

 Eskom	<b>STANDARD</b>	<b>Transmission System Operator</b>
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Title: **CERTIFICATION AND  
PERFORMANCE MONITORING  
OF GENERATION RESERVES**

Reference Number: **240-110150430**

Alternative Reference Number: **46-8**

Area of Applicability: **Eskom Holdings SOC  
Ltd**

Functional Area: **Ancillary Services**

Revision: **3**

Total Pages: **36**

Next Review Date: **September 2024**

Disclosure Classification: **PUBLIC**

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Date **15/09/2021**

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Date **15/09/2021**

Date **21 September 2021**

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## **1. INTRODUCTION**

Reserves are procured based on ancillary services technical requirements. The South African Grid Code requires the System Operator to contract for reserves to control frequency. Service providers are required to adhere to the reserve performance requirements to ensure SO achieves minimum system reliability targets as defined in the Grid Code and Southern African Power Pool (SAPP) operating guidelines.

## **2. SUPPORTING CLAUSES**

### **2.1 SCOPE**

This document outlines the procedure for certification, de-certification and performance monitoring for each reserve category.

### **2.2 NORMATIVE/INFORMATIVE REFERENCES**

240-154245832 Control of system frequency under normal and abnormal conditions

SAPP Operating Guideline

Latest Ancillary Service Technical Requirements

SA Grid Code (SAGC)

32-1211 TEMSE AGC functional description

### **2.3 DEFINITIONS**

Unit- As defined in the grid code

Facility – means 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.

Acceptable performance – Means a percentage performance greater than or equal to 90% over a month or reporting period.

Service Provider - A legal entity who contracts to provide reserves and operates one or more units or one or more facilities that supply power to the Transmission or Distribution System

Instantaneous Reserve - The Instantaneous Reserve is the generating capacity or consumer load contracted to respond to a change in frequency in both directions. The purpose of Instantaneous Reserve is to arrest the frequency at acceptable limits following a contingency, for example a generator trip or customer load reduction. It must respond fully within 10 seconds and must be sustained for at least ten- minutes.

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MCR -The sent out capacity that a unit is rated to produce continuously under normal conditions.

Regulating reserve - Generation capacity or demand side managed load available to start responding to AGC instructions within 10 seconds and be fully activated in ten-minutes. The purpose of this is to allow for enough capacity to control the frequency and control area tie-lines power within acceptable limits in real time.

Ten minute reserve - Generating capacity (synchronised or not) or demand side managed load that can respond within ten-minutes when called upon. The purpose of this reserve is to restore instantaneous reserve and regulation reserve to the required levels after an incident. Emergency reserve is excluded from ten-minute reserve.

Emergency reserve - Reserves that are infrequently used. The SO can use this capacity not only for reserves but also for emergency operation and voltage control.

Supplemental reserve - These are generating capacity or customer loads that can respond within a notice period of ten- minutes to six hours to restore other reserves. This reserve remains utilised until it can be replaced by other capacity or for a maximum duration (at least 2 hours) agreed with the supplier. It is contracted annually with the supplier, and is normally bid available day-ahead through the normal scheduling process. It is required to ensure an acceptable day-ahead risk, and to allow time for cold reserve plant to be called up.

## **2.4 ABBREVIATIONS**

<b>Abbreviation</b>	<b>Description</b>
ACE	Area Control Error
AGC	Automatic Generation Control
AMS	Average of Maximum and Sustained (response)
AS	Ancillary Services, System Operator
CDS	Consistent Data Set
C&I	Control and Instrumentation
DCS	Distributed Control System
DMP	Demand Market Participation
EMS	Energy Management System (e.g. TEMSE)
EL1	Emergency Level 1
IPS	Interconnected Power System

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MCR	Sent-out Maximum Continuous Rating
NC	National Control
NCSS	National Control System Support
PLC	Programmable Logic Controller
RTU	Remote Terminal Unit
SAGC	South African Grid Code
SCADA	System Control and Data Acquisition
SO	System Operator Department
TEMSE	Transmission Energy Management System Evolution
TF	Target Frequency
CE	Control Error

## **2.5 ROLES AND RESPONSIBILITIES**

### **2.5.1 Ancillary Services, System Operator**

The Ancillary Services section is responsible for determining minimum reserve requirements for each reserve category. In addition, AS certifies, manages the performance of service providers and sets the standards for performance.

### **2.5.2 National Control, System Operator**

National Control (NC) operates the Power System in a safe, economical and secure manner, and maintains reliability and quality of supply. NC maintains the frequency within the statutory limits by balancing supply and demand. Reserves are made available for this purpose and frequency control is achieved by following procedure 240-154245832, "Control of system frequency under normal and abnormal conditions", and others. National Control will give feedback on reserves performance problems to AS.

### **2.5.3 National Control System Support, System Operator**

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

### **2.5.3 Service Providers**

Service providers contract via a formal agreement to provide the reserves to the system operator. Service providers offer certified and contracted reserves daily and adhere to minimum performance requirements. Where SO highlights deficient performance, a service provider shall ensure that steps are taken to rectify performance as soon as possible.

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## **2.6 PROCESS FOR MONITORING**

Not applicable

## **2.7 RELATED/SUPPORTING DOCUMENTS**

240-154245832, Control of system frequency under normal and abnormal conditions

## **3. CERTIFICATION AND DE-CERTIFICATION OF ALL RESERVE CATEGORIES**

### **3.1 PRE-CERTIFICATION PROCESS**

The Service provider will ensure that all systems, interfaces and signals are commissioned before applying for certification. The Service provider will apply formally, in writing, to the Ancillary Services (AS) section for certification and send the information required about each resource. Appropriate metering of each unit's generation must be available to National Control's Energy Management System at 4-second time intervals or higher resolution. The data requirements are included in section 10 for each category.

The test period will be agreed upon between the Service providers and AS. For new facility/unit the start will be at least **10 working days** after the request was received to enable the unit to be registered on the relevant SO system(s) and for the AS staff to arrange necessary tests.

Before the unit/ facility can be certified, the unit/ facility will be recorded as Uncertified in relevant SO system(s).

### **3.2 CERTIFICATION PROCESS**

The details of the required tests are given under each category. Once the test is completed successfully a written record of the test results will be compiled and archived by AS. A signed certificate will be prepared by AS and posted to the Service provider, and the facility will be stored by AS within 10 working days after performing the last test. The information recorded on the certificate is as shown under appendix A. Other information about the facility will also be stored as described in Section 10. Any costs incurred by the Service provider in the certification process will be for the account of the Service provider.

### **3.3 PERFORMANCE MONITORING**

A contracted/ certified facility shall be monitored over a month or reporting period. Acceptable performance is deemed as having a percentage performance greater than or equal to 90% over a month or reporting period else it will be classified as poor performance.

### **3.4 RE-CERTIFICATION PROCESS**

#### **3.4.1 Negotiated and compulsory derating**

If performance of a facility remains below the acceptable performance for at least **three** consecutive months then AS may request the Service provider to accept a lower certified capacity provided it is above the minimum requirement as set out in 3.4.3.

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### **3.4.2 Requested change in certified capacity**

The Service provider or AS may at any time request a change up or down in the certified capacity of a resource. This may then be negotiated and agreed between the parties concerned.

### **3.4.3 Minimum Certified Capacity**

Minimum certification levels are set as follows:

<b>Service</b>	<b>Minimum certified capacity</b>
Instantaneous reserve	3% of MCR
Regulating reserve	10% of MCR
Ten-minute reserve	10% of MCR
Emergency level 1	1% of MCR
Non-Emergency Level1 reserve	10 % of MCR
Supplemental	10% of MCR

## **3.5 DE-CERTIFICATION PROCESS**

If the performance is below the acceptable performance for at least one month, AS will request the Service provider to investigate the root cause. If the problem is found to lie with SO, then SO should fix the problem within a month. If the problem lies with the Service provider, then the Service provider should fix the problem within one month.

If the response has remained below the acceptable performance for three consecutive months and is below the minimum requirement such that it cannot be de-rated then AS shall decertify the resource unless otherwise agreed with SO.

After de-certification, no payments will be made until the resource is re-certified. This will occur only after a successful certification test.

## **3.6 NON-PROVISION OF SERVICE.**

i) If no service is provided by a facility or a facility is bid unavailable for a reserve category continuously for **three** consecutive months while not on maintenance, the Service provider shall be required to indicate their intention to provide the service in future. A good technical reason must then be furnished to AS and service should be resumed as soon as technically possible.

ii) If the Service provider does not want to provide the service at all in future and provides an adequate reason to AS the resource will be de-certified after an agreement between AS and the Service provider is reached. Where applicable a grid code exemption should be sought.

iii) If the service provider continues to bid the facility unavailable and provides no satisfactory reason for the service not being provided or bid available then AS shall decertify the facility.

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iv) A Service provider shall request de-certification of any of his resources at any time for long standing technical reasons. In this case a **grid code exemption** should be sought.

### **3.7 MEASUREMENTS DATA**

Measurements data for each generating facility/unit should be available in real time via the EMS System Control and Data Acquisition System (SCADA). 4-seconds or higher resolution sent-out data is required on every commissioned generating unit.

If measurements data is not available or is not received by AS, the Service provider must be informed immediately. Data may need to be retrieved from site. If the problem is on the System Operator side, SO will be afforded one month to correct the problem. If the problem lies on the Service provider's side then the Service provider has one month to fix the metering and communications (e.g. for the AGC information). During this period the facility/ unit is expected as far as possible to perform as per the certified capacity.

After one month SO will estimate the unit/facility's performance until such a time that accurate data is available and where necessary performance will be revised accordingly.

## **4. INSTANTANEOUS RESERVE**

### **4.1 CERTIFICATION**

#### **4.1.1 Testing Period**

The service provider shall apply formally, in writing (e-mail), to the Ancillary Services department for certification and send the information required (see **section 10.1**).

The start of the test period will be agreed upon between the Service provider and SO. For new facility/unit the start will be at least **10 working days** after the request was received to enable the unit to be registered on the relevant SO system/s.

To ensure plant reliability while providing IR response, the testing period shall continue for **one month** or until at least two frequency incidents have occurred if this is longer than one month. Testing may occur during commissioning, provided the 4-second metering is received by EMS.

During the test period the unit/facility will have a similar status to a certified unit/facility for all hours of the day except that the resource may not be contracted for reserve and the Service provider will not receive payments during the testing period. The status is "**Uncertified**".

#### **4.1.2 IR settings**

The service provider shall ensure that the following settings are applied before commencing with the test as per the GR6 section of the South African grid code- Network code:

	<b>Setting</b>
Dead-band	+/-150mHz or $49.85 < \text{Hz} < 50.15$
Droop	4%

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#### **4.1.3 Certification criteria**

##### **i) Low frequency incidents**

The criterion for passing the tests is as follows: An average response of several low frequency incidents will be measured over the test period. A low frequency incident occurs whenever the frequency drops below the target frequency (TF) of **49.75 Hz** for longer than 4s. The incident is in force from when the frequency falls below TF until the frequency rises back into the dead band or for **10 minutes**, whichever occurs earlier. However the measurement of sustained response is until the frequency rises above 49.75 Hz.

The initial loading level is the average sent out level during the **ten seconds** before the start time. The start time is defined as the time (snapshot) when the frequency first falls below 49.75 Hz as shown in figure 4.1 and 4.2.

The **Maximum** response is the **maximum** sent out loading over the first ten seconds after the start time minus the initial loading level.

The **Sustained** response is the **average** response during the period starting 10 seconds from the start time and ending 10 minutes after the start time, or when the frequency rises above **49.75 Hz**, whichever occurs first. (See **Fig 4.1** and **4.2**).

The AMS (average of maximum and sustained) response in MW for each incident is measured. AMS Response =  $0.5 * (\text{Maximum Response} + \text{Sustained Response})$ .

The facility/unit qualifies for certification if the average AMS response over all incidents counted in the month exceeds **3.0 % of MCR**.

Only incidents in which the **initial frequency exceeds** or equals **49.85 Hz** and **minimum frequency** is **less** than or equal to **49.75 Hz** will be considered. It is assumed that full governor response occurs below 49.75 Hz due to the action of response limiters on most units.

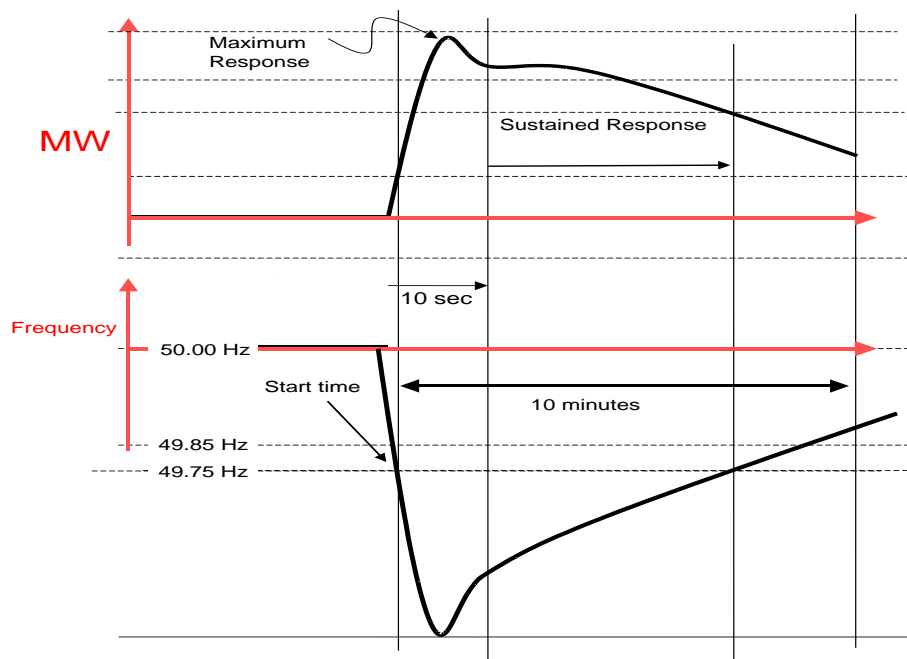
If the unit is offline or if the sent-out loading is near maximum such that the capacity available to pick up to reach the maximum continuous rating (MCR) (minus any recorded load losses) is less than **3.0 % of MCR** then the incident is not used for certification.

The response of each generating unit during each frequency incident may be found in the relevant SO system(s), and each Service provider can view their respective unit's data.

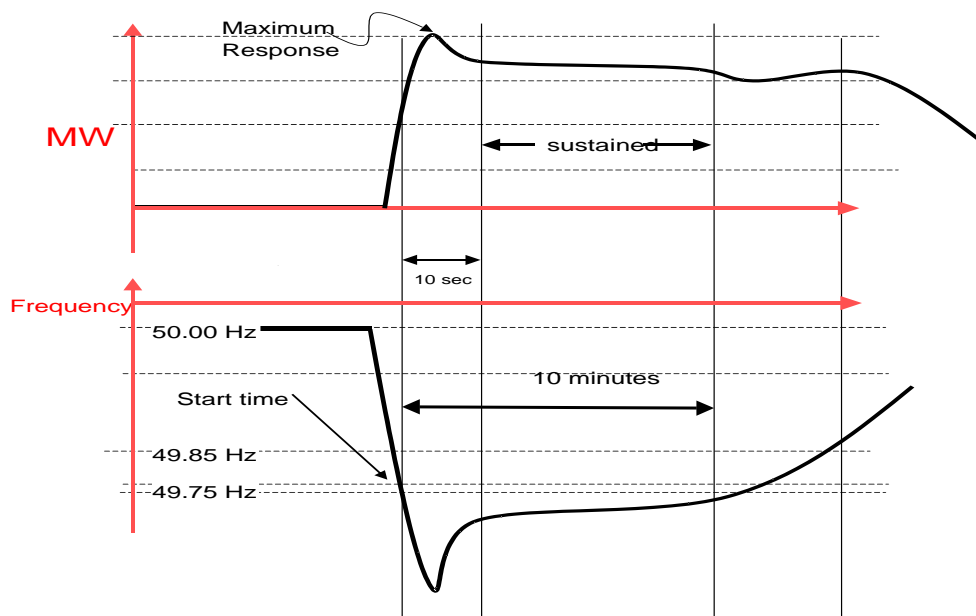
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**Fig 4.1: Low frequency incidents shorter than 10 minutes**



**Fig 4.2: Low frequency incidents longer than 10 minutes**

## ii) High frequency incidents

The criterion for passing the tests is as follows: An average response of several high frequency incidents will be measured over the test period. A high frequency incident occurs whenever the frequency rises above the target frequency (TF) of **50.25 Hz** for longer than 4s. The incident is in force from when the frequency rises above TF until the frequency recovers back to the dead band or for **10 minutes**, whichever occurs earlier. However the measurement of sustained response is until the frequency drops below 50.25 Hz.

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The initial loading level is the average sent out level during the **ten seconds** before the start time. The start time is defined as the time (snapshot) when the frequency first rise above 50.25 Hz as shown in figure 4.3 and 4.4.

The **Maximum** response is the **maximum** sent out loading over the first ten seconds after the start time minus the initial loading level.

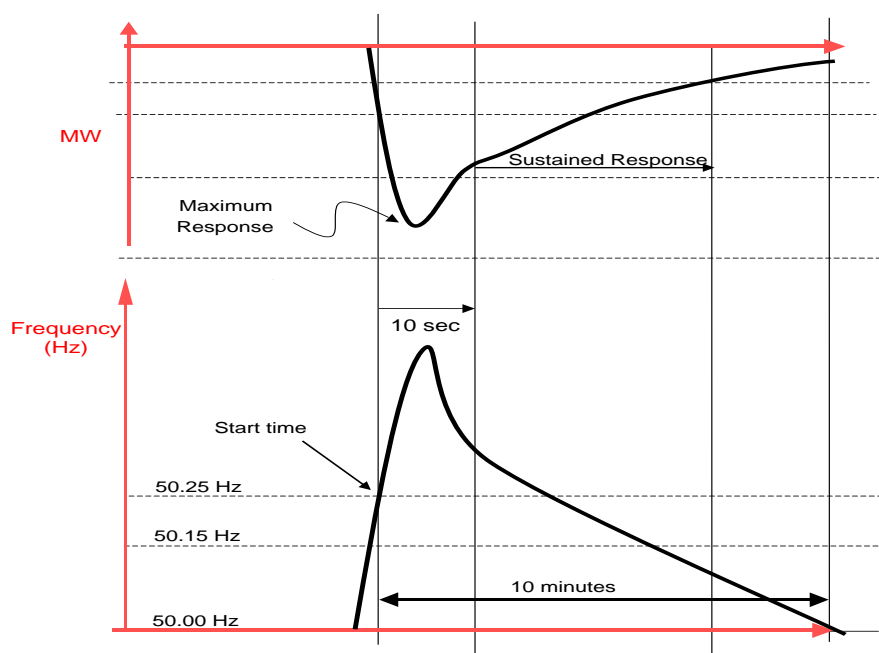
The **Sustained** response is the **average** response during the period starting 10 seconds from the start time and ending 10 minutes after the start time, or when the frequency drops below **50.25 Hz**, whichever occurs first. (See **Fig 4.3** and **4.4**).

The AMS (average of maximum and sustained) response in MW for each incident is measured.  
AMS Response =  $0.5 * (\text{Maximum Response} + \text{Sustained Response})$ .

The facility/unit qualifies for certification if the average AMS response over all incidents counted in the month exceeds **3.0 % of MCR**.

Only incidents in which the **initial frequency is below** or equals **50.15 Hz** and **maximum frequency is greater** than or equal to **50.25 Hz** will be considered. It is assumed that full governor response occurs above 50.25 Hz due to the action of response limiters on most units.

If the unit is offline or if the sent-out loading is near minimum generation limit such that the capacity available to reduce generation to reach the minimum stable generation limit is less than **3.0 % of MCR** then the incident is not used for certification.

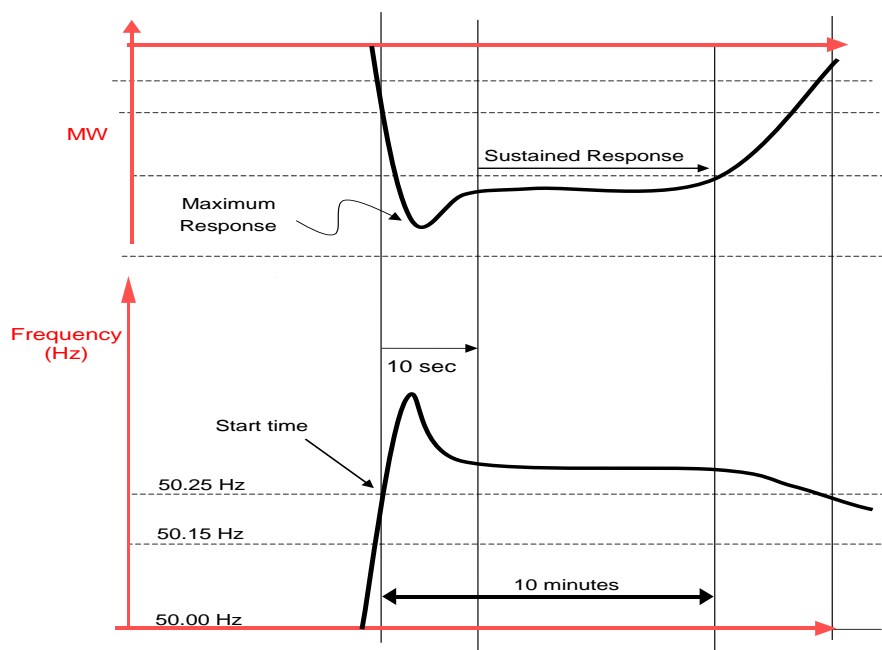


**Fig 4.3: High frequency incidents shorter than 10 minutes**

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**Fig 4.4: High frequency incidents longer than 10 minutes**

The average response over all measured responses in the test month shall be used to determine the **certified capacity** in MW. The certification test will be done based on the incidents that occur however a certified facility/unit shall respond to both low and high frequency incidents. The certification process must be completed by AS within **ten** working days after completing the test. A signed certificate will be sent to the Service provider and also stored by AS for record keeping.

## **4.2 PERFORMANCE MONITORING**

### **4.2.1 Monitoring Process**

The performance of all facility/unit is analysed and a report is sent monthly unless agreed otherwise

A frequency incident is automatically recorded on relevant SO system(s) for reserve performance whenever the frequency drops or exceeds a target frequency, TF of **49.75 Hz or 50.25 Hz**. For units or facilities the 4-second sent-out values as provided by EMS are recorded in relevant SO system(s) for the 10 minutes following each triggered frequency event.

During the first week of every month the **frequency incidents** recorded during the previous month will be analysed to measure the performance of all instantaneous reserve facilities/units, and a report will be sent to all the units concerned.

The unit performance is measured only for incidents in which:

- i) The unit is **online**, and has **bid available** for instantaneous reserve.
- ii) If the unit has bid **inflexible** for the hour it is assumed to be off governing and will not be measured.

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In addition to the above, for low frequency incidents (refer to Figure 4.1 or 4.2):

- the **initial** frequency is greater than or equal to **49.85** Hz and

- the frequency falls **below 49.75** Hz for more than 4 seconds.

-If the unit or facility's initial loading level is closer to the maximum continuous rating (minus recorded load losses) or the available reserve capacity is less than the **certified** instantaneous reserve capacity then the unit is not measured.

In addition to the above, for high frequency incidents (refer to Figure 4.3 or 4.4):

- the **initial** frequency is lower than or equal to **50.15** Hz and

- the frequency increases **above 50.25** Hz for more than 4 seconds.

If the unit or facility's sent-out loading is near minimum generation limit such that the capacity available to reduce generation to reach the minimum stable generation limit is less than the certified instantaneous reserve capacity then the unit or facility is not measured.

For each low and high frequency incident the maximum response in the first 10 seconds and the sustained response are measured, as described in section 4.1. The average of maximum and sustained response is used: AMS response (MW) = 0.5 \*(Maximum response + Sustained response).

If the AMS response is **negative**, it is set to zero. The percentage response for each incident is the AMS response in MW as a percentage of the **certified** capacity. The average of all percentage responses of included low and high frequency incidents over the month is the percentage performance for the month.

#### **4.2.2 Performance Requirements:**

The performance requirements for instantaneous reserve are based on three frequency ranges as follows:

**Range 1:** 49.85 Hz to 50.15 Hz, this is the frequency dead band where no response is required, hence no monitoring is done in this range.

**Range 2:** For low frequencies, 49.85 Hz to 49.75 Hz and for high frequencies, 50.15 Hz to 50.25 Hz, this is outside of the dead band, a proportional MW response per frequency change is expected from units/facilities.

**Range 3:** For low frequencies, below 49.75 Hz and for high frequencies, above 50.25 Hz, units/facilities shall fully activate their response within 10 seconds.

## **5. REGULATING RESERVE**

### **5.1 CERTIFICATION**

A service provider which requires certification for regulating reserve shall apply formally (in writing) to AS for certification. The unit/facility shall demonstrate capability to AS.

Prior to the certification request, all signals required for AGC operation must be commissioned with NCSS in accordance with information requirements as per SAGC requirements. Further

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the AS and NCSS will test together with the facility's relevant personnel that pulses can be sent from the EMS system successfully and all pulses are received by the unit/facility's AGC equipment and that the unit controller (SCADA, PLC or DCS) works. If this is not working, the hardware / software will need to be fixed before certification is requested.

On requesting certification, the unit/ facility must provide the information as per **Section 10.2** to AS, and a **test date** is agreed between AS, NCSS, NC and the Service provider. At least **10 days' notice** is required. The test date may be postponed if system conditions do not permit the test to proceed. NC will decide on the day

Certification for regulating reserve will consist of the following three tests namely the ramp rate, sustained response and response delay tests.

The following needs to be done before starting the test:

- i) The unit/facility is selected "on" at the station and "on" by National Control.
- ii) Units/Facility performing regulation must be given regulation contracts (EX mode with regulation contracts mode in EMS).EMS

#### **5.1.1 Ramp rate test**

NC instructs the unit/facility to ramp up over the maximum available range to MCR at the highest available ramp rate. This is followed by a ramp down over the same range. The ramp must be done using AGC control. The AS AGC specialist must be present in the control room.

Service provider should prove that the unit/facility is capable of performing the full range and rate that is required for certification. The table below shows the minimum ramp rate and ramp range requirements for regulating units/facility (Ramping requirements may be higher than minimum and as agreed with the SO):

**Table 5:** Minimum ramping requirements for AGC units in the unit's effective capability region as per GRC6 sectioning the grid code.

	<b>Minimum Requirement</b>
Ramp rate (MW/minute)	1.67% of MCR
Ramp range (MW)	10% of MCR

- a) The unit/facility shall be set to a loading level such that there is enough room to start the test with an up ramp. The instantaneous reserve of the facility/unit shall be selected to "off".
- b) SO shall ramp the unit/facility using the EMS ramp test facility at the ramp up rate required and for the full range required.
- c) When the unit/facility has reached the upper limit, a ramp down shall be initiated (within a minute) to return to the initial position at the rate required.
- d) When the ramp is completed, graphs of the test results (ramp up and down with the unit/facility set point and actual generation) will be archived by Ancillary Services.

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### **5.1.2 Sustained Response Test.**

- a) The unit/facility shall run on AGC for at least **six consecutive** hours.
- b) The unit/facility must then move as required by AGC for the test period. Hourly AGC data is captured for the test in relevant SO System(s).
- c) To be certified, the unit/facility's average Control Error (CE) must be less than **the minimum of 1% of MCR or 5MWh per hour for all six hours"**.

If the resource fails, the test may be repeated. Up to 3 attempts are allowed but problems should be fixed before repeating a test. The resource should be able to remain on AGC for the **six consecutive hours** without causing the unit to cycle or cause any instability related problems.

- d) On certification, a graph of the unit/facility for each hour shall be saved and archived by AS. The graphs should also be sent to the Service provider as evidence of the test together with the verdict (pass or fail). If the test is successful a certificate will be issued.

### **5.1.3 Response Delay Test**

The requested movement (AGC pulses) over the time period and the actual sent-out change of the unit are analysed from the ramp test data and data recorded from the six consecutive hours the resource is operated on AGC. Units providing AGC shall commence responding to AGC commands within a maximum of **12 seconds** since the first AGC command.

Once the unit/facility has satisfactorily completed the three tests above, it will be certified for regulating reserve by the Ancillary Services section in System Operator. The following data is sent by AS to the Service provider: the date of test, AGC movement graphs, measured ramp rate achieved during the up and down ramp, the increase in sent-out in MW, pulse performance, and whether the test was successful. A signed certificate will be sent to the service provider and also stored by AS for record keeping.

## **5.2 PERFORMANCE MONITORING**

The performance of all resources is analysed and a report is sent monthly. The unit/facility is monitored on an hourly basis. The unit or facility's control error (CE) is measured each hour.

AGC movement and performance data is calculated on the hour. The data is used as a performance measurement and for calculation of payments. The hourly data will be available, under normal running conditions, within an hour after the hour.

The service provider may **monitor** his own information and can request corrections on obviously erroneous measurements at any time.

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### **5.2.1 Calculation of Unit or Facility Control Error (CE)**

The measurement of performance of a unit or facility is based on the general principle that a unit/ facility providing regulation must be close to the set point required by the AGC controller, including any primary frequency support requirement.

The set point of the unit/ facility can thus be seen as the current contract from SO for units or facilities providing regulating reserve. The performance is measured by calculating the closeness of the actual generation to the new dynamic contracted generation including primary frequency support. It is important to realise that there are calibration errors in the generation output and set point values sent from the unit or facility to the AGC software module. The service provider should not be penalised due to these errors. A calibration error is calculated, which assumes a perfect response from the unit/ facility and is the average error between contracted setpoint plus primary frequency support and actual generation for each hour:

$$\text{Calibration error}_{\text{hour}} = \text{average generation}_{\text{hour}} - \text{average (contracted setpoint + primary frequency support)}_{\text{hour}} \quad (5.2.1)$$

The contracted setpoint is then corrected with this calibration error for every AGC cycle measured. This, together with the required primary frequency support, gives a final supply contract for each cycle (Equation 5.2.2).

$$\text{supply contract}_{\text{cycle}} = \text{contracted set-point}_{\text{cycle}} + \text{primary frequency support}_{\text{cycle}} + \text{calibration error} \quad (5.2.2)$$

Actual generation less the supply contract will give a supply error every AGC cycle (Equation 5.2.3)

$$\text{supply error}_{\text{cycle}} = \text{actual generation}_{\text{cycle}} - \text{supply contract}_{\text{cycle}} \quad (5.2.3)$$

The absolute integral of the supply error<sub>cycle</sub> for the hour is then a measure of the performance of the unit or facility, giving a control error in MWh (Equation 5.2.4).

$$\text{control error}_{\text{hour}} = \text{Integral I supply error}_{\text{cycle}} \quad (5.2.4)$$

If the control error is less **than the minimum of 1% of MCR or 5MWh** then the unit has performed and will be paid for providing the required service.

### **5.2.2 Hourly (real-time) monitoring**

National Control staff should monitor the AGC performance in real time. If a resource is found to seriously affect the frequency performance (e.g. pulse signal leads to the unit moving in the wrong direction leading to an oscillation in frequency) then the resource may be immediately suspended off AGC. It is the service provider's responsibility to monitor AGC limits and also declare any capacity limitations to National Control that may affect the unit or facility's AGC response. The AS AGC staff should also be informed so they can examine the cause of the problem and fix it.

### **5.2.3 Suspension of a resource from AGC.**

SO reserves the right to suspend any unit/facility that is found to compromise the AGC system.

- a) If CE is consistently not met, or if the unit/facility is not responding to control pulses, then it can be suspended with immediate effect. Also if a unit is found to be cycling continuously due to its response exacerbating the ACE/ frequency profile, it may be suspended.

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- b) SO will warn and request the service provider to take the unit/facility off AGC immediately and fix the problem.
- c) If the service provider does not take the unit/facility off AGC, and the problem is not fixed while the service provider continues to offer the unit/ facility available for AGC, then the National Control operator may take it off AGC. National Control will then suspend scheduling of the unit/facility for regulation until the problem is cleared.
- d) The service provider is responsible for the maintenance of all equipment located on their site and

is required to communicate with NC and AS about the problem.

- e) After the problem is fixed the service provider needs to inform AS in writing. AS will then test the

Unit/ facility and if successful the service provider shall declare the resource available from the next scheduling period onwards.

- f) If the problem is found to lie with SO, then SO should fix the problem within a month from the day the cause of the problem was found.

#### **5.2.4 Performance monitoring calculations**

The following variables are used to calculate RR performance of a unit or facility:

$RR_A$  = RR availability to ensure required regulating capacity is delivered.

$RR_1$  = RR performance 1 (CE) to ensure a unit follows the contracted AGC set point.

$RR_2$  = RR performance 2 (Pulses) to ensure at least 90% of requested AGC pulses are responded to

#### **RR Availability ( $RR_A$ )**

- Regulating range (hourly) = AGC High limit (Ave hourly) – AGC Low limit (Ave hourly)
- RR availability

Unit or facility has RR contract (hourly):

$$RR_{AC} = \frac{\text{Average of regulating range for all hours on AGC with RR contract}}{2 * \text{contracted Day-ahead RRup capacity}}$$

Unit or facility has no RR contract (hourly):

$$RR_{AN} = \frac{\text{Average of regulating range for all hours on AGC with no RR contract}}{10\% * \text{Unit or Facility MCR}}$$

- Monthly %RR **availability** ( $RR_A$ ) = average of  $RR_{AC}$  and  $RR_{AN}$

#### **RR Performance**

- (i) Unit or facility performance in %:

$$RR_1 = 100\% - \% \text{hours in a month where CE is } \geq 1\% \text{ of MCR}$$

- (ii) Unit or facility performance in %:

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$$RR_2 = 100\%, \text{ if } \left( \frac{\text{Total acknowledged pulses}}{\text{Total requested pulses}} \right) \geq 90\%$$

Requested pulses are a total number of AGC up and down pulses sent from TEMSE to the unit/ facility during the hour. Acknowledge pulses are calculated as the minimum between:

- The actual movement (MW change) in the up and down direction found between each 4-second set point feedback for the given unit/facility compared to the value before (4 seconds back) summed over the part of the hour the unit is on AGC
- and the requested pulses in the up and down direction.

$$\text{Else} = \left( \frac{\text{Total acknowledged pulses}}{\text{Total requested pulses}} \right) \text{ over a month.}$$

$$\begin{aligned} \text{(iii) Overall Unit or facility percentage performance over a month} \\ = RR_A * RR_1 * RR_2 \end{aligned}$$

If the overall Unit or facility percentage performance **over a month** is less than 90%, the service provider will be deemed to have failed to deliver acceptable performance.

In addition AS will check if units bid available for AGC in a given month were actually put on AGC and able to move. If such a unit or facility is contracted for AGC but turns out to be inflexible or not to be on AGC for long periods, then the AGC program will keep sending pulses with no response, leading to poor frequency control. All occurrences of this behaviour will be noted in the monthly report and strongly discouraged. If the **ramp rate** is set lower by the station, for example due to plant instability, NC and AS shall be informed as it should also be changed in EMS.

## **6. TEN-MINUTE RESERVE**

### **6.1 INTRODUCTION**

Ten-minute reserve is generating capacity (synchronised or not) or consumer load that can respond within 10 minutes when called upon. The purpose of this reserve is to restore Instantaneous and regulating reserve to the required level after an incident, and it must be available for at least two hours. No resources may offer themselves for Ten-minute reserve if they are scheduled only in emergency conditions.

### **6.2 CERTIFICATION PROCEDURE**

Service providers who intend to have their unit or facility certified for ten-minute reserve shall inform AS in writing. The information shall be provided as indicated in **Section 10.3** to AS for the resource to be certified: The request shall include the notification mechanism used to start the reserve utilization. A **test date** shall then be agreed between AS, NC and the service provider. At least **10** working days' notice shall be given.

Supply side resources for ten-minute reserve include synchronised generating units or facilities that can pick up load manually whilst generating or can start and be synchronised within 10 minutes. Non-commercial units may be tested provided the 4-second metering data is available in EMS.

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### **6.3 TEST PROCEDURE**

A single test will be arranged between Ancillary Services, National Control and the unit or facility after all required communication links, notification mechanism and metering are put in place. The test period will continue until at least one successful result is obtained. A maximum of three tests is allowed.

a) For off-line units or facilities, the unit/facility will be required to respond to the notification trigger by coming on-line and increasing generation to at least **10% of MCR** above minimum generation stable level within **10 minutes** of the notification by NC and **sustaining** the response for at least **60 minutes**. The **maximum** MW response within 10 minutes of notification and the **average** MWs during the time on-line (up to the 60 minutes) is measured. The **certified** Ten-minute capacity is the **AMS response**.

b) For on-line units or facilities, the unit/facility must increase generation by the agreed amount from an agreed starting level by at least **10% of MCR** within **10 minutes** of the notification by National Control and to then **sustain the response** for at least 30 minutes. The unit must be **off AGC** during the test. The minimum response (pickup) must exceed or equal **10% of MCR**. The certified capacity is **AMS response** achieved. In the event that before or during the test the unit or facility has technical constraints that affect its plant capability, the test shall be postponed.

The unit/ facility's actual capability as tested is taken as the certified capacity. The certificate shall be completed and sent to the Service provider, and the resource shall be certified within 10 working days of the test. During the test period the unit/facility will not be allowed to offer Ten-minute reserves.

### **6.4 PERFORMANCE MONITORING.**

The usage of ten minute reserves will be monitored closely in real-time by National Control Principles on which ten minute reserve performance monitoring will be based on

- As per NERSA's Scheduling and Dispatch Rules, ten minute reserve dispatch instructions shall be logged as resource name, date and time and expected sent-out or MW response.
- Only units contracted for ten minute reserve will be measured. This will be based on day ahead hourly reserve contracts.

The methodology is based on measuring whether the unit achieves its required capacity over the required duration.

#### **6.4.1 Real-time reporting and monitoring.**

SO will investigate each incident as it happens. If the problem is found to lie with SO's equipment, then the problem will be fixed within one month. A performance failure occurs if the unit/facility failed to respond to a ten-minute reserve dispatch instruction.

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The following real-time reporting is required.

**a) Offline units or facilities**

Whenever this plant is dispatched by National Control for ten-minute reserve (when contracted) and fails to come on-line within 10 minutes of the instruction, the NC Operator **shall** capture a note in the relevant SO system(s) to amongst others include the date and time of the request, the resource name and reason.

**b) On line units or facilities**

If an on-line unit or facility contracted for ten-minute reserve fails to pick up load dispatch instruction, and no load loss was booked preventing this pickup, then the NC Operator shall capture a note in the relevant SO system(s) to amongst others include the date and time of the request, the resource name and reason.

#### **6.4.2 Monthly Performance Monitoring.**

The percentage performance over the month for units or facilities is calculated as the number of times the resource performed successfully over the number of times the unit or facility was requested to come on-line. A monthly report may be provided to the Service provider on request.

### **7. EMERGENCY RESERVE**

#### **7.1 INTRODUCTION**

Emergency reserve consists of all available resources that are available to generate or to curtail load within an agreed notice period, but which are used less often than Ten-minute reserve due to high cost. The response must be available for 120 minutes or more. These resources generally do not bid in day ahead. The interruptible load contracts, some gas-turbine plant, other expensive or severely energy-restricted plant and the capability of generating units to generate above full load in an emergency (i.e. EL1) are currently all considered as emergency reserve.

Emergency level 1 generation is additional capacity made available for generation above the Maximum Continuous Rating (MCR) by an on-line unit or facility. The response should be sustainable for at least 120 minutes or for the duration of the Emergency Level 1(EL1) in-force instruction by National control, whichever is the shorter. For all generating units or facilities, only the response during the **time on-line** and during the EL1 incident is measured. All units or facilities called up for EL1 are taken off AGC.

### **7. CERTIFICATION PROCESS FOR NON-EL1 RESERVES**

A unit/facility intend to be certified shall inform AS in writing, and submit the data as given in **section 10.4**. All new resources not previously certified must demonstrate the capability to drop or pickup load within the agreed notification period. Certification shall be performed after one successful test. A maximum of three attempts are allowed. The test is successful if the criteria below are met. The certification of EL1 is handled in the **section 8**.

#### **7.2.1 TEST PROCEDURE**

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The date for the test is agreed between the Service provider, AS and NC after all necessary metering is in place. Up to 3 attempts are allowed.

For off-line (e.g. gas turbines) units or facilities, the -unit/ facility shall deliver the minimum of at least 10% MCR capacity within **10 minutes** of the notification by NC, and **sustaining** maximum loading for at least **60 minutes**. The **maximum** MW response within 10 minutes of notification and the **average** MWs during the event (up to the 60 minutes) is measured. The **certified** emergency reserve capacity is the **AMS** response of the unit or facility.

### **7.2.2 PERFORMANCE MONITORING OF NON-EL1 RESERVES.**

The usage of emergency reserves will be monitored closely in real-time by National Control Principles on which emergency reserve performance monitoring will be based on

- As per NERSA's Scheduling and Dispatch Rules, emergency reserve dispatch instructions shall be logged as resource name, date and time and expected sent-out or MW response.
- Only units contracted for emergency reserve will be measured. This will be based on day ahead hourly reserve contracts.
- The methodology is based on measuring whether the unit achieves its required capacity over the required duration.

For all incidents of non-compliance (e.g. of gas turbines failing to start or interruptible load not tripping) NC Operator shall capture a note in the relevant SO system(s) to amongst others include the date and time of the request, the resource name and reason. The service provider shall take immediate corrective action so that the resource will work the next time.

#### **7.2.2.1 Real-time reporting and monitoring.**

The following reporting and monitoring is required for certified off-line emergency reserve:

Whenever unit or facility is called up by NC and fails to deliver capacity in ten minutes and / or fails to sustain the response as per the dispatch instruction, NC Operator shall capture a note in the relevant SO system(s) to amongst others include the date and time of the request, the resource name and reason.

#### **7.2.2.3 Performance monitoring.**

Each certified emergency resource will have its **MW response** measured after each incident. This is the **average delivered MW** from the start to end time of the incident as per dispatch instruction. For very long incidents only the **first 3 hours** are measured due to time constraints.

The average response of all units or facilities over the calendar month is reported by AS to the service providers within 10 working days of the start of each month.

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## **7.3 CERTIFICATION AND PERFORMANCE MONITORING OF EL1 EMERGENCY RESERVE**

### **7.3.1 CERTIFICATION**

#### **7.3.1.1 Certification of generating units**

A Service provider who intend to participate in EL1 shall request AS for certification in writing and provide the data in **section 10.4**. A test date shall then be arranged with National Control and AS. An actual EL1 incident may be used. The unit must be taken off AGC and governing and raise its output to the EL1 level as accepted by the manufacturer as safely achievable in normal conditions. The resource shall be certified after the first acceptable test performed by the unit or facility. Up to three attempts are allowed.

To pass the unit or facility must raise its output to at least **1% of MCR** above MCR and sustain this level for at least **60 minutes**. Thus the average of maximum and sustained output over the hour must exceed 1% of MCR.

### **7.3.2 PERFORMANCE MONITORING**

A monthly report of the EL1 performance of every certified resource is sent to the service provider within 10 working days of the start of each month.

Each certified emergency resource on-line and dispatched to deliver EL1 capacity will have its MW response measured after each incident. The average response over the calendar month is reported to the service provider in the monthly report, and shall be used as a basis for calculating the payments.

When calculating EL1 performance the event start time is taken as an official EL1 start time from NC system (s) plus a EL1 time delay(see table below)

The delay time may be **larger** if the initial sent out of the unit is **less** than **80%** of MCR. This is to allow time for ramping up, and for mills to be put in (in case of thermal power plant).

The following EL1 delay times will be used:

<b>Plant type</b>	<b>Time delay</b>
Hydro and Pump storage	No delay
Non synchronous	No delay
Thermal power plant	<b>10 minutes</b> if initial sent out $\geq$ 80% of MCR and <b>30 minutes</b> for initial sent out < 80%.

The end time is the official end time as per NC instruction. If the measured incident lasts less than **20 minutes after the start plus delay time**, the response is not included in the monthly report.

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If the actual duration of EL1 **exceeds 120 minutes**, the first 120 minutes of the incident after the official start time plus delay time shall be used to measure the AMS response.

If an incident lasts from morning peak until after evening peak then two incidents are measured. The first incident covers the first 120 minutes (the start time allows for the lag as above), and the second incident will be over the last 2 hours (120 min), provided this includes the evening peak hour. If not, then the evening peak load hour is measured.

If a unit is requested to go back onto AGC or to reduce output (e.g. due to VAR control) or come off-line during the EL1 incident this represents the end-time for the EL1 measurement. This time must be captured by NC Operator and put in the relevant SO system(s). If the time is not captured by NC Operator the service provider may inform AS of the pullback. AS will then re-measure the incident with the new end time, or if this is not available not include the incident.

Only **online** units or facilities **certified** for EL1 and **requested** to go to EL1 by National Control are measured. Of these units or facilities if a recorded **load loss** is in force no response is measured.

Units or facilities shall provide periods during which EL1 will not be possible due to technical reasons to Ancillary Services by email as soon as possible, and incidents in these periods will not be measured.

The unit or facility is counted **available** for EL1 in an incident if there was **no** booked load loss, and the service provider has not informed AS in advance that the resource is not available for EL1. Thus if a resource is not available for the entire month and AS was informed, its EL1 performance will not be measured.

SO analyses real-time 4 sec data from EMS over the period from measured start to measured end of the incident for all generating units or facilities while they are online. The response is calculated as follows:

The **maximum** response to the EL1 instruction is calculated as:

**Maximum response** = Maximum sent-out MW over the measured period - MCR + Calibration factor

Where,

Calibration factor is **only considered** where there is no measured sent-out i.e. sent-out is estimated from generated values and estimated auxiliary consumption, where accurate sent-out data is available calibration factor will be zero.

Calibration factor = official unit sent out over the hour – average of 4 seconds sent out values in EMS over the same hour. The sent-out in EMS is calculated from the generated MW taking into account the auxiliaries consumption. The hour is chosen to include the time of highest system load during the incident. The calibration factor corrects for metering differences between the 4-second data and the official hourly sent-out metering.

**Sustained response** = average sent-out MW over the measured period – MCR + Calibration factor.

The average of maximum and sustained response (AMS response) is:

**AMS response** = 0.5 x Maximum response + 0.5 x Sustained response

The Positive AMS response to an incident in MW is Positive AMS Response = max (0, AMS Response).

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The monthly **% performance** is then the average of the positive AMS responses over the month divided by the certified capacity.

The unit or facility **certified** MW for EL1 in each season (summer or winter) will be the **contracted MW** specified in the Ancillary Services Agreement and shall not be lower than **1% of MCR**.

Coal fired dry-cooled units may choose to have a contracted capacity which varies monthly provided they can send the information to AS. This curve is then agreed between the service provider and AS and put in the Ancillary Services agreement.

## **9. SUPPLEMENTAL RESERVE**

### **9.1 INTRODUCTION**

Supplemental reserve consists of all resources available to generate or reduce load within **six hours** of notice being given. To qualify for certification, the resource's response must be sustainable for at least 120 minutes (**2 hours**). This reserve is not counted as part of operating reserve.

### **9.2 CERTIFICATION PROCESS**

A resource that intend to be certified shall inform AS in writing, and submit the data as given in **section 10.5**. The notification mechanism must also be agreed. The date of the test is arranged between NC, AS and service provider.

A single successful test is required. If the test fails up to 3 attempts are allowed. During the test the unit or facility is called up by NC, and must first synchronise and then pick up load and deliver the required capacity within 6 hours of notification, and then remain online for at least one hour, unless otherwise instructed by NC.

### **9.3 PERFORMANCE MONITORING.**

The usage of supplemental reserves will be monitored closely by the SO. All incidents of non-conformance (e.g. of units/facilities failing to start) will be reported to the service provider.

#### **9.3.1 Real-time reporting and monitoring.**

The following reporting and monitoring is required:

Whenever the resource is dispatched NC Operator shall capture a note in the relevant SO system(s). If the unit or facility fails to respond within the agreed notice period (6 hours to contracted capacity), or to remain on-line for 120 minutes (or as long as required by National Control whichever is shorter), the unit or facility is non-compliant. In this case NC Operator shall capture a note in the relevant SO system(s) to amongst others include the date and time of the request, the resource name and reason.. Ancillary Services shall inform the service provider about the incident in writing. The service provider shall then address the non-conformance and report back within one month.

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### **9.3.2 Monthly Performance Monitoring**

The number of times during the month that a unit or facility is called upon to provide supplemental reserve within the 6 hour period is counted. The % performance is the number of successful call-ups over the total number of NC dispatch instructions.

## **10. DATA REQUIREMENTS FOR CERTIFICATION**

### **10.1 INSTANTANEOUS RESERVE DATA**

- Station / unit / facility name in full
- 5-character code name (as in EMS)
- Maximum sent-out (MCR) as per CDS (Consistent Data Set) and data provided by non-Eskom service providers
- MCR generated capacity (MW)
- Minimum stable generation (MW)

#### **TEST SECTION:**

Refer to the certification template in the appendix A

### **10.2 REGULATING RESERVE DATA**

- Station/unit /facility name in full.
- 5-char code name in EMS
- Maximum sent-out (MCR) as per CDS and data provided by non-Eskom service providers
- MCR generated capacity (MW)
- Minimum stable generation (MW).
  - High regulating limit
  - Low regulating limit
  - AGC up ramp rate
  - AGC down ramp rate
  - AGC set point feedback
  - True AGC unit status
  - Gross active power (Generated)
  - Nett active power (Sent-out)

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- Raise block
- Lower block

**TEST SECTION:**

- Refer to certification template in appendix A

**10.3 TEN-MINUTE RESERVE DATA**

- Station/unit / facility name in full.
- 5-char code name (as in EMS)
- Maximum sent-out (MCR) as per CDS
- MCR generated capacity (MW)
- Minimum stable generation MW
- Quick Start Flag (commits in 10 min) Y/N
- Certified MW for quick start plant is installed capacity (MCR)

**TEST SECTION:**

- Refer to the certification template in appendix A

**10.4 EMERGENCY (AND EL1) RESERVE DATA**

- Station/unit /facility name in full.
- 5-char code name (as in EMS)
- Maximum sent-out (MCR)
- MCR generated capacity
- Official EL1 generated capacity
- Minimum stable generation
- Quick Start Flag (commits in 10 min) Y/N

**TEST SECTION:**

- Refer to certification template in the appendix A.

**10.5 SUPPLEMENTAL RESERVE DATA**

- Station/unit /facility name in full.

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- 5-char code name (as in EMS)
- Maximum sent-out load (MCR)
- MCR generated capacity
- Call-up time in hours

**TEST SECTION:**

- Refer to the certification template in the appendix A

## **11. AUTHORIZATION**

<b>Name</b>	<b>Designation</b>
I Fick	General Manager, System Operator
G. Hurford	National Control Manager
L. Du Plessis	National Operations Manager
K.C. Masike	Technical operations Manager
S. Joseph	Ancillary Services Manager
B. Mdunge	Generation Production and Control Manager
D. Joubert	Energy Trading Manager
S. Ndlovu	Energy Trading Manager
A. Wilson	Business Integration & Performance Management Manager
A. Steenkamp	Performance and Development Manager
K. Sobuwa	Chief Engineer, Production Engineering Integration
M. Khumalo	Chief Engineer, Production Engineering Integration
S. M'Builu Ives	Manager Production
Keith Bowen	Middle Manager Wholesaler
Akash Prakash	Middle Manager Energy Planning & Marketing

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## **12 REVISIONS**

<b>Date</b>	<b>Rev.</b>	<b>Remarks</b>
July 2009	0	Reformatted and revised from of Procedure SPC 46-8
January 2013	0	Procedure was due for revision
September 2016	0	Procedure revised from expired 46-8
September 2019	0	Procedure revised from expired 240-110150430
August 2021	3	Procedure revised to Rev.2

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## 13 APPENDIX A

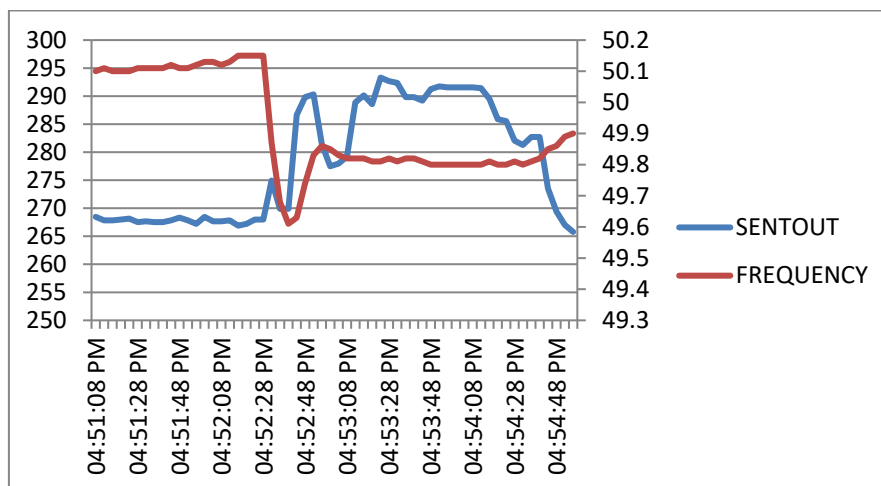
### 13.1 Certification Test Results/Supporting Information:

#### 13.1.1 Instantaneous Reserves

##### Test results

Governing test results for the Maximum response, Sustained response and Average response as per 240-110150430					
Incident date		Start Time		End Time	
Incident No.		Max Response (MW)	Sust Response (MW)	Avg Response (MW)	Avg Response (%)
Unit/facility name					
Incident date		Start Time		End Time	
POWI Incident No.		Max Response (MW)	Sust Response (MW)	Avg Response (MW)	Avg Response (%)
Unit/facility name					
Incident date		Start Time		End Time	
Incident No.		Max Response (MW)	Sust Response (MW)	Avg Response (MW)	Avg Response (%)
Unit/facility name					
Incident date		Start Time		End Time	
Incident No.		Max Response (MW)	Sust Response (MW)	Avg Response (MW)	Avg Response (%)
Unit/facility name					

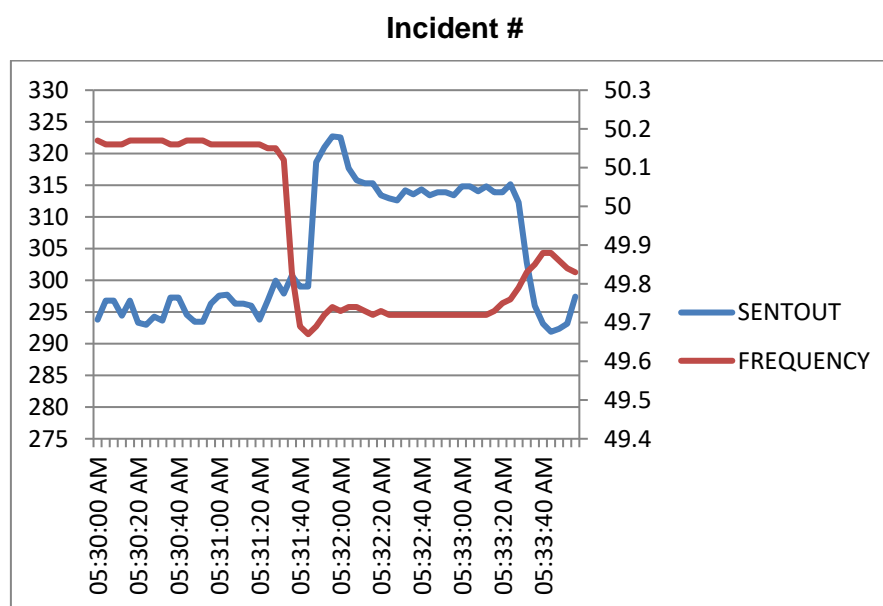
##### Incident #



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### 13.1.2 Regulating Reserve

#### Sustained Response and Response Time Delay Results

Sustained Response Test			Response Time Delay Test			
Date/Hour	Required Regulation UCE (MWh)	Actual UCE (MWh)	Required Regulation time delay (secs)	Setpoint Start Time (s)	Sentout Response Time (s)	Time Delay(s)
	< 5		< 12			
Outcome						

#### Pulse performance

Pulse performance			
Date/Hour	Total requested pulses	Total Actual pulses	Pulse % performance

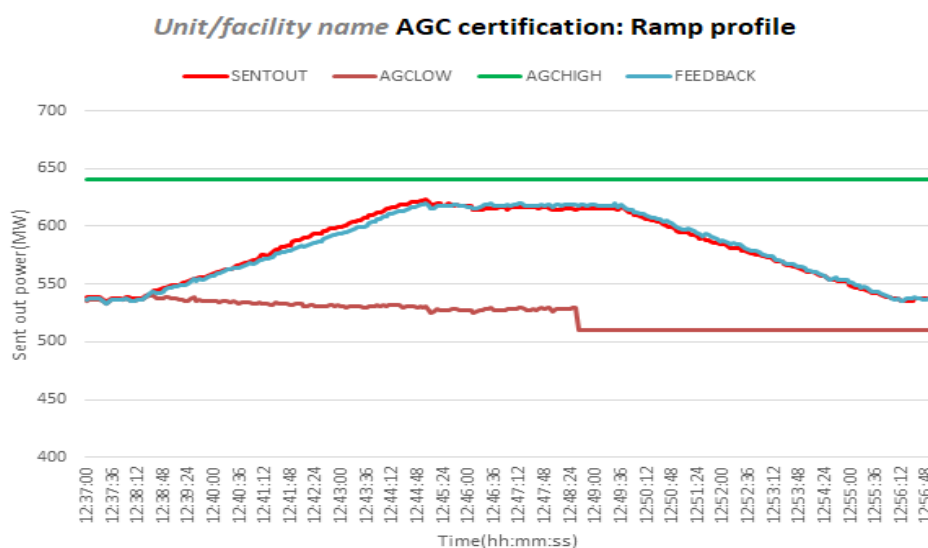
#### Ramp Rate Results

Ramp Rate Test								
Start Time	End Time	Ramp Direction Up/Down	Required Ramp rate (MW/min)	Required Ramp rate MW	Actual Ramp rate (MW/min)	Ramp Initial MW	Ramp Final MW	Actual Ramp Range MW
		Up						
		Down						

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**Ramp profile**

**13.1.3 Emergency Level 1**

**Test Results:**

EL1 test results for the ramp duration and sustained response as per 240-110150430								
Unit								
Unit MCR sentout MW								
Date								
Sustained response duration and % MCR capacity								
EL1 Start Time	EL1 End Time	Required Sustained Response Duration (Hours)	EL1 Duration (Hours)	Max Response	Sustained Response	EL1 Capacity delivered (MW)	Required % MCR Capacity (%)	Actual Achieved Response (% MCR Capacity)
		1					1	
Outcome								

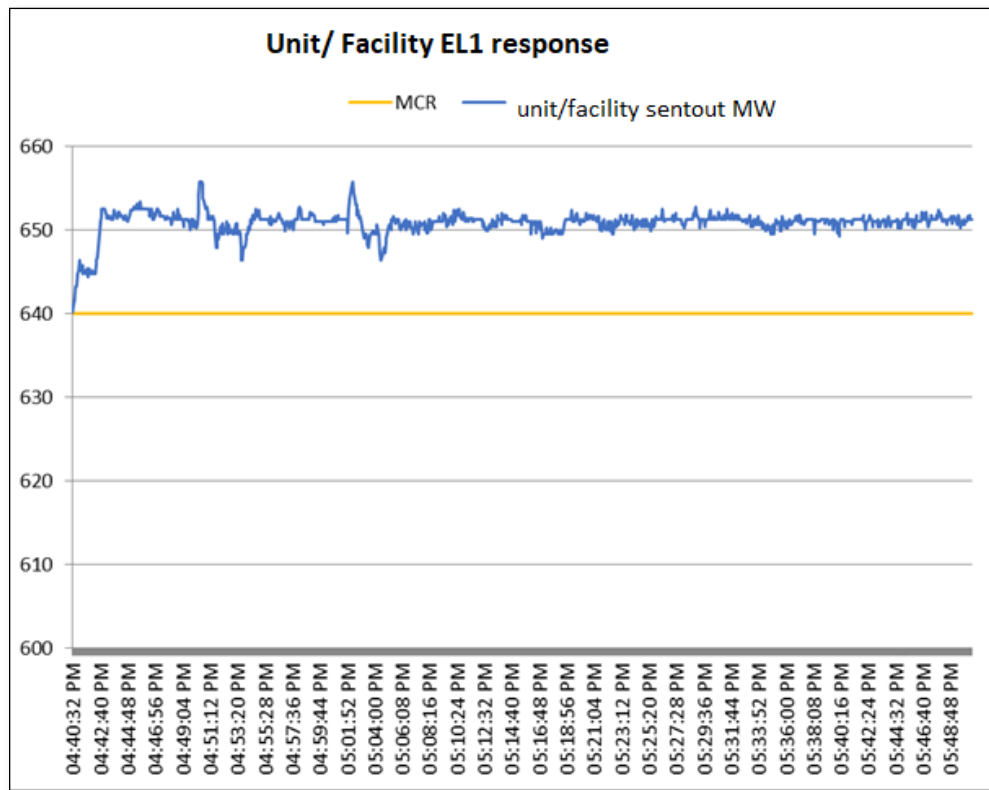
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### Plot



### 13.1.4 Non EL1

#### Test Results

Reserve	Non EL 1 Emergency				
Unit					
MCR-Sent out					
Min Required Capacity (MW)					
Date					
Start Time	End Time	Initial(MW)	Final (MW)	Non EL1 Capacity (MW)	Ramp Rate(MW/min)

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### EL1 Response

Facility SENTOUT — MCR

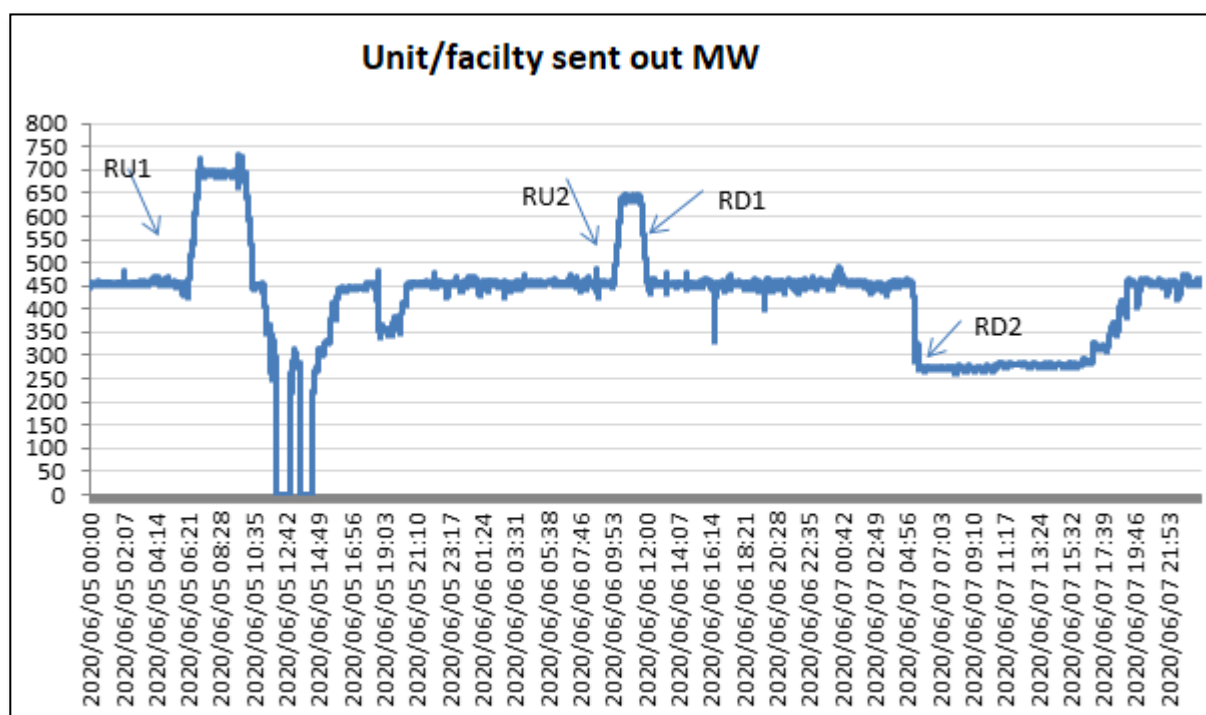
Time(hh:mm:ss)

Time(hh:mm:ss)	Facility SENTOUT	MCR
10:57:36	0	0
11:00:24	100	100
11:11:12	100	100
12:00:00	100	100
12:58:48	100	100
12:57:36	100	100
13:26:24	100	100
13:55:12	100	0
14:24:00	100	100
14:52:48	100	100
15:21:36	100	100
15:50:24	100	100
16:19:12	100	0
16:48:00	100	0
17:16:48	100	0
17:45:36	100	100
18:14:24	100	100
18:43:12	100	100
19:12:00	100	100
19:40:48	100	100
20:09:36	100	0
20:38:24	100	0
21:07:12	100	100
21:36:00	100	100
22:04:48	100	0
22:33:36	100	100
23:02:24	100	0
23:31:12	100	100

Reserve	Ten minute					
Unit						
MCR-Sentout						
Min Req Capacity (MW)						
Date						
Start Time	End Time	Initial (MW)	Final (MW)	Ten min Capacity (MW)	Ramp rate (MW/min)	Upward/downward ramp
			Average	0	0	

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### Plot



RU1: Upward ramp 1, RU2: Upward ramp 2  
RU1: Downward ramp 1, RU2: Downward ramp 2

### **13.1.6 Supplemental Reserve**

#### **Test results**

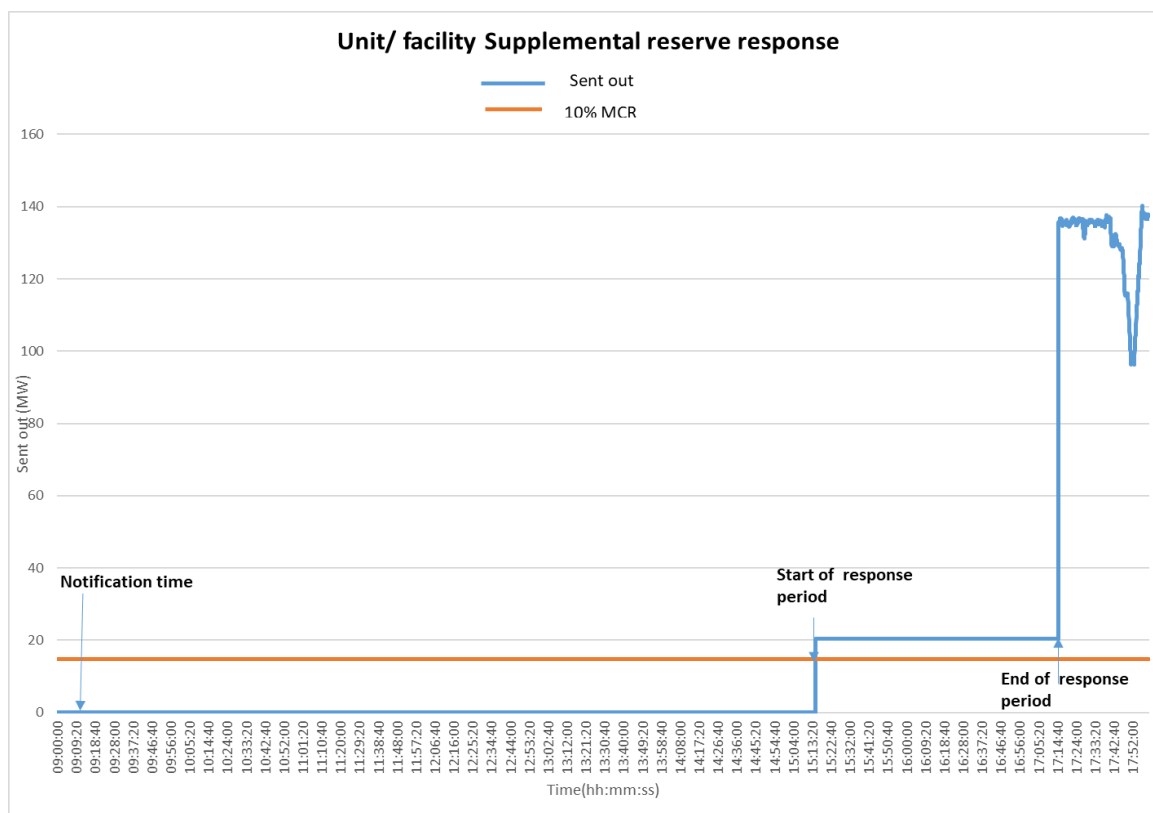
Test Results						
Unit						
MCR-Sentout						
Date						
Sustained response duration and % MCR capacity						
Start Time	End Time	Required Sustained Response Duration (Hours)	ActualSustained Response Duration (Hours)	Supplemental Capacity delivered (MW)	Required MCR Capacity (%)	Actual Achieved Response (% MCR capacity)
		2			10	
Outcome						

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### Plot



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