	Guideline	**Transmission/** **System Operator/** Grid Code Management

Title: **Power Stations Frequency Tests Guideline**

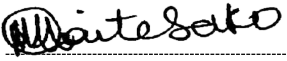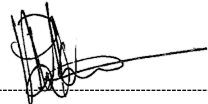|	
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Content

Tables

1. Introduction

This document provides guidance for the *units* that are to demonstrate Instantaneous Reserves (IR) capability and mandatory over frequency governing.

2. Supporting Clauses

2.1 Scope

This guideline is applicable but not limited to the following electrical energy technologies:

- Coal
- Gas
- Hydro
- Renewable Power Plants

2.1.1 Purpose

The purpose of this document is to provide the guideline to the power stations as to how to conduct frequency tests for IR and/or mandatory governing capability as defined in the South African Grid Code.

2.1.2 Applicability

The document is applicable to Transmission System Operator and the Generator.

2.1.3 Effective date

The effective date is as per authorisation date.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed below:

2.2.1 Normative

[1] SAGC Governance Version 10

[2] SAGC System Operation Code Version 10

[3] SAGC Network Version 10

[4] SAGC Information Exchange Version 10

[5] SAGC Preamble Version 10

[6] 240-110150430 Certification And Performance Monitoring Of Generation Reserves

2.2.2 Informative

N/A

2.3 Definitions

- *Generator* - A legal entity licensed to engage in the production of electricity through a *unit* or *power station.*

- *Unit* – An *alternator* and all the related equipment, including the *generator transformer* that can be connected to the *TS.*

- *Power station* – One or more *units* at the same physical location.

2.4 Abbreviations

Provide explanations of terms and abbreviations including documents, titles and departmental references that may cause confusion if not explained, and that are used in this document.

Abbreviation	Explanation
AGC	Automatic Generation Control
Hz	Hertz
IR	Instantaneous Reserves – means Primary Frequency Control, Frequency Bias or Frequency Compensation
rpm	Revolutions per minute
SAGC	South African Grid Code
SO	System Operator
TS	Transmission system
MW	Megawatt/s

2.5 Roles and Responsibilities

- **System Operator** – Ensures that the Generator complies with the South African Grid Code from which this document was derived and manages this document.

- **Generator** – It is the responsibility of the Generator to demonstrate compliance to the SAGC and also to send the test results for the tests herein to the System Operator (Grid Code Management department)

2.6 Process for Monitoring

The original document will be kept at the SO document centre and reviewed every three years.

2.7 Related/Supporting Documents

N/A

3. Power Stations Frequency Tests Guideline

The following guidelines aim to assist *power stations* align their frequency response tests with the grid code requirements listed in the SAGC - Network Code.

Power Stations with unit simulators, where feasible, are encouraged to test the response capabilities of their units on the simulators first, using the procedures below. This will provide some assurance prior to the actual tests and provide opportunity to confirm the implemented philosophies.

All tests will be done with AGC switched off, to avoid the possible influence of AGC on the test results.

The starting load points for each test will be determined by each site, taking into consideration the amount of load to be added or reduced, as the case may be. As an initial guideline, the tests should be performed at a load which the units are operated 70% of the time and which supports the required response within the unit capabilities.

3.1 Instantaneous Reserves Tests

As per the Network Code clauses 3.1.6.3 (1), 3.1.6.5 (1), 3.1.6.6 and 3.1.6.7, *units* that are to demonstrate IR capability will carry out the tests following the methodology discussed herein.

In a similar way depicted in Table 1, complete a table prior to demonstration stating the current frequency dead band and droop settings.

	Grid code requirement	As currently applied
Frequency dead band (Hz)	49.85<f<50.15	
Droop setting (%)	4	

Table 1. Instantaneous Response *Unit* settings.

3.1.1 Over-frequency response test

a) Record the steady state running parameters of the *unit* prior to and during the tests including but not limited to MW, turbine speed and frequency. The data must have a maximum of 1 second resolution.

b) Demonstrate *unit* response to frequency excursions in the range 50Hz to 50.5Hz and record *unit* parameters including but not limited to load (MW), frequency (Hz) and speed (rpm). Compliance to the test frequency can be demonstrated as follows [Network Code 3.1.6.3 (1) and 3.1.6.7]:

- o Dead band response – within the dead band (No MW change is expected);
    - • Test – Simulate a frequency rise to 50.15Hz for at least 1 minute.
- o Dead band response – outside the dead band (MW change is expected, refer to Appendix A);
    - • Test – Simulate a frequency rise from within the dead band to 50.25Hz.
    - • The Grid Code requires a minimum response of 3% within 10s (System Operator may ask for a 5% setpoint). The response shall be sustained for at

least 10 minutes. The actual response will depend on the IR limit set by the station. Refer to Appendix A.

3.1.2 Under-frequency response test

a) Record the steady state running parameters of the *unit* prior to simulation and during the tests including but not limited to MW, turbine speed and frequency. The data must have a maximum of 1 second resolution.

b) Demonstrate *unit* response to frequency excursions in the range 49.85Hz to 49.5Hz and record *unit* parameters including but not limited to load (MW), frequency (Hz) and speed (rpm). Compliance to the test frequency can be demonstrated as follows [Network Code 3.1.6.5 (1), 3.1.6.7 and SO code 4.1.1(2)]:

- o Dead band response – within the dead band (No MW change expected)
  - Test – Simulate a frequency fall to 49.85Hz for at least 1 minute.
- o Dead band response – outside the dead band (MW change is expected, refer to Appendix A)
  - Test – Simulate a frequency fall from within the dead band to 49.75Hz.
  - The Grid Code requires a minimum response of 3% within 10s (System Operator may ask for a 5% setpoint). The response shall be sustained for at least 10 minutes. The actual response will depend on the IR limit set by the station. Refer to Appendix A.

Note: Coal-fired *units* not equipped with a dead band facility shall have a droop of 10% or less. At 49.75Hz a *unit* that does not have a dead band and does not limit the response will respond two and a half times more if the *unit* is on a 4% droop. If the desired response from coal-fired *units* is 5% of MCR sent out at 49,75Hz, then this is equivalent to a 10% droop with no dead band.

3.2 Mandatory Over-frequency Response Tests

As per Network Code clause 3.1.6.3 (1), *units* that are to demonstrate Mandatory response capability will carry out the tests following the methodology discussed herein.

In a similar way as depicted in Table 2, complete a table prior to demonstration stating the current mandatory frequency dead band and droop settings.

	Grid code requirement	As currently applied/declared
Mandatory Frequency dead band (Hz)	+500mHz dead band (50.5Hz)	
Droop setting (%)	4	
Minimum Generation	Declared	

Table 2. Mandatory response *Unit* settings and minimum generation.

3.2.1 Over-frequency response tests

The following tests are applicable to prototype units, refurbished units and units that have failed to perform as expected during frequency incidents.

3.2.1.1 With IR switched off

a) Record the steady state running parameters of the *unit* prior to and during the tests including but not limited to MW, turbine speed and frequency. The data must have a maximum of 1 second resolution.

b) Demonstrate *unit* response to frequency excursions in the range of 50.5Hz to 50.8Hz by increasing intensity up to 50.8Hz frequency excursion, for example the first test to 50.6Hz and the second test to 50.8Hz. Record *unit* parameters including but not limited to load (MW), frequency (Hz) and speed (rpm). Compliance to the test frequency can be demonstrated as follows [Network Code 3.1.6.3 (1) and 3.1.6.7]:

   o Dead band response – within the dead band (No MW change expected)

   - Test – Simulate a frequency rise in steps to 50.5Hz for at least 1 minute. For example, steps may be 50.25Hz and 50.5Hz.

   o Dead band response – outside the dead band (MW change is expected, refer to Appendix A)

   - Test 1 – Simulate a frequency rise from within the dead band to 50.6Hz. Sustain for 10 minutes. Remove the simulation and allow the unit to reload and settle at the starting point.

   - At 50.6Hz, a 5% of MCR reduction is expected within 10 seconds.

   - Test 2 – Simulate a frequency rise from within the dead band to 50.8Hz. Sustain for 5 minutes (note - the Grid Code requires 10 minutes). Remove the simulation and allow the unit to reload and settle at the starting point.

   - At 50.8Hz, a 15% of MCR reduction is expected within 10 seconds.

3.2.1.2 With IR switched on.

Note: These mandatory tests with IR switched On **must not be done** on the units where there are limits greater than 10% or no limits to their Instantaneous Reserve.

Repeat the 50.6Hz and 50.8Hz tests done above with IR switched on. The response of the unit must not be less than when IR was switched off.

Record the steady state running parameters of the *unit* prior to and during the tests including but not limited to MW, turbine speed and frequency. The data must have a maximum of 1 second resolution.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Corrie Visagie	Chief Technologist - Generation
Khaya Sobuwa	Chief Engineer – Generation
Machiel Viljoen	Corporate Specialist - Generation
Marathon Ntusi	Chief Engineer – Ancillary Services
Nerino Baruffa	Senior Consultant – Group Technology
Siju Joseph	Middle Manager – Ancillary Services
Target Mchunu	Chief Engineer – Grid Code Management
Themba Khoza	Chief Engineer – Grid Code Management

5. Revisions

Date	Rev.	Compiler	Remarks
May 2020	1	TT Motsei	First issue.

6. Development Team

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

- Marathon Ntusi – Chief Engineer, Ancillary Services

- Maite Sako – Chief Engineer, Grid Code Management

- Olebogeng Katametsi – Engineer, Grid Code Management

- Ruvashan Pillay – Engineer, Grid Code Management

- Khaya Sobuwa – Chief Engineer, Generation

- Corrie Visagie – Chief Technologist, Generation

- Nerino Baruffa - Senior Consultant, Generation.
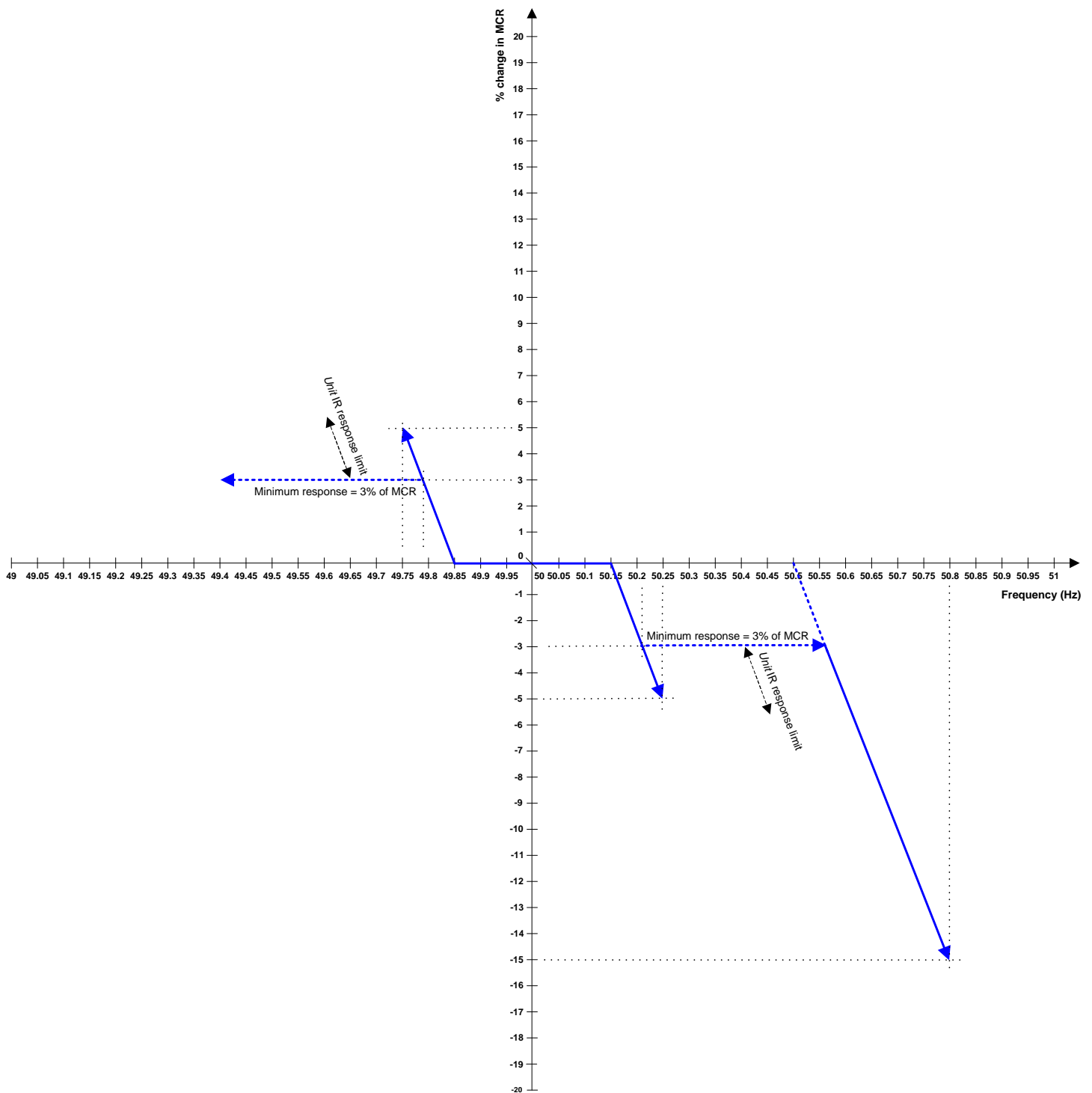
7. Acknowledgements

The constructive discussions and guidance presented by the development team and Generation representatives are hereby highly appreciated – Graphical representation of governing requirements.

Appendix A. IR and Mandatory governing requirements