SYSTEM OPERATOR

Ancillary Services Technical Requirements for 2023/24 – 2027/28

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ANCILLARY SERVICES TECHNICAL REQUIREMENTS FOR 2023/24 – 2027/28

1. INTRODUCTION

This document specifies the technical requirements for ancillary services for the financial year period 2023/24 till 2027/28. Its purpose is to make known the technical requirements of the System Operator with respect to ancillary services. The technical requirements as specified in this document will be used to develop a medium-term view of requirements for ancillary services for the forthcoming 5-year horizon.

The following requirements are defined as ancillary services:

- Reserves
- Black-Start
- Unit Islanding
- Reactive Power Supply and Voltage Control
- Constrained Generation

2. METHODOLOGY

The ancillary services technical requirements are determined based on approved methodologies developed by the System Operator.

3. RESERVES

3.1 INTRODUCTION

The definitions of the five reserve categories included in ancillary services are defined in the South African Grid Code [1]. The minimum requirement for each reserve category is revised annually. Each reserve category has its own requirement and is exclusive, that is capacity reserved for one category cannot be used for another category.

3.2 INSTANTANEOUS RESERVE

3.2.1 Description

Instantaneous reserve is generating capacity or demand side managed load that must be fully available within 10 seconds to arrest a frequency excursion outside the frequency dead-band. This reserve response must be sustained for at least 10 minutes. It is needed to arrest the frequency at an acceptable level following a contingency, such as a generator trip, or a sudden surge in load. Generators contracted for instantaneous reserve are also expected to respond to high frequencies (above 50.15 Hz) as stipulated in the South African Grid Code.

3.2.2 Technical Requirements

The Instantaneous reserve requirement was determined through a dynamic simulation study by establishing the effect of governing on system frequency. The study considered various scenarios, which included various levels of generation and demand side capacity. Renewables (RE) were included in the study as per 2019 IRP [2]. Their impact was assessed during off peak periods, i.e. when demand was at its lowest, representing a low inertia scenario. RE impact is noticeable during off peak but overall the impact on reserves was not significant. The minimum requirements, which are based on only **generators providing instantaneous reserves**, are shown in

Table **1**.

Table 1: Instantaneous reserve requirements

Season	Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Summer/ Winter	Peak	650	650	650	650	650
	Off peak	850	850	850	850	850

The study has indicated that less instantaneous reserve is required over peak periods, due to higher system inertia during peak compared to off peak periods. Instantaneous reserve can also be provided by loads i.e. demand response. Previous studies have indicated the optimum split between generators and loads as follows:

Peak periods		Off peak periods		Reserve provider
Generators MW	Demand Response MW	Generators MW	Demand Response MW	
650	0	850	0	Generators only
600	200	800	200	Generators and loads
550	400	750	400	Generators and loads
500	600	700	600	Generators and loads
450	800	650	800	Generators and loads
400	1000	600	1000	Generators and loads

3.3 REGULATING RESERVE

3.3.1 Description

Regulating reserve is generating capacity or demand side managed load that is available to respond within 10 seconds and is fully activated within 10 minutes. The purpose of this reserve is to make enough capacity available to maintain the frequency close to scheduled frequency and keep tie line flows between SAPP control areas within schedule.

3.3.2 Technical Requirements

The IPS needs sufficient regulating range up and down every hour of the day to keep the frequency and SAPP tie line flows within schedule while meeting the peak load within the peak hour. The optimum regulating up and down reserve requirement is based on catering for variability of load and renewables for 95% of the time and also compliance with SAPP CPS performance requirements.

A) Variability study

The purpose of this study was to determine the minimum regulating reserve capacity to ensure that load and renewables variability do not compromise frequency control requirements. A production simulation study was undertaken to determine the optimum reserve capacity. Various demand and generation performance scenarios were considered i.e. Low demand low performance and moderate demand moderate performance. Figure 1 below depicts simulation results for 2023 and 2027.

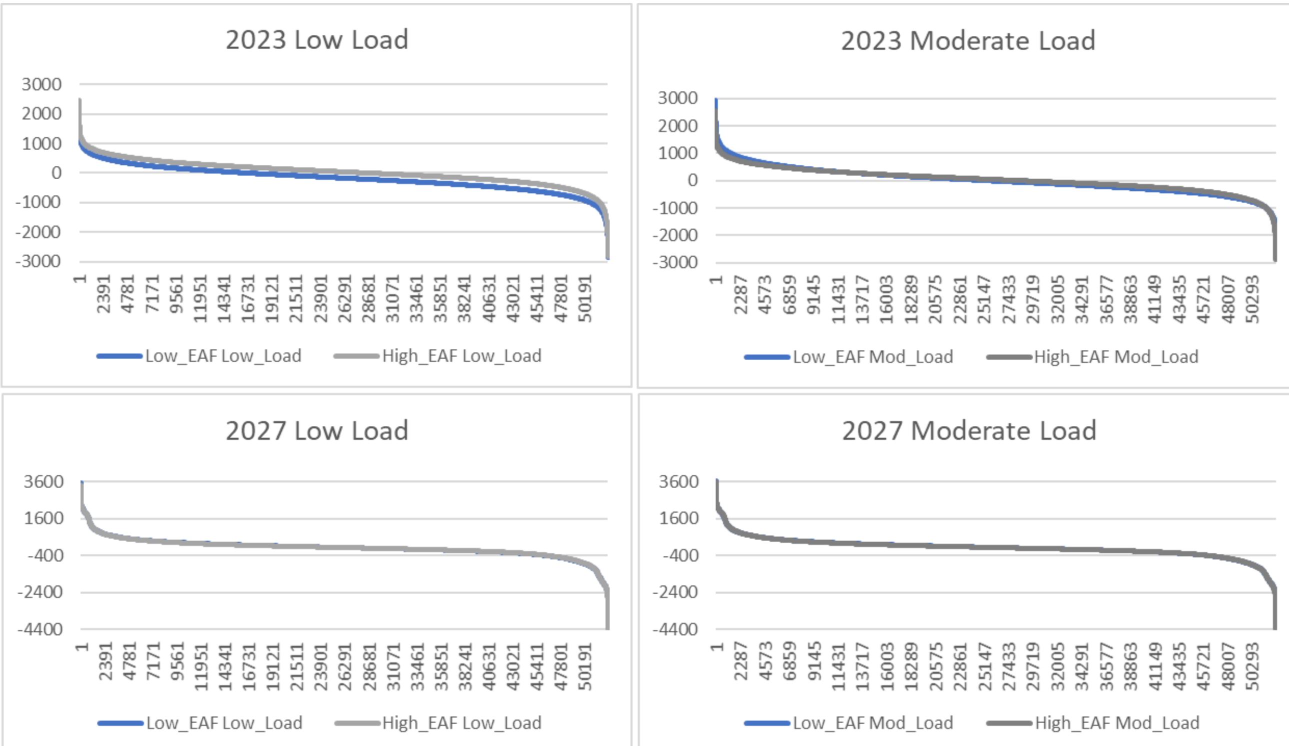


Figure 1: 2023 and 2027 variability study results

Using Figure 1 above, recommended regulating up/down reserve requirements are 545 MW in 2023 and 700 MW in 2027.

The minimum Regulating Reserve requirements, taking load variation and renewable energy unpredictability into consideration, are given in Table 2 below:

Table 2: Regulating up and down reserve requirements

Reserve	Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Regulating up	Summer (Pk/off pk)	545	560	575	600	700
	Winter (Pk/off pk)	545	560	575	600	700
Regulating down	Summer (Pk/off pk)	545	560	575	600	700
	Winter (Pk/off pk)	545	560	575	600	700

Regulating reserve capacity (regulating up + regulating down) is determined by AGC high and low limits set by the service provider to enable regulating up and down.

3.4 TEN-MINUTE RESERVE

3.4.1 Description

Ten-minute reserve is generating capacity or demand side managed load that can respond within 10 minutes when called upon. It may consist of offline quick start generating plant (e.g. hydro or pumped storage) or demand side load that can be dispatched within 10 minutes. The purpose of this reserve is to restore Instantaneous and Regulating reserve to the required levels after an incident. Ancillary Services requires Ten-minute reserve resources which may be used for up to 600 hours per year (assuming a usage over 50 weeks, 4 days and 3 hours per day). In addition, if the cost of any potential Ten-minute reserve resource is close to or higher than gas turbines, it must be used as an emergency reserve resource. Any new Ten-minute reserve resource must have no onerous energy restrictions since this reserve may be required to be used every day.

3.4.2 Technical Requirements

A) Credible multiple contingency requirement

A credible multiple unit contingency trip is defined in the SA grid code as a typical loss of three coal fired units. To ensure reliability it was assumed that the total operating reserve should be sufficient to replace the loss of the three biggest coal fired units. Thus, from 2023/24 to 2027/28, the biggest three units have a capacity of 3 x 722 = 2166 MW. The Ten-minute reserve requirement = Total Operating – Instantaneous – Regulating

B) SAPP Requirement

SAPP Operating Guidelines state that a minimum of 931 MW of total operating reserve is currently required from the Eskom control area.

The credible multiple contingency criterion yields a higher requirement for Ten-minute reserves. The Ten-minute reserve requirements are shown in Table 3 below:

Table 3: Ten-minute reserve requirements

Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Peak (Summer/ Winter)	1005	990	975	950	850
Off-Peak (Summer/ Winter)	805	790	775	750	650

3.5 EMERGENCY RESERVE

3.5.1 Description

Emergency reserves should be fully activated within 10 minutes [1]. Emergency reserves include interruptible loads, generator emergency capacity (EL1), and gas turbine capacity. Emergency reserve capacity is required less often than Ten-minute reserve. The reserve must also be under the direct control of National Control. These requirements arise from the need to take quick action when any abnormality arises on the system.

3.5.2 Technical requirements

The technical requirement is based on the total average of unplanned capacity losses from the entire generation fleet. The optimum emergency reserve requirement is based on catering for forced outages or generator trips for 95% of the time.

A) Contingency study

The purpose of this study was to determine the minimum emergency reserve capacity to ensure that the power system is returned to normal conditions following disturbances. A production simulation study was undertaken to determine the optimum reserve capacity. Various demand and generation performance scenarios were considered i.e. Low demand-low performance, moderate demand-moderate performance and low demand – high performance etc. Figure 2 below depicts simulation results for 2023 and 2027.

Figure 2: 2023 and 2027 contingency study results

Using Figure 2 above, recommended emergency reserve requirements are 1400 MW in 2023 and 1200 MW in 2027.

The emergency reserve requirements are given in Table 4 below:

Table 4: Emergency reserve requirements

Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Winter Peak/ Off peak	1400	1350	1300	1250	1200
Summer Peak/ Off peak	1400	1350	1300	1250	1200

3.6 SUPPLEMENTAL RESERVE

3.6.1 Description

Supplemental reserve is generating or demand side load that can respond in 6 hours or less to restore operating reserves. This reserve must be available for at least 2 hours [1]. This capacity is used to ensure an acceptable day-ahead risk.

3.6.2 Technical requirements

The technical requirement is based on the average loss of coal fired power station capacity greater than 3000MW, which was calculated to be approximately 3800 MW. This capacity should be replaced by the sum of operating, emergency and supplemental reserve capacity. Thus, Supplemental capacity = Total Power Station capacity – Operating reserve - Emergency reserve. The supplemental reserve requirements are as follows:

Table 5: Supplemental reserve requirements

Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Winter Peak/ Off peak	200	250	300	350	400
Summer Peak/ Off peak	200	250	300	350	400

RESERVE REQUIREMENTS SUMMARY

The overall reserve requirements may be summarised as follows:

Table 6: Summary of reserve requirements

Reserve	Season	Period	2023/24 MW	2024/25 MW	2025/26 MW	2026/27 MW	2027/28 MW
Instantaneous	Summer	Peak	650	650	650	650	650
		Off peak	850	850	850	850	850
	Winter	Peak	650	650	650	650	650
		Off peak	850	850	850	850	850
Regulating	Summer	Peak	545	560	575	600	700
		Off peak	545	560	575	600	700
	Winter	Peak	545	560	575	600	700
		Off peak	545	560	575	600	700
Ten-minute	Summer	Peak	1005	990	975	950	850
		Off peak	805	790	775	750	650
	Winter	Peak	1005	990	975	950	850
		Off peak	805	790	775	750	650
Operating	**Summer/ Winter**	**Peak/ Off peak**	2200	2200	2200	2200	2200
Emergency			1400	1350	1300	1250	1200
Supplemental			200	250	300	350	400
Total			**3800**	**3800**	**3800**	**3800**	**3800**

4. SYSTEM RESTORATION SERVICES

System restoration services are those services that are required in the unlikely event of a failure of the multiple system defence barriers protecting the IPS from a blackout. These services form part of the national system restoration plan, which is a highly confidential document that details the sequence(s) required to restore the IPS for a range of blackout scenarios for the current network topology.

Two system restoration services are defined for the IPS, with a third service currently being developed. These services are:

1. Black-start (GCR8) **[3]**
2. Unit islanding (GCR2) **[3]**
3. Self-start *(still to be formalised following inclusion in the Grid Code in conjunction with associated Ancillary Services documentation and processes)*

Provision of these services assumes the absence of an established grid, with the entire IPS being completely blacked out at the start being an extreme possibility.

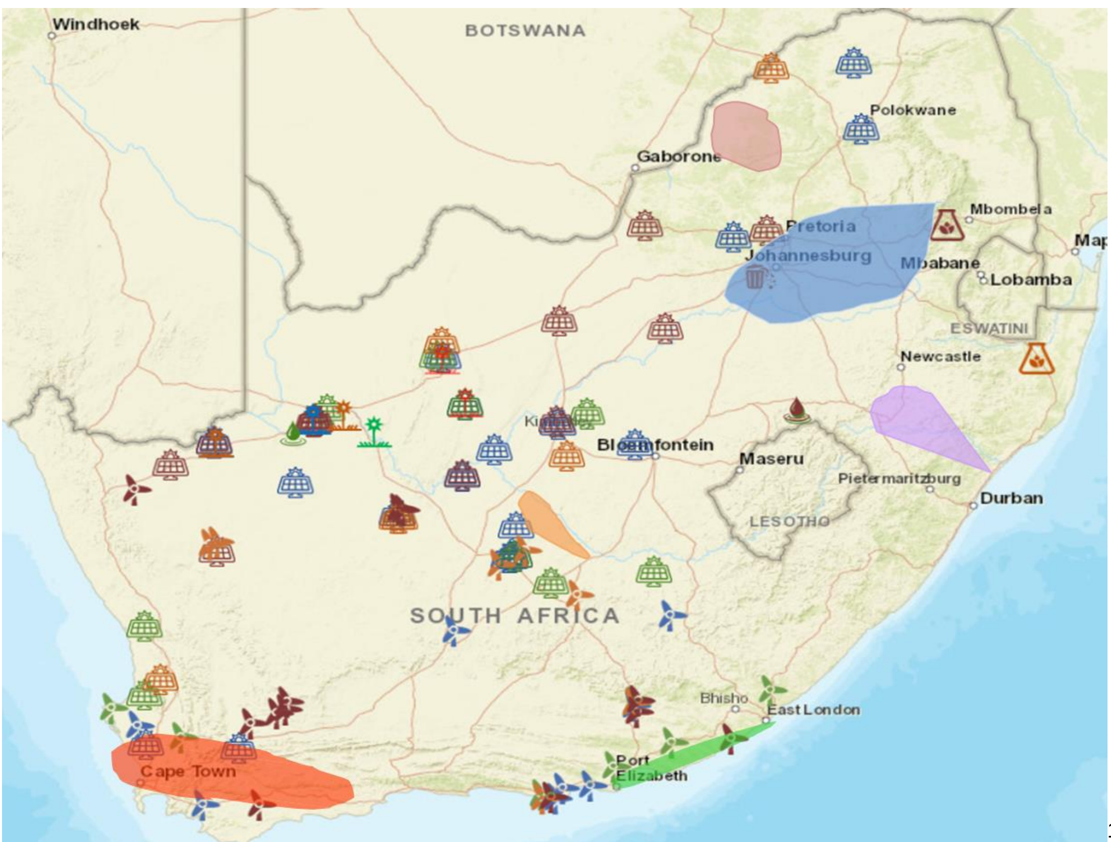
For black-start, this capability is defined as the ability to start independently (i.e., start-up without external support), energise the surrounding transmission and distribution networks, supply load, and act as a start-up supply for other generating capacity to be synchronised as part of a process of restoring the power system.

For unit islanding, this capability is defined in terms of a generating unit being able to disconnect from the transmission network and to control all necessary parameters such that the generator remains at speed and excited while supplying its auxiliary load – in a blackout scenario, they would need to maintain the islanded state for at least two hours and act as a start-up supply for other capacity to be synchronised as part of a process of restoring the power system.

For self-start, this capability is defined as the ability to start independently (i.e., start-up without external support), energise the surrounding transmission and distribution networks, and supply load.

Based on the need to start-up generation and supply load, location is a key consideration for all three services. Consider the following geographical representation of generation resources:

Legend
Shaded areas = Existing generation (incl. IPP peaking); Icons = REIPPPP projects



[1]

[1] Original image sourced from IPP Office (https://www.ipp-projects.co.za/ProjectDatabase/Map)

To be considered as a system restoration option within the current time horizon, a potential service provider would need to be able to provide their capability in the proximity of:

1. One of the shaded areas with existing generation
2. An area with a high concentration of renewables such that a sustainable island can be formed

Outside of these areas, the reactive power generated by energising long, lightly-loaded transmission lines connected to major load centres and other generators will likely make voltage control extremely unstable. Thus, only facilities that are in these regions will be considered at this time.

The full testing requirements and process for system restoration service providers are detailed in [3]. However, the aim of this section is to present the high-level requirements that a potential service provider would need to consider before approaching the System Operator for future certification.

4.1 BLACK-START SERVICE PROVIDER REQUIREMENTS

First and foremost, all black-start service providers must meet the requirements specified in the Grid Code [1] [3]. However, potential service providers should be aware of the following selection criteria and specific System Operator requirements that are necessary for consideration as a black-start facility:

1. Service providers shall be power stations or power plants comprised of synchronous generators with on-site self-starting capability
2. Peaking facilities may only be considered for black-start if there is capability to provide start-up power for a base-load generator that can then provide power continuously throughout the restoration

3. Black-start capability shall take precedence over self-start capability and both services may not be contracted for from the same power station or power plant
4. New black-start projects shall be considered primarily on proximity to non-black-start generators and proximity to sufficient load (residential and/or other resistive loads will be advantageous)
5. Selection priority may be given to projects in areas of the network with significant generation, but minimal system restoration capability present
6. Selection priority may be given to projects that have the capacity to start-up multiple generators within an achievable radius
7. Selection priority may be given to projects in areas with existing network infrastructure or requiring relatively minimal network upgrades to accommodate the new facility
8. All ratings may be considered but selection priority shall be given to those facilities with generators or generating units that are rated 100 MVA or larger
9. Power stations or power plants with generating units that are capable of operating at power factors outside of the Grid Code limits, have synchronous condenser operation capability, or other means of additional reactive power control may be assessed favourably
10. Renewables and battery energy storage shall not be considered for black-start until such time that the grid-forming inverter technology reaches maturity in a restoration context
11. Each contracted black-start facility shall be operationally available to black-start for at least 90% of the year
12. Base-load black-start facilities shall be capable of starting at least one on-site base-load generator within 4 hours, following a system blackout
13. Peaking black-start facilities shall be capable of starting a minimum of two or more on-site peaking generators (one unit in Generating mode, others in SCO mode) within 2 hours, following a system blackout. These facilities shall then be capable of energising a defined portion of the transmission/distribution system, and enabling the start-up of a black-start support station from blackout conditions within 4 hours

14. Base-load black-start facilities and black-start support stations shall be capable of picking up instantaneous load blocks of up to 50 MW and/or ramping within their defined range
15. Peaking black-start facilities shall be capable of picking up instantaneous load blocks of up to 15 MW and/or ramping up within their defined range
16. All black-start facilities shall be capable of controlling the frequency within the continuous operating range (49.0 – 51.0Hz), and maintaining voltage within acceptable limits (± 5% of nominal) during the grid reconnection and load pick-up process
17. All facilities shall have redundancy of self-start equipment
18. Self-start equipment at all black-start facilities shall be capable of supplying the inrush current of any transformers or motors required to be energised as part of the system restoration
19. The barring, lubrication, jacking and hydrogen seal oil facilities on the generating units shall be independent from the main supply during a system blackout condition and these facilities must be able to operate for an extended period (i.e., at least two hours) after loss of the external supply to ensure the safe run-down of the turbo-generators from nominal to barring speed
20. After starting up independently and initiating the black-start process, the facility shall be capable of remaining synchronised and available long enough for subsequent base-load units to be started up and synchronised as part of the larger system restoration
21. Black-start facilities shall be capable of attempting at least three consecutive start-ups. This implies that the facility shall always maintain adequate emergency fuel/power for self-start equipment to enable three consecutive start-up attempts to provide start-up power for other generators
22. Adequate spares (agreed between SO and the black-start facility) shall be maintained at all facilities to ensure that required maintenance or refurbishment can be completed as soon as possible such that black-start capability is not compromised

23. For base-load black-start facilities and black-start support stations, sufficient material supply (e.g., coal, diesel, fuel oil, propane gas, demineralised and potable water, hydrogen, etc.) shall be maintained by the facility for the entire restoration process (i.e., three consecutive start-up attempts of a single unit, loading and grid restoration)

4.2 UNIT ISLANDING SERVICE PROVIDER REQUIREMENTS

As with black-start, all unit islanding service providers shall meet the requirements specified in the Grid Code [1] [3]. However, as unit islanding capability cannot be provided by all technologies, it is important to define the selection criteria that will be applied in considering potential unit islanding service providers:

1. All unit islanding facilities shall have a fully commissioned and operational AVR
2. Apart from monitoring equipment, no special modifications to commercially operational plant shall be made for the purpose of islanding, i.e., all plant and equipment shall be part of the standard equipment and capability of the facility
3. All unit islanding facilities shall be capable of energising a dead HV busbar on site
4. Peaking plant shall not be considered for unit islanding certification
5. Renewable energy sources shall not be considered for unit islanding certification without grid forming capability
6. Battery energy storage shall not be considered for unit islanding certification
7. Only 100 MVA non-hydro generators and larger may be considered for islanding certification
8. Only remote generators with insufficient local load shall be automatically disregarded for unit islanding certification based on location i.e., all adequately-sized generators of the appropriate technology and usage philosophy shall be considered
9. The System Operator shall define all minimum criteria (not limited to the above) that is deemed necessary to select a generator/facility as a potential service provider

4.3 SELF-START SERVICE PROVIDER REQUIREMENTS

As mentioned above, the self-start service is in the process of being established with amendments for the Grid Code awaiting approval from the Eskom Expert Team (EET) and Grid Code Advisory Committee (GCAC). Once approved, all self-start service providers must meet the requirements specified in the Grid Code [1] [3]. Additionally, Ancillary Services will publish approved standard(s) addressing testing, certification and performance monitoring requirements that service providers shall be expected to adhere to – these requirements are also in the process of being drafted and approved. In the interim, potential service providers can refer to the planned selection criteria and technical requirements below that will be necessary for consideration as a self-start facility:

1. Service providers shall be power stations or power plants comprised of synchronous generators with on-site self-starting capability
2. Self-start capability shall only be considered for contracting if black-start capability is not viable
3. Selection shall be based primarily on proximity to sufficient load (residential and/or other resistive loads will be advantageous)
4. Selection priority may be given to projects in areas of the network with a large customer base
5. Selection priority may be given to projects in areas with existing network infrastructure or requiring relatively minimal network upgrades to accommodate the new facility
6. All ratings may be considered but selection priority will be given to those facilities with generators or generating units that are rated at 100 MVA or larger
7. Power stations or power plants with generating units that are capable of operating at power factors outside of the Grid Code limits, have synchronous condenser operation capability, or other means of additional reactive power control may be assessed favourably

8. Facilities shall be capable of independently starting at least one on-site generator within 2 hours following a blackout
9. Facilities shall be capable of controlling frequency within the continuous operating range between 49 – 51 Hz.
10. Facilities shall be capable of controlling voltage within ±5% of nominal bus-bar voltage using the AVR and/or on-load tap change on the generator transformer. SCO capability to be made available as per [3]
11. Units at the facility shall be capable of picking up discrete block loads of up to 15 MW as will be required during system restoration
12. Facilities shall have redundancy of self-start equipment
13. Self-start equipment shall be capable of supplying the inrush current of any on-site transformers or motors required to be energised as part of the system restoration
14. Each contracted facility shall be operationally available to self-start for at least 90% of the year
15. Facilities shall always maintain adequate emergency fuel/power (75% of full capacity) for self-start equipment to enable multiple consecutive start-up attempts
16. A specific minimum level of primary fuel storage (expressed in unit generating hours) defined by the System Operator shall be required to be retained for system restoration purposes
17. Adequate spares (agreed between SO and the self-start facility) shall be maintained to ensure that any required maintenance or refurbishment can be completed as soon as possible such that self-start capability is not compromised

4.4 SYSTEM RESTORATION SYSTEM REQUIREMENTS

In addition to the requirements for potential system restoration facilities to be considered for service provision, as listed above, the System Operator also has requirements to ensure that a safe and flexible system restoration process is completed as swiftly as possible.
Ideally, all power stations on the network should be capable of all system restoration services, where possible. This would enable the most robust response to any variation on the considered blackout scenarios, regardless of location or root cause. However, this is impractical as the aggregated financial impact to the System Operator (as the buyer of these services) would be prohibitively high for the proportionate value to the power system. For this reason, it is important that service providers are procured at a level which reduces customer impact/restoration time in a blackout, without being excessive or surplus to system requirements.

Unit islanding is not a capability that is offered by all generators, and while it is the primary response mechanism to a blackout, it is not guaranteed that islanding will be successful or sustained by all certified islanding units. Considering this, having a significant base-level of certified islanding units increases the likelihood of having successful islanding across the network. For this reason, the System Operator will consider any potential unit islanding facilities, provided they meet all requirements listed in 4.2 above. With unit islanding provision projected to decrease over time, there is no upper limit imposed on procuring new unit islanding service providers at this time.

For black-start and self-start, there is a need for being more circumspect with regards to defining a requirement. Unlike unit islanding, both black-start and self-start can be reattempted in the event of failure, meaning that a failed black-start or self-start attempt does not represent the loss of immediate capability as with unit islanding. As such, this represents the last and most important response option to a blackout. Additionally, international benchmarking gives an indication at the rate at which other utilities (at both a smaller and larger scale) procure these services. These services need to be procured at a level that reduces overall restoration time of the national demand. Considering that the peak national demand for 2022/23 was 34 666 MW, the following table summarises the combined black-start and self-start requirements to ensure an adequate restoration process for the current time horizon:

Table 7: Black-start and self-start system requirements

	Grid Code Minimum	Current Status	Minimum Procurement Target	Moderate Procurement Target	Aggressive Procurement Target
No. of facilities	2	3	3 + BS + SS = 5	3 + BS + SS = 8	3 + BS + SS = 13
Time Frame	-	-	2023-2027	2023-2032	2023-2037
Comment	Grid Code minimum	Current status	Two new facilities in next five years	Five new facilities in next ten years	Ten new facilities in next fifteen years
Where BS = new black-start facilities // SS = new self-start facilities					

5. REACTIVE POWER AND VOLTAGE CONTROL

Reactive power supply and voltage control form part of the ancillary services required by the System Operator to efficiently perform its main function of supplying electrical power.

5.1 TECHNICAL REQUIREMENTS

The technical requirements for reactive power and voltage control include requirements from the Grid Code, Renewables Grid Code and System Operator.

A) Grid Code Requirements for Conventional Generation

1. As required by the Grid Code, Network Code [3], all units greater than 100 MW shall be capable of supplying rated power output (MW) at any point between the limits of 0.85 power factor lagging and 0.95 power factor leading at the HV side of the generator transformer.
2. Reactive power output shall be fully variable between these limits under AVR, manual or other controls.
3. SO shall control power station export/import of reactive power through TEMSE or telephone.
4. When a unit is in pumping or generating, reactive power supply is mandatory in full operating range
5. Voltages shall not deviate by more than ±5% from declared voltages under normal operating conditions.
6. Gas Turbine units built after the implementation of the Grid Code shall be capable of operating in SCO.
7. Generators shall conduct prototype and routine tests to demonstrate reactive capability.

All units built after the implementation of the South African Grid Code shall be equipped with power system stabilisers. Reactive output shall be fully variable to achieve acceptable levels of voltage (± 5%) under automatic or manual control.

B) Grid Code Requirements for Renewables Power Plants (RPP)

1. During start-up / energising, the Renewables Power Plants (RPP) may only consume or export not more that 5% of rated reactive power from the transmission system.
2. Different power factor categories (A – C) depending on the output power are specified in the RPP Code.
3. The RPP shall be equipped with reactive power control functions capable of controlling the reactive power supplied by the IPP at the point of connection (POC) as well as a voltage control function capable of controlling the voltage at the POC via orders using set points.
4. The RPP shall ensure that they can function/operate under any of the three different modes mentioned below. Furthermore, the reactive power and voltage control functions are mutually exclusive, which means that only one of the three functions mentioned below can be activated at a time:
    a. Q-control
    b. Power Factor–control
    c. Voltage-control

5. The applied parameter settings for reactive power and voltage control functions shall be determined before commissioning by the Network Service Provider (NSP) in collaboration with the SO.

C) System Operator (SO) Requirements

1. SO shall use peaking stations (pump storage and OCGTs) in SCO for voltage control.
2. All installed thermal and peaking stations will be used for voltage control at the discretion of the SO.
3. All generators shall have automatic voltage regulators (AVR)/converters in an automatic voltage control mode.
4. All generators shall inform/update SO of any restriction that might affect the reactive power support.
5. All generators capable of voltage control shall be required to do reactive capability tests as stipulated in the Grid code.

6. CONSTRAINED GENERATION

6.1 INTRODUCTION

The Grid Code [3] specifies that the System Operator manage real-time system constraints within safe operating limits, using constrained generation as one of the ancillary services as required. In particular, it requires multiple outages of a credible nature be studied to ensure that the operation of the system protects against cascading outages for such an event, wherever practical. It further requires that the System Operator identify those system constraints that limit the capacity to meet demand, and draw conclusions on the need for this service over the forthcoming 5-year horizon. An input in establishing the need for the service includes determining the constraints with duration beyond a few hours that have a significant impact and high probability. This requirement excludes long duration planned transmission maintenance outages that coincide with full generation at the corresponding power station from the list of system constraints requiring constrained generation where they can be avoided, for example, as such planned transmission outages are expected to be coordinated with the generation outages.

6.2 NATIONAL SYSTEM CONSTRAINTS

The SA Grid Code System Ops Code, section 4.3 specifies that any power stations run out of schedule to respect operational limits be compensated for the resulting financial loss so suffered from the lack of IPS capacity and related market rules, as part of constrained generation.

6.2.1 Cape Constraint

Consistent with the System Operator's obligations to operate the IPS in a safe, reliable and economic manner, the risk to meeting local demand while refuelling Koeberg Nuclear Power Station (KNPS) was assessed. A production simulation study, using the renewable generation expansion plan outlined in IRP2019 and latest production data, was used to establish the associated additional cost for peaking generation in the Cape resulting from regional transmission constraints, particularly affecting the capacity to meet the local demand during refuelling events at KNPS. From this, the following OCGT constrained generation requirements were determined:

Table 8: Summary of OCGT energy requirements for refuelling of KNPS

Financial year	Study category	Max units required	OCGT energy needed (GWh)
2023/24	Planned operation (N-0)	0	0
	Non-refuel (N-1)	0	0
	Refuel (N-1-1)	0	0
2024/25	Planned operation (N-0)	0	0
	Non-refuel (N-1)	0	0
	Refuel (N-1-1)	0	0
2025/26	Planned operation (N-0)	0	0
	Non-refuel (N-1)	0	0
	Refuel (N-1-1)	0	0
2026/27	Planned operation (N-0)	0	0
	Non-refuel (N-1)	0	0
	Refuel (N-1-1)	0	0
2027/28	Planned operation (N-0)	0	0
	Non-refuel (N-1)	0	0
	Refuel (N-1-1)	0	0

Based on these results, the System Operator chooses to continue to impose no restrictions on when KNPS may be refuelled.

Regarding the operation of Palmiet Pumped Storage Scheme, the System Operator maintains the minimum top dam level at 5 unit generating hours (UGH). The restriction on Palmiet not being on planned maintenance during refuelling outages at KNPS remains.

7. ACCEPTANCE

This document has been seen and accepted by:

Name	Designation
Andre Scholtz	Power System Manager
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Louis du Plessis	National Operations Manager
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Norman van der Merwe	Power System Manager
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Rudolph Binneman	National Control, Generation Scheduler
Siju Joseph	Ancillary Services Manager
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8. REVISIONS

Date	Rev.	Compiler	Remarks
October 2023	1.0	VG Smith	New document

9. DEVELOPMENT TEAM

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

- Ike Tshwagong
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- Musa Gumede
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10. SUPPORTING CLAUSES

10.1 Scope

This document specifies the technical requirements for ancillary services for financial years 2023/24 to 2027/28.

The purpose of the document is to make the System Operator's requirements known to ensure a reliable network and provide optimal usage of ancillary services for the next five financial years.

All suppliers of ancillary services need to meet all aspects of the South African Grid Code relating to these services.

10.2 Abbreviations and Definitions

CPS: Control Performance Standard
GX: Generation division
IRP: Integrated Resource Plan (for Electricity)
IPS: Interconnected Power System
KNPS: Koeberg Nuclear Power Station
OCGT: Open cycle gas turbine
OP: Operating Procedure
OS: Operating Standard
SAPP: Southern African Power Pool

Peak and Off-peak: Peak periods are considered only during weekdays. There are two peak periods in the daily system load profile, morning peak and evening peak, occurring at different times of the day during winter and summer months. Public holidays are treated the same as weekends with no peak periods. In winter, identified as May to August, the morning peak occurs from 06:00 to 09:00 and the evening peak occurs from 17:00 to 20:00. In summer, covering the remainder of the year outside winter, the morning peak occurs from 09:00 to 12:00 and the evening peak from 18:00 to 21:00. Thus the peak periods occur for six hours of the day every weekday.
Residual load: That portion of the load not met by renewable generation

RE: Renewable energy (generation)
SAPP: Southern African Power Pool
SO: System Operator
SOG: System Operator Guideline
UGH: Unit generating hours

10.3 Roles and Responsibilities

The provision of these requirements is monitored regularly via the monthly performance reports.

10.4 REFERENCES

1. "The South African Grid Code: System Operator Code", Rev 10.1 January 2022
2. Integrated Resource Plan for Electricity 2019, Government Gazette, no. 42784, 18 October 2019
3. "The South African Grid Code: Network Code", Rev 10.1 January 2022