, System Operator

National Control System Support (NCSS) is responsible for providing operational support, EMS data support and relevant SO system/s software support during certification and performance monitoring of service providers.

2.5.4 Grid Code Management, System Operator

- Grid Code Management is responsible for approving all the GCR compliance tests including reactive power before the unit achieves commercial operation (CO).
- GCM is also responsible for ensuring the compliance status of the Generators required to provide reactive power support, as per GCR4.

2.5.5 Service Providers

- Service providers that are contracted to provide voltage control, are responsible for providing these services to the System Operator, as stipulated in their respective contracts in line with the minimum performance standards stipulated in this standard.

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- Where SO highlights poor performance, service providers are responsible for ensuring that performance is improved up to the acceptable level as soon as possible.
- The service providers are responsible for acknowledging and responding to National Control's requests as required on a real time basis, as well as providing a dynamic response to system voltage changes under normal and abnormal conditions (which requires that service providers ensure that plant or systems that are required to enable voltage control capabilities are in working order when generating units are in service).

2.6 Process for Monitoring

Refer to document content.

2.7 Related/Supporting Documents

240-180300098, Certification and Performance Monitoring for Generators Capable of Operating in a Synchronous Condenser Mode

3. REACTIVE POWER CAPABILITY TESTING/CERTIFICATION AND PERFORMANCE MONITORING REQUIREMENTS

The contents of this document covers the generator reactive power capability testing, certification and performance monitoring requirements and processes. The Grid Code and the ASTR also guide the contents.

3.1 VOLTAGE CONTROL TESTING AND CERTIFICATION REQUIREMENTS

Generators are required to test their reactive power capabilities every six years or after a major general overhaul (GO), or whichever comes first based on the Grid Code or certified power factor requirements. The generator shall be required to either conduct a prototype test (new generators) or a routine tests (existing generators). System Operator (SO) shall assess and issue a certificate for successful tests, otherwise the generator shall be expected to test again after an unsuccessful test.

3.1.1 Prototype Testing Requirements

- (1) Prototype tests are conducted on new generators as part of Grid Code compliance in preparation for commercial operation (CO).

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- (2) If the test is successful (in conjunction with all other required tests being completed successfully), the generator capable of providing the required power factor range, will then be given the CO letter of confirmation by Grid Code Management and will be certified to provide reactive power by AS.

3.1.2 Routine Testing Requirements

- (1) This type of test is applicable to those generators which have already been certified in terms of GCR4 or/and according to ancillary services requirements.
- (2) Once the generator is certified for the provision of reactive power, the generator is then obliged to conduct a routine test on a six yearly interval or after a general overhaul (GO) that had an effect on the machine's capability to provide reactive power, whichever comes first.
- (3) If the routine test is not successful, the generator is required to retest until the test is successful. Should the test fail in three consecutive attempts, the generator will be eligible for decertification.

3.1.3 Voltage Control Testing Methodology

The generator shall carry out routine and prototype response tests in order to demonstrate the required reactive power capabilities. The following steps shall be taken into consideration when performing the reactive power tests and these steps are applicable for either prototype or routine tests.

- (1) The reactive capability shall be tested for all modes of operation of the generating unit.
- (2) The generator may change the AVR set-point and/ or main transformer tap setting in order to achieve the required machine operating point. However, the machine must be able to operate at the AVR set-point and/or main transformer tap setting under normal operating conditions. It may be necessary to change the tap settings of adjacent units to achieve the required operating point, provided that it would not impose undue risk to the adjacent units or to the power system.
- (3) The measurements shall include:
 - Active power, reactive power and voltage on both sides of the main transformer.
 - The main transformer tap setting;
 - Active and reactive power on the primary windings of the unit transformers.
 - Generator Field current/ECS Exciter output excitation current.

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- Generator operating temperatures.
 - Generators step up transformer operating temperatures.
- (4) The test shall be performed at 100% of MCR active power and at least 100% of maximum reactive power in both leading (inductive/importing from IPS) and lagging (capacitive/exporting to IPS) operating modes.
- (5) **For testing in over-excited operation**, the operating point shall be such that the machine is at maximum active and reactive power output or until the boundary value of the effective capability diagram is reached, whichever occurs earlier. This operating point shall be maintained until the machine temperatures have stabilized. It shall be verified that the temperatures of the machine and generator transformer remained within limits that are acceptable for continuous operation.
- In the case where operation at maximum active and reactive power output would cause the generator transformer rating to be exceeded, it is acceptable that the generator output be limited to the point corresponding to rated operation of the transformer. The capability of the machine in question should then be de-rated to this point corresponding to the generator transformer limit.
- (6) **For testing in under-excited operation**; the operating point shall be as close as possible to the under-excitation limiter. It shall be verified that the machine temperatures remained within limits that are acceptable for continuous operation.
- (7) The reactive power capability of the synchronous generator shall be calculated at the generator's rated voltage from the measurements taken during the test (for both over-excited and under-excited operations), which may have been performed at off-nominal conditions

3.1.4 Testing Arrangement and SO Assessment

The Service Provider shall apply formally, in writing (e-mail), to the System Operator stating the intent to get tested for certification and contracting. The start of the test period will be agreed upon between the Service Provider and SO. The facility/unit will be expected to start testing preparations at least 10 working days after the request was received to enable the unit to be registered on the relevant SO system/s. The generator will be tested for one hour in leading and one hour in lagging operating modes.

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To ensure plant reliability, prior arrangements must be done between the Service Provider, Ancillary Services, National Control and Grid Code Management to choose the suitable date and time for the test. As soon as the test is completed, the station (or service provider) have to submit the test report to be assessed before certification process starts. The unit/facility will be certified provided that the test was declared a success by Ancillary Services and a certificate will be issued within 10 working days.

3.1.5 Testing Template

The reactive power testing template serves as a guide to the Service Provider (or generators) on how to test the capability and what data and information is required to enable System Operator to analyse the test results and declare whether the test is successful or not. The certificate template for the requirement of reactive power capability testing can be found in **appendix C** of this standard.

3.1.6 The Reactive Power Success/Acceptance Criteria

The reactive power testing will be declared successful if the generator can;

- i) Operate at machine maximum continuous Mvar absorption (under-excited) at rated voltage for 1 hour. The AVR or tap change settings can be adjusted to achieve the required operating point.
- ii) And/or operate at machine maximum continuous Mvar injection (over-excited) at rated for 1 hour. The AVR or tap change settings can be adjusted to achieve the required operating point.
- iii) The machine should be able to achieve the leading and lagging power factor ranges as stipulated in the code or the certified power factor range.
- iv) It shall be verified that the machine temperatures remained within limits deemed acceptable for continuous operation.

3.1.7 Certification Process

The Service Provider shall perform the test as per the requirements of this standard and the SAGC, and the test report should be issued to System Operator within 2 weeks after the test. System Operator will then evaluate and analyse the results before confirming whether the test was successful or not. System Operator will issue a certificate which is valid for 6 years, otherwise the Service Provider will have to repeat the unsuccessful test.

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The generator is expected to inform the System Operator when there is a change regarding the specified reactive power limits and power factor capability range. The generators that have been tested and certified should not deviate by more than $\pm 5\%$ of the previously certified results when tested again after six years, otherwise they will be requested to test the generator again.

3.1.8 De-certification process

Performance monitoring of the generator shall be done according to this standard and Grid Code requirements which includes testing of the reactive power capability on regular basis every six (6) years. If the reactive power percentage performance is rated less than the acceptable reactive performance criteria for more than three consecutive months, then the Service Provider shall provide a written report to the SO/AS detailing the reasons within one month and rectify the performance. If the performance is not rectified within three months, then:

- The Unit/Service Provider shall be eligible for decertification, and the Ancillary Service certificate withdrawn in respect of reactive power provision. While the stated criteria define eligibility for decertification, the SO shall apply discretion based on system risk. For example, if a generator is technically eligible for decertification but its removal poses a significant risk to system security, the decision to decertify will be subject to system risk assessment(s) or alternative remedial actions considered. This risk-based approach ensures that enforcement does not compromise grid stability

The Unit/Service Provider shall be permitted to apply to the SO for recertification and issuance of the Ancillary Service certificate in respect of reactive power for the Unit following decertification, based on the following:

- The re-certification and issuance of the Ancillary Service certificate in respect of reactive for the Unit shall only be permitted if the Unit/Service Provider is retested successfully.

The service provider shall notify System Operator in writing when the Unit can no longer provide reactive power capability as certified and provide detailed technical description of the problem. If solving the problem will take more than three months, then the unit is advised to apply for a temporary NERSA exemption. The Unit shall be tested every 6 years and any violation may lead to decertification.

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3.2 VOLTAGE CONTROL PERFORMANCE MONITORING

3.2.1 Reactive Power Performance Monitoring

The RP performance monitoring is based on reactive power capability testing conducted every 6 years and ensuring that the generator busbar (BB) voltages are kept within the $\pm 5\%$ limits of the nominal voltage for 95% of time or more in a single month. Generators are expected to respond to RP instruction when requested by National Control to support the power system voltages.

Generator Certification is given a weighting of 40% and BB voltage is given a weighting of 60% to make a total of 100% as shown on the table below. BB voltages are given a high percentage due to generators being expected to respond and support the network voltages under normal and abnormal conditions.

Table 1: Monthly Reactive Power Performance Percentage Assessment Criteria

Parameter	Percentages (%)	Description
Certification	40%	Reactive Power capability test requirement every 6 years
Busbar Voltage	60%	95% of the time operating the BB voltage within $\pm 5\%$ of the nominal voltage

The monthly RP certificate score will be “1” if a generator has a valid certificate and “0” if a generator has an expired certificate as shown in the table 2 below.

The monthly BB voltage score will be “1” if the BB voltage was operated within the $\pm 5\%$ of the nominal voltage for 95% of the time or more, otherwise it will be a score of “0” if the BB voltage was operated outside of the $\pm 5\%$ of the nominal voltage for less than 95% of the time as shown in table 2 below.

Table 2: Monthly Reactive Power Performance Assessment Criteria

Parameter	Score	Description
Certification	1	Valid Reactive Power (RP) Capability Certificate
	0	Expired RP Capability Certificate
Busbar Voltage	1	> 95%
	0	< 95%

The monthly performance factor will be calculated as follows:

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- Monthly performance score per unit = (0.4 x Certificate) + (0.6 x BB Voltage).
 - Thus, Station monthly performance = Total monthly performance score per unit

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
Raj Pandaram	Integrated Power System Reliability Services Manager, System Operator
Phokoane Moshodi	Grid Code Management Manager, System Operator
Lyle Naidoo	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
Elizabeth Marikela	Power System Manager, System Operator
Nico Fourie	Power System Manager, System Operator
Bonginkosi Sibeko	Chief Engineer, System Operator
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Maite Sako	Chief Engineer, System Operator
Target Mchunu	Chief Engineer, System Operator
Ike Tshwagong	Chief Engineer, System Operator
Zakhele Mbungela	Engineer, System Operator

5. Revisions

Date	Rev.	Compiler	Remarks
January 2026	1	SJ Malakapatlo	First issue

6. Development Team

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

1. Ike Tshwagong
2. Selaelo Malakapatlo

7. Acknowledgements

N/A

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**APPENDIX A: SYSTEM VOLTAGE AND POWER FACTOR LIMITS INCLUDING VC
FLOW CHART**

Table 3: System voltage limits and generator power factor limits

Transmission Network		
Voltage	Normal Conditions	Disturbance Conditions
88kV, 132kV, 400kV and 765kV	±5% of nominal	±5% of nominal
Generators/Service Provider		
Power Factor	Lagging	Leading
Generators/IPPs	0.85	0.95
Renewables	0.95	0.95

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APPENDIX B: GENERATOR TESTING AND CERTIFICATION RACI MATRIX

R = Responsible, A = Accountable, C = Consulted, I = Informed

Process		Key Function	R	A	C	I	Deliverable
Reactive Power Capability Requirement	Capability Tests (before or after CO)	a) Testing of the Unit to prove Reactive Power Capability	SP	SP	AS&GCM		Unit test procedure & schedule
		b) Compilation and submission of the raw data and test report for assessment by the System Operator	SP	SP	AS/GCM		Capability test report
		c) Assessment and acceptance of the raw data and test report for all Generating Units.	AS	AS	GCM/SP	GCM/SP	AS assessment report
		d) Feedback & issuing of certificates to Units (compliant to the GCR 4 capability test (Prototype)).	AS	GCM		SP	Capability test certificate
		e) Feedback & issuing of certificates to all Generating Units (Routine).	AS	AS		GCM/SP	Capability test certificate
	Performance Monitoring (before or after CO)	f) Monitoring of the contracted Units to observe reactive power capability.	AS	AS		GCM/SP	ASPR dashboard
		g) Non-performance & exemption of Units built after the code is done through the GC governance process.	GCM	GCM	AS	SP/AS	Temporary or permanent exemption
		h) Non-performance & decertification of Units contracted by AS.	AS	AS		GCM/SP	Decertification report
		i) Coordinate waivers for all Generating Units .	AS	AS	GCM	SP	Waiver request letters

AS – Ancillary Services
GCM – Grid Code Management
SP – Service Provider

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APPENDIX C: CERTIFICATION TEMPLATE



SYSTEM OPERATOR

**Testing Template for Reactive Power (RP)
Certification**

Compiled by

Functional Responsibility

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.....

Date:

Date:

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1. Basic Information

Service Provider	Test Date	Start Time
				End Time

2. Process

Certification	X	Decertification	
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3. Product

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

4. Reason for Certification

Service Provider conducted Reactive Power capability tests as per this standard for voltage control certification.

5. Test Results/Supporting Information

- Leading (inductive/importing from IPS) and Lagging (capacitive/exporting to IPS) Reactive Power Testing
 - The test shall be performed at 100% of MCR active power and at least 100% of maximum reactive power in both leading (inductive/importing from IPS) and lagging (capacitive/exporting to IPS) operating modes.
 - Each Reactive power mode either leading or lagging shall be tested for a period of 1 hour.

Date	Time (Duration)	Generator Transformer 400kV Side		
		Mvar	PF	
.....	Lagging
.....	Leading

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Comments:

Testing in over-excited operation, while in Generating mode, the operating point shall be such that the machine is at maximum reactive power output or until the boundary value of the effective capability diagram is reached, whichever that occurs earlier. This operating point shall be maintained until the machine temperatures have stabilized. It shall be verified that the temperatures of the machine and generator transformer remained within limits that are acceptable for continuous operation.

Testing in under-excited operation, the operating point shall be as close as possible to the under-excitation limiter. It shall be verified that the machine temperatures remained within limits that are acceptable for continuous operation. The Service Provider shall calculate the reactive capability at rated machine voltage from the measurements taken during the test, which may have been performed at off-nominal conditions.

6. Recommendations

Under recommendations the Service Provider is expected to state the following;

- (1) Were the tests carried out in line with Voltage Control Certification Standard?
- (2) Did the generator reach the maximum reactive power output for both leading and lagging operation?
- (3) What was the actual maximum reactive power output for both leading and lagging operations?
- (4) Was the operating point maintained until the machine temperatures have stabilised?
 - It shall be verified that the temperatures of the machine and generator transformer remained within limits deemed acceptable for continuous operation.

Yours sincerely

Name Surname

**GENERAL MANAGER: POWER STATION NAME
COMPANY/DIVISION**

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APPENDIX D: CERTIFICATION FORM

POWER STATION NAME		
UNIT NUMBER		
DATE		
Reactive power test results		
GENERATING		
Over-excited (lagging power factor):		
▪ Generator active power at which test performed (>95% MCR)		MW
▪ Generator reactive power at rated real power output		Mvar
▪ Generator terminal voltage		kV
▪ Generator current		kA
▪ Voltage on HV side of main transformer		kV
▪ Tap setting of main transformer		
▪ Active power of auxiliaries		MW
▪ Reactive power of auxiliaries		Mvar
▪ Active power measured on HV side of main transformer		MW
▪ Reactive power measured on HV side of main transformer		Mvar
Under-excited (leading power factor):		
▪ Active power at which test performed (>95% MCR)		MW
▪ Reactive power at which under-excitation limiter becomes active		Mvar
▪ Generator terminal voltage		kV
▪ Generator current		kA
▪ Voltage on HV side of main transformer		kV
▪ Tap setting of main transformer		
▪ Active power of auxiliaries		MW
▪ Reactive power of auxiliaries		Mvar
▪ Active power measured on HV side of main transformer		MW
▪ Reactive power measured on HV side of main transformer		Mvar
POWER STATION NAME		
UNIT NUMBER		
DATE		
Voltage control test results		
MACHINE VOLTAGE REGULATION TEST		
Minimum machine terminal voltage (physical and percentage of rated)		kV, %
Maximum machine terminal voltage (physical and percentage of rated)		kV, %
MAIN TRANSFORMER VOLTAGE REGULATION TEST		
Minimum open circuit HV voltage at rated machine voltage		kV
Maximum open circuit HV voltage at rated machine voltage		kV
Certification form accepted		
Signed: (Generator)		Signed: (System Operator)
Date:		Date:

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APPENDIX E: CERTIFICATION LETTER

(Power Station Manager Name and Surname)

Date:

(Power Station Manager)

dd-mm-yyyy

(Power Station Name)

Enquiries:

(Power Station Address)

Tel +27 11 XXX XXXX

Dear (Power Station Manager Name)

**RE: CERTIFICATION OF (POWER STATION NAME/SERVICE PROVIDER), UNIT (UNIT NUMBER)
FOR REACTIVE POWER CAPABILITY**

This certification letter serves to confirm that ... "Power Station Name" ..., unit ... ("*Unit Number*") ... has verified its reactive power capability range according to the standard "*Certification and Performance Monitoring of Generators Capable of Providing Reactive Power (RP) Support*". Ref "**559-2053203657**". The unit is hereby certified according to the test held on ..."XXXX-XX-XX", ("*date of test*") for the reactive power capability as per the diagram attached and for the following range:

Date	Time (Duration)	Generator Transformer 400kV Side		
		Mvar	PF	
.....	Lagging
.....	Leading

The certification is valid for a period of 72 months from the date of the successful reactive power test, "XXXX-XX-XX, ("*from date*") to "XXXX-XX-XX" ("*to date*").

Yours sincerely

Name & Surname
**GENERAL MANAGER: SYSTEM OPERATOR
TRANSMISSION**

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