The South African Grid Code

The System Operation Code

Version 7.0
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1. Introduction

(1) This code sets out the responsibilities and roles of the participants as far as the operation of the interconnected power system (IPS) is concerned, and more specifically issues related to:
- reliability, security and safety
- ancillary services
- market operation actions required by the System Operator
- independent actions required and allowed by customers
- operation of the IPS under abnormal conditions, and
- field operation, maintenance and maintenance co-ordination/outage planning.

2. Operation of the IPS

(1) The System Operator shall be responsible for the safe and efficient operation of the IPS.

(2) The System Operator shall operate the IPS in accordance with the provisions of the System Operation Code.

(3) All participants shall co-operate in setting up operational procedures under the direction of the System Operator to ensure proper operation of the IPS.

(4) The System Operator shall have ultimate authority and accountability for the operation of the IPS, in accordance with the conditions of its licence and subject to the provisions of section 5 and section 10.

(5) SAPP and other international tie-line operations shall be governed by the SAPP and related agreements.

2.1 System Operator obligations

The System Operator shall be responsible for the following:

2.1.1 System reliability and safety

(1) The System Operator shall operate the IPS to achieve the highest degree of reliability practicable and appropriate remedial action shall be taken promptly to relieve any abnormal condition that may jeopardise reliable operation. Power transfers as defined in paragraphs (3), (4) and (8) within this section, and other transfers as far as feasible, shall be adjusted as required to achieve or restore reliable IPS operation.

(2) The System Operator shall dispatch generation on the IPS according to market rules, subject to the constraints of safety of personnel and equipment, IPS security, reliability and the environment.

(3) The System Operator shall co-ordinate voltage control, operating on the IPS and security monitoring on a system-wide basis in order to ensure safe, reliable, and economic operation of the IPS.

(4) The System Operator shall operate the IPS, as far as is reasonable, with sufficient operating reserve capacity to carry its expected load as per the frequency control requirements of this code.

(5) During or after a system disturbance, the System Operator shall give high priority to keeping all synchronised units running and connected to the IPS, or islanded on their own auxiliaries, in order to facilitate system restoration, as defined in section 4.
(6) *Black start services* shall be contracted for with at least two suitable facilities to enable the restoration of the power system following the loss of all generation and interconnections with neighbouring countries.

(7) The *System Operator* shall make all reasonable endeavours to retain international interconnections unless it becomes evident that continued parallel operation of the affected parts of the *IPS* would jeopardise the remaining system or damage equipment.

(8) Should it become unsafe to operate *units* in parallel with the system when critical levels of *frequency* and voltage result on the *IPS* from a disturbance, the separation and/or safe shutdown of units shall be accomplished by the *System Operator* in such a way as to minimise the time required to resynchronise and restore the system to normal.

(9) In the event of a system separation, the *System Operator* shall ensure that the part of the *IPS* with a generation deficit shall automatically remove sufficient load to permit early recovery of voltage and *frequency* so that system integrity may be re-established.

(10) The *System Operator* may shed customer load to maintain system integrity. Following such action, customer load shall be restored as soon as possible with due consideration of the possibility of cascading failure or operating at abnormally low *frequency* or voltage for an extended period of time.

(11) An internationally interconnected power system operator may request that the *System Operator* takes any available action to increase or decrease the active energy transfer across the international borders by the way of emergency assistance. Such requests shall be met by the *System Operator* provided it has the capability to do so without jeopardising the network integrity within South Africa.

(12) The *System Operator* shall operate the *IPS* in such a way as to minimise adverse effects of disturbances on *customers*.

### 2.1.2 System security

(1) The *System Operator* shall operate the *IPS* as far as practical so that instability, uncontrolled separation or cascading outages do not occur as a result of the most severe double contingency. Multiple outages of a credible nature shall be examined and, whenever practical, the *System Operator* shall operate the *IPS* to protect it against instability, uncontrolled separation and cascading outages.

(2) The *auxiliary supply* to nuclear *power stations* (such as Koeberg) shall be considered the most important load on the *IPS*. A *generator* may enter into a detailed agreement with the *System Operator* regarding essential grid supplies for nuclear safety for each nuclear *power station*. The *System Operator* shall cooperate with the relevant *generator* in establishing such an agreement. This agreement shall address the operational limits within which the network is suitable to provide nuclear safety supplies, including

- dynamic and transient stability limits
- voltage stability limits
- steady state limits
- *transmission* connecting equipment reliability.

(3) The *auxiliary supply* to all base-load *power stations* shall be regarded as the second most important load on the *IPS*. The *System Operator* shall regard all essential supplies as identified by the *Distributors* as having the same priority.

(4) The *System Operator* is responsible for efficient restoration of the *TS* after supply *interruptions*.

(5) The *System Operator* shall operate and maintain primary and emergency *control centres* and facilities to ensure continuous operation of the *IPS*.  

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2.1.3 Agreements for off-site grid supplies to nuclear power stations

(1) The System Operator shall, upon request, enter into an agreement as required in section 4.9 of the Network Code.

(2) The System Operator shall have back-to-back agreements as applicable with the TNSP and/or distributor for the provision of off-site supplies to nuclear power stations.

(3) The System Operator shall provide feedback and illustrate to the customer, on an ongoing basis, the status of the integrity of the off-site supply.

(4) All the various IPS phenomena that are likely to occur shall be addressed in the off-site supply agreement. Examples of such phenomena that are likely to effect the integrity of the off-site supply, and that need to be addressed are as follows:
   - Systems common to a substation that are likely to lead to tripping of multiple lines, transformers, reactors, and/or Static Voltage Compensators (SVC)
   - Appropriate part system islanding and its associated load shedding and frequency control plans
   - Appropriate loading of plant within its specified limits
   - Appropriate fault clearing times and associated voltage depressions
   - Phase unbalance and waveform distortion
   - Sufficient reactive power supply and voltage support
   - Sufficient dynamic and transient (first swing) stability margin and the availability of appropriate countermeasures; also provision of adequate protection where required
   - Countermeasures and adequate protection for sub-synchronous resonance (SSR)

(5) Where such phenomena are likely to occur, appropriate planning, design, modifications, operation and maintenance of its associated countermeasures and protection systems shall be addressed by the NTC. Where practical, countermeasures and/or protection may be provided, maintained and operated by the customer.

2.1.4 Operational measures

(1) The System Operator shall establish and implement operating instructions, procedures, standards and guidelines to cover the operation of the IPS under normal and abnormal system conditions. The System Operator shall maintain a database with version control of all such documents in compliance with license conditions.

(2) The System Operator shall operate the IPS, as far as reasonably possible, within defined technical standards and equipment ratings.

(3) The System Operator shall manage constraints on the TS through the determination of operational limits and the purchase of the constrained generation ancillary service.

(4) The System Operator shall ensure the development, publication and implementation of adequate procedures for the efficient scheduling of generation and network outage as defined in section 15.

(5) To achieve a high degree of service reliability, the System Operator shall ensure adequate and reliable communications between SO Control Centre and other control centres, power stations and substations. Communication facilities to be provided and maintained by customers are specified in the Information Exchange Code.

(6) The System Operator shall be responsible for the ongoing determination of the TS protection philosophy (as contrasted to equipment protection).

(7) The System Operator shall determine, and review where necessary, relay settings for main and backup protection on the IPS.
3. **Scheduling of generation and ancillary services**

   (1) The *System Operator* shall provide a day-ahead demand forecast for the *IPS*.

   (2) The *Market Operator* shall provide the *System Operator* with the daily 24 hours day-ahead energy and **ancillary services** schedule before 14:00 each day.

   (3) The responsibility for executing the energy and **ancillary services** schedule shall lie with the *System Operator*.

   (4) The System Operator shall undertake rescheduling on the basis of the market rules.

4. **Ancillary services**

   (1) The *System Operator* shall be responsible for the provision of all short-term reliability services for the *IPS*. These include restoration, the balancing of supply and demand, the provision of quality voltages and the management of the real-time technical risk.

   (2) The *System Operator* shall certify providers of ancillary services and keep a register of all certified providers.

   (3) The *System Operator* shall determine reliability targets for the purposes of acquiring **ancillary services** in consultation with relevant *participants*. The reliability targets shall be selected so as to minimise the sum of the cost of providing the reliability plus the cost to the *customer* of limited reliability. The cost of providing suitable **ancillary service** levels shall be calculated annually for budget purposes.

   (4) The *System Operator* shall be responsible for procuring the required **ancillary services** as described in this section in accordance with the license and market rules.

   (5) The *System Operator* shall state opportunities for the provision of **ancillary services** as described in the Network Code, section 7.4.

   (6) The following services are defined as **ancillary services**:
       - Reserves as defined in section 4.1 of this code
       - **Black start** and **unit islanding**
       - Constrained generation
       - Reactive power supply and voltage control from **units**
       - **Regulation and load following**

4.1 **Operating reserves**

   (1) Operating reserves are required to secure capacity that will be available for reliable and secure balancing of supply and demand within ten minutes and without any energy restrictions. Operating reserves shall consist of: **instantaneous reserve**, **regulating reserve** and **ten minute reserve**. The total reserve make-up is shown below.
4.1.1 Instantaneous reserve

(1) The System Operator shall ensure instantaneous reserve is available as needed to arrest the frequency at acceptable limits following a contingency, such as a unit trip or a sudden surge in load. A sudden increase in frequency is not included as part of instantaneous reserve. (Generating units are required to respond to high frequencies (above 50 Hz) by means of governing.)

(2) The requirement on the System Operator is to keep the frequency above 49.5 Hz following all credible single contingency losses. The largest loss is the loss of a Koeberg unit at full load, i.e. 920 MW (the Cahora Bassa infeed is classified as a multiple incident).

(3) It is also a requirement on the System Operator to keep the frequency above 49.0 Hz after credible multiple contingencies, currently being the loss of 1 800 MW generation (typically three coal-fired units or the loss of the Cahora Bassa infeed).

(4) Those generators that are contracted for Instantaneous Reserve Low Frequencies are also required to provide the capacity for Instantaneous Reserve for high frequencies between the applicable deadband and the 50.5 Hz mandatory requirements as per Network Code, section 3. These units are required to respond with at least contracted capacity for low frequencies or according to the agreed droop characteristic. The response is required fully within ten seconds, to
4.1.2 Regulating reserve

(1) Regulating reserve is reserve that is under AGC and can respond within ten seconds and be fully active within ten minutes of activation. This reserve is used for second-by-second balancing of supply and demand. The reserve is also used to restore instantaneous reserve within ten minutes of the disturbance.

4.1.3 Ten-minute reserve

(1) Ten-minute reserve is required to balance supply and demand for changes between the day-ahead market and real time such as load forecast errors and unit unreliability. Ten-minute reserve is used to restore regulating reserve when required. Ten-minute reserve must be activated, on request, within ten minutes and must be sustainable for two hours.

(2) The amount of reserved required is to be calculated by the System Operator and shall be based on SAPP minimum requirements, supplemental and emergency reserve availability, and other reserve considerations.

4.1.4 Emergency reserve

(1) Emergency reserve is typically made up from contracted interruptible load, gas turbines and emergency generation (EL1 and EL2).

(2) Emergency reserve is a less frequently used reserve and is used when the IPS is not in a normal condition and to return the IPS to normal conditions while slower reserves are being activated. The reserve can be used by the System Operator for supply and demand balancing, network stability and voltage constraints. This reserve shall be activated, on request, within ten minutes and shall be sustainable for two hours.

4.1.5 Supplemental reserve

(1) Supplemental reserve is used to reduce the short-term risk. This reserve is available for at least two hours. It is contracted to ensure an acceptable day-ahead risk.

4.2 Black start and unit islanding

(1) Islanded units shall be capable of running in the islanded state for at least two hours before reconnecting to the network.

(2) All units capable of unit islanding are required to contract the service provision to the System Operator. The System Operator shall certify units capable of islanding.

(3) To ensure optimal operation of the IPS, the System Operator may deploy system islanding schemes on the network, e.g. an out-of-step tripping scheme.

(4) The System Operator shall determine the minimum requirements for each black start supplier and ensure that the contracted suppliers are capable of providing the service.

4.3 Constrained generation

(1) Constrained generation is the service supplied by a power station to the NTC by constraining its power output below (alternatively above) the unconstrained schedule level. The service is required to ensure that the IPS remains between appropriate operational limits (e.g. thermal, voltage or stability limits).
(2) In providing the service, the power station experiences a financial loss, for which it shall be compensated by the NTC, according to the market rules. Constrained generation is required to meet TS reliability as there are no current rules for market splitting across transmission constraints or the handling of units in strategic positions.

(3) The identification of the specific TS constraints applicable at any point in time shall be the responsibility of the System Operator.

4.4 Reactive power supply and voltage control from units

(1) Voltage control and the supply or consumption of reactive power are inter-related in the sense that the voltage is affected by changes in the reactive power flow. System stability depends on the voltage profile across the system. In view of these considerations it is necessary from time to time to employ certain power stations to supply or consume reactive power, whether or not they are producing active power, for the purpose of voltage control.

(2) The unit shall be able to provide reactive power without having to produce or consume a large quantity of real power. The System Operator shall control the amount of reactive power. This may be done directly through the energy management system or by telephone.

(3) When a unit is generating or pumping, reactive power supply is mandatory in the full operating range as specified in the Network Code, section 3.

4.5 Regulation and load following

(1) This service is the automatic matching of supply and demand in real time by increasing or decreasing the active power of units. The control system for this is called automatic generation control (AGC) and it can send a command, to increase or decrease real power output when signalled to do so.

(2) The resources contracted by the System Operator for this service shall operate under AGC control and shall be able to alter their generation or load under direct control of AGC to the performance requirements specified by the System Operator. The requirement for the total capacity of regulation to be provided by the suppliers of this service is specified under regulation reserve. This requirement is to meet the frequency and tie-line control standards as defined by the System Operator and the SAPP.

5 Operational authority

(1) The System Operator shall have the ultimate authority to instruct operating on the TS. Operational authority for other networks shall lie with the respective asset owners.

(2) The System Operator shall enter into operating agreements with each TNSP for safe and efficient operating of the TNSP network.

(3) Network control, as it affects the interface between a TNSP and a customer, shall be in accordance with the operating agreements between the participants.

(4) Except where otherwise stated in this code, no participant shall be permitted to operate the equipment of another without the permission of such other participant. In such an event the asset owner shall have the right to test and authorise the relevant operating staff in accordance with its own standards before such permission is granted.

(5) Notwithstanding the provisions of section 2.1, participants shall retain the right to safeguard their equipment.
6 Operating procedures

(1) The System Operator shall develop and maintain operating procedures for the safe operating of the TS, and for assets connected to the TS, as per section 2.1.4. These operating procedures shall be adhered to by participants when operating equipment on the TS or connected to the TS.

(2) Each customer shall be responsible for his own safety rules and procedures at least in compliance with the relevant safety legislation. Customers shall ensure that these rules and procedures are compatible with the System Operator procedures defined in paragraph (1).

(3) The SAPP operating agreements shall apply in the case of operational liaison with all international power systems connected to the TS.

(4) Customers and service providers shall enter into operating agreements as defined in the service provider licenses.

7 Operational liaison

(1) The System Operator shall sanction the shutting down and synchronising of units.

(2) If any participant experiences an emergency, the other participants shall assist to an extent as may be necessary to ensure that such emergency does not jeopardise the operation of the IPS or health of plant.

(3) In the event that it is physically possible for a customer to transfer load or embedded generators from one point of supply to another by performing switching operations on the customer’s network, the operating agreement shall cover at least the operational communication and notice period requirements, and switching procedures for such load transfers.

(4) The TNSP, in consultation with a specific generator, shall compile both a comprehensive maintenance philosophy, and a test and inspection plan for all equipment, systems and schemes installed in the specific HV yards, addressing concerns from both parties.

(5) The TNSP shall provide notification to generators of any work to be performed on any VT and/or CT circuits in HV yards, protection schemes or functions of HV yards. The TNSP will compile recommissioning programmes for such work in consultation with the generator.

(6) The TNSP and customers shall agree on the busbar configuration(s) at each point of supply during normal and emergency conditions. Details of such configuration(s) shall be included in the operating agreement between the participants.

(7) Generators shall inform the System Operator of any environmental limitations that would affect the dispatch of the plant.

8 Emergency and contingency planning

(1) The System Operator shall develop and maintain contingency plans to manage system contingencies and emergencies that are relevant to the performance of the IPS. Such contingency plans shall be developed in consultation with all participants, as per section 2.1.4, shall be consistent with internationally acceptable utility practices, and shall include but not be limited to

- under-frequency load shedding
- meeting SATEPSA disaster management requirements including the necessary minimum load requirements
- forced outages at all points of interface, and
- supply restoration.
(2) Emergency plans shall allow for quick and orderly recovery from a partial or complete system collapse, with least cost solution and minimum impact on customers.

(3) The System Operator shall periodically verify contingency and/or emergency plans by actual tests to the greatest practical extent possible. In the event of such tests causing undue risk or undue cost to a participant, the System Operator shall take such risks or costs into consideration when deciding whether to conduct the tests. Any tests shall be carried out at a time that is least disruptive to the participants and embedded end-use customers. The costs of these tests shall be borne by the respective asset owners. The System Operator shall ensure the co-ordination of the tests in consultation with all affected participants.

(4) The System Operator shall specify minimum emergency requirements for distributor control centres, power station local control centres and substations to ensure continuous operation of their control, recording, annunciator and communication facilities.

(5) Other participants shall comply with the System Operator's reasonable requirements for contingency and emergency plans.

(6) The System Operator shall set the requirements for automatic and manual load shedding. Participants shall make available loads and schemes to comply with these requirements.

(7) The System Operator shall be responsible for determining all operational limits on the TS, updating these periodically and making these available to the participants.

(8) The System Operator shall conduct load flow studies regularly to determine the effect that various component failures would have on the reliability of the IPS. At the request of the System Operator, distributors shall perform related load flow studies on their part of the network and make the results available to the System Operator.

9 System frequency and ACE control under abnormal frequency or imbalance conditions

(1) The System Operator shall be responsible for the balancing of supply and demand in real time through the implementation of the energy schedules and utilisation of ancillary services.

(2) Frequency shall be controlled according to quality criteria as defined by NRS 048 and Southern African Power Pool requirements

(3) Figures 1(a) and (b) summarise the governor and load shedding requirements for low and high frequency control as required by the system operator.
Figure 1(a): Low frequency requirements
9.1 Description of normal frequency or balancing conditions

(1) The control area is considered to be under normal frequency conditions when
   • the immediate demand can be met with the available scheduled resources, including any
     expensive contingency resources; and
   • the ACE deficit does not exceed the available reserves for longer than 10 minutes; and
   • the frequency is not less than 49.8 Hz for longer than 10 minutes; and
   • the frequency is within the range 49.5 to 50.5 Hz; and
   • the interconnections are intact; and
   • there are no security and safety contraventions.

(2) The control area is considered to be under abnormal conditions if it is not in a normal condition as defined above.

9.2 Operation during abnormal conditions

(1) When abnormal conditions occur, corrective action shall be taken as stipulated in table 1, until the abnormal condition is corrected.
Table 1 Operation during abnormal conditions

<table>
<thead>
<tr>
<th>CONDITION FOR USAGE</th>
<th>RESOURCES IN DEFAULT ORDER OF USAGE</th>
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</thead>
<tbody>
<tr>
<td><strong>Warnings</strong></td>
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<tr>
<td>When a shortfall in supply is expected to occur, issue warnings in sequence until sufficient capacity is obtained to cover the shortfall</td>
<td>Emergency level 1 (EL1) generation warning Interruptible load shedding warning Emergency level 2 (EL2) generation warning</td>
</tr>
<tr>
<td>Generation deficit foreseen with gas turbine operation and load shedding expected</td>
<td>Warning to municipalities Warning to SAPP members</td>
</tr>
<tr>
<td>i) Deficit of 2.5% expected with all generation at maximum and all possible municipal assistance in operation, excluding municipal gas turbines</td>
<td><strong>Load reduction warning</strong> Warning to SAPP members</td>
</tr>
<tr>
<td>ii) F &lt; 49,7 Hz and expect F &lt; 49,5 Hz for longer than two hours</td>
<td></td>
</tr>
<tr>
<td><strong>Gradual frequency decline – refer to merit order in control room for order of use</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CONDITION FOR USAGE</strong></td>
<td><strong>RESOURCES IN DEFAULT ORDER OF USAGE</strong></td>
</tr>
<tr>
<td>If frequency falls below 50 Hz and an abnormal condition exists, the System Operator shall apply resources in the order listed until the condition returns to normal</td>
<td>Run all available plant at MCR Emergency Level 1 (EL1) generation Dispatch emergency capacity according to System Operator merit order, such as: • SAPP non-firm sales • unscheduled hydro • contracted interruptible load • Emergency Level 2 (EL2) generation • SAPP emergency energy • gas turbines</td>
</tr>
<tr>
<td>F&lt;49,5Hz and expect load shedding or curtailment</td>
<td>Mutual standby assistance from municipalities</td>
</tr>
<tr>
<td>i) Sufficient advance notice available and expect F &lt; 49,2 Hz All emergency measures introduced except municipal gas turbines</td>
<td>Load curtailment</td>
</tr>
<tr>
<td>ii) F &lt; 49,5 Hz for &gt; 1 hour is expected</td>
<td></td>
</tr>
<tr>
<td>i) Immediate load reduction required, expect f &lt; 49,2 Hz after all emergency measures introduced except municipal gas turbines</td>
<td>Load shedding</td>
</tr>
<tr>
<td>ii) F &lt; 49,2 Hz for 15 minutes</td>
<td></td>
</tr>
<tr>
<td>iii) F &lt; 49,0 Hz immediately</td>
<td></td>
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<tr>
<td>F&lt;49,1 Hz with all other emergency measures introduced in the time available</td>
<td>Municipal gas turbines</td>
</tr>
<tr>
<td><strong>Rapid frequency decline - Automatic operation by under-frequency relays – apply in order</strong></td>
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<tr>
<td><strong>CONDITIONS FOR USAGE</strong></td>
<td><strong>RESOURCES IN ORDER OF USAGE</strong></td>
</tr>
<tr>
<td>1. F &lt; 49,5 Hz</td>
<td>1. Abnormal condition exists</td>
</tr>
<tr>
<td>2. F &lt; 49,5 Hz for 10 seconds</td>
<td>2. Pumped storage start (including pump load shed) Interruptible contracted load shed (after pumped storage) Manual load shed</td>
</tr>
<tr>
<td>3. F &lt; 49,4 Hz for 20 seconds</td>
<td>3. Gas turbine start and emergency reserve market</td>
</tr>
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<td>4. F &lt; 49,2 Hz for 0,3 seconds</td>
<td>4. Voluntary u/f load shedding 1 Voluntary u/f load shedding 2</td>
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</tbody>
</table>
F < 49.1 Hz for 0.3 seconds
F < 49.0 Hz for 0.3 seconds
5. F < 49.0 Hz for 0.5 seconds
6. F < 48.8 Hz for 0.5, 1.2, 2 seconds
F < 48.5 Hz for 0.5, 1.2, 2 seconds
F < 48.2 Hz for 0.5, 1.2, 2 seconds
F < 47.9 Hz for 0.5, 1.2, 2 seconds
Voluntary u/f load shedding 3
5. Tie-line trips
6. Mandatory u/f load shed – stage1
Mandatory u/f load shed – stage2
Mandatory u/f load shed – stage3
Mandatory u/f load shed – stage4

Frequency restoration after rapid decline

<table>
<thead>
<tr>
<th>CONDITIONS FOR USAGE</th>
<th>RESOURCES IN ORDER OF USAGE</th>
</tr>
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<tbody>
<tr>
<td>1) By units:</td>
<td></td>
</tr>
<tr>
<td>F &lt; 49.4 Hz (low-frequency alarm at power station)</td>
<td>If no contact with the System Operator and low-frequency alarm, increase generation either to Emergency level 2 or until F &gt; 49.5 Hz</td>
</tr>
<tr>
<td>F &gt; 50.6 Hz (high-frequency alarm at power station)</td>
<td>If no contact with the System Operator and high-frequency alarm, decrease generation either to minimum constraint requirement of system operations or until F &lt; 50.5 Hz</td>
</tr>
<tr>
<td>2) By the System Operator</td>
<td>Take restoration action as soon as possible after U/F relays have operated</td>
</tr>
</tbody>
</table>

Prolonged capacity deficit – Durations

<table>
<thead>
<tr>
<th>CONDITIONS FOR USAGE</th>
<th>RESOURCES IN ORDER OF USAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency level 1 and 2</td>
<td></td>
</tr>
<tr>
<td>Emergency reserve – as per contracts</td>
<td></td>
</tr>
<tr>
<td>Gas turbines – continuous</td>
<td></td>
</tr>
<tr>
<td>Mutual standby – continuous</td>
<td></td>
</tr>
<tr>
<td>Load reduction/shedding – as short as possible</td>
<td></td>
</tr>
<tr>
<td>Municipal gas turbines - 1 hour in any 4-hour period</td>
<td></td>
</tr>
</tbody>
</table>

(2) The corrective action includes both supply-side and demand-side options. Where possible, warnings shall be issued by the System Operator on expected utilisation of any contingency resources.

(3) Subject to conditions of table 1, the order in which each category of emergency resources such as load shedding, emergency generation and gas turbines are to be used may be rotated, based on contractual arrangement. The System Operator shall issue an updated list.

(4) Termination of the use of emergency resources shall occur as the plant shortage situation improves and after frequency has returned to normal.

(5) During emergencies that require load shedding, the request to shed load shall be initiated in accordance with agreed procedures prepared and published by the System Operator.

(6) Automatic under-frequency systems shall be kept armed at all times, apart from gas turbines, which shall be armed by the System Operator when a shortage is expected.

10 Independent action by participants

(1) Each participant shall have the right to reduce supply or demand, or disconnect a point of connection under emergency conditions, if such action is necessary for the protection of life or equipment. Each participant shall give advance notice of such action where possible. Examples include hot connections, solid breakers, malfunctioning protection, etc.
(2) During customer emergencies that require load shedding, the request to shed load shall be initiated in accordance with agreed procedures prepared and published by the System Operator.

(3) Independent action may be taken for nuclear units licensed by the National Nuclear Regulator, in terms of the National Nuclear Regulatory Act (Act 47 of 1999).

(4) Following such emergency operations as may be necessary to protect the integrity of the IPS or the safety of equipment and human life, the participants shall work diligently towards removing the cause of the emergency and the supply shall be reconnected immediately after the emergency conditions have passed.

11  Voltage control

(1) The System Operator shall be responsible for the voltage control of the TS, the substations of the NTC and all other networks agreed to with customers.

(2) The System Operator shall operate, under normal operating conditions, in accordance with section 4.14 of the Network Code.

(3) Electricity shall be supplied at three-phase alternating current which shall have a declared voltage between defined limits, at the points of supply, as agreed between the participants in the operating agreement.

(4) TS voltages shall be controlled during normal operation to be at least within statutory limits at the points of supply and otherwise as agreed with customers.

(5) Voltages shall not deviate by more than 5% from the declared voltage under normal operating conditions for any two ten-minute periods within a calendar year, except where otherwise agreed between participants. Normal operating condition is defined as a state where no network component on the affected part of the TS is out of service due to a forced outage beyond the control of the system operator or due to a planned outage.

12  Fault reporting and analysis/incident investigation

(1) Generators shall report loss of output and tripping of units and change of status of AGC and governing to the System Operator within 15 minutes of the event occurring.

(2) In the event of an MUT, the relevant generator shall take the following action:
   • The generator shall submit a written report to the System Operator within one month for any multiple unit trip that could in future cause a category 1 or 2 trip, identifying the root causes of the incident and the corrective actions taken.
   • Category 2: generator shall provide a full report as per Network Code, section 3, and this shall be treated as a major incident.

(3) Distributors and end-use customers shall report the loss of major loads (>100MW) to the System Operator within 15 minutes of the event occurring. Warning of the reconnection of such loads shall similarly be given with at least 15 minutes’ advance notice.

(4) Incidents on the IPS involving sabotage or suspected sabotage, as well as threats of sabotage, shall be reported to the System Operator.

(5) The NTC shall investigate any incident that materially affected the quality of the service to another participant. These include interruptions of supply, disconnections, under or over voltage or frequency incidents, quality of supply contraventions, etc. A preliminary incident report shall be available after three working days and a final report within three months. The NTC shall initiate and co-ordinate such an investigation, arrange for the writing of the report and involve all affected participants. All these participants shall make all relevant information available to the NTC and
participate where reasonably required. The NTC shall make the report available to any requesting participant within the confidentiality constraints.

(6) Any participant shall have a right to request an independent audit of the report, at its own cost. If these audit findings disagree with the report, the participant may follow the dispute resolution mechanism. If the audit agrees with the report, the report recommendations shall stand.

(7) Recommendations that require a change in the Grid Code shall be submitted to the review process as defined in the Governance Code. Such recommendations shall only be implemented upon approval of the amendment.

(8) All other recommendations shall be implemented by the participants within the time frames specified.

13 Commissioning

(1) The System Operator shall verify commissioning / maintenance programmes concerning operating at IPS substations as far as is needed to ensure adequate co-ordination and reliability of the IPS.

(2) All significant aspects of commissioning, by customers or TNSPs, of new equipment associated with the transmission system, or re-commissioning of such existing equipment, shall be agreed in writing with the System Operator, acting reasonably, before such commissioning starts.

(3) The said aspects may include, but not be limited to the following:
   • Commissioning procedures and programmes
   • Documents and drawings required
   • Proof of compliance with standards
   • Documentary proof of the completion of all required tests
   • SCADA information, to be available and tested before commissioning
   • Site responsibilities and authorities, etc.

(4) Participants shall give minimum notice of one month, unless otherwise agreed, from the date of receipt of the request for all commissioning or re-commissioning. Where commissioning is likely to involve a requirement for dispatch and/or operating for test purposes, the participant shall notify the System Operator of this requirement, including reasonable details as to the duration and type of testing required.

(5) When commissioning equipment at the point of connection, the TNSP shall liaise with the affected customers on all aspects that could potentially affect the customers’ operation.

(6) Pursuant to clause 13 (1) and (2), the TNSP or customers shall perform all commissioning tests required in order to confirm that the plant and equipment meets all the requirements of the Grid Code that have to be met before going on-line. The System Operator may request relevant tests (or results of such tests) to be demonstrated in accordance with this Code before accepting such plant for operating.

14 Risk of trip

(1) Generators shall identify and report all MUT risks to the System Operator.

(2) Participants shall minimise to the extent reasonably practical and economic, the risk of tripping/loss of output on their own plant and equipment, associated with their operation and maintenance.

(3) Special care shall be taken by all participants when planning or executing work on protection panels, by introducing a review step in the planning of work process. The outage process described
in the maintenance co-ordination/outage planning section shall be followed. The System Operator shall treat all such work as risk-related outages.

(4) There are two types of risk of trip (ROT), namely scheduled and unscheduled.

(5) The scheduled ROT is typically associated with secondary equipment, such as testing of a protection scheme. A participant shall request the risk of trip in advance and it is subject to acceptance by the System Operator. The System Operator has the right to refuse work associated with such a request based on system conditions and reschedule.

(6) The unscheduled ROT is typically associated with primary equipment, e.g. a generator tube leak. In such a case it is compulsory for the participant to inform the System Operator of the risk event and of the plant status, within 15 minutes of the risk being identified, for plant exceeding a 100 MVA rating.

(7) When an ROT of equipment or loss of output could occur on any part of the IPS, the affected participants shall be informed and shall acknowledge the ROT.

(8) The asset owner shall inform the System Operator, and the System Operator shall in turn inform other affected participants when the risk has been removed.

15 Maintenance co-ordination/outage planning

(1) Optimal operation of the IPS shall be achieved by the System Operator co-ordinating scheduled outages of generators, equipment of the TNSPs, and associated metering, communication and control facilities that affect IPS operation.

15.1 Outages of generators¹

15.2 Outages of TNSP equipment and associated metering, communication and control facilities that affect IPS operation

15.2.1 Responsibilities

(1) It is the responsibility of the participant requiring the outage on plant for planned maintenance, repairs, auditing, emergency repairs, construction, refurbishment, projects, inspection, testing or to provide safety clearance for other activities such as servitude clearance, line crossings and underpasses to request the outage from the TNSP.

(2) The TNSP shall ensure that where there are more than one outage request per bay, within a specific time period, the parties involved, shall where possible combine the outages into a single outage of the same piece of plant. If another outage request for the same bay(s)/plant is noticed within an acceptable time period, the TNSP outage scheduler shall request the parties involved to combine their requests into a single outage. In the case of conflicting outages (simultaneous outages which may increase the risk of loss of supply to a substation or area), the TNSP outage scheduler shall consider the priority and relative urgency of the requests and reflect this against the validated request. The TNSP outage scheduler is also responsible for ensuring that necessary resources are available for the outage and that negotiations of risk-related outages have taken place with relevant stakeholders. The TNSP outage scheduler is responsible for ensuring that the requested outages can physically be executed from a plant perspective.

(3) The System Operator shall appoint an outage scheduler to assess the viability of a scheduled outage and either to allow or turn down the request. This scheduler shall optimise plant utilisation by evaluating network and generation capabilities, different system configurations and risk factors.

¹ Still to be drafted
It is also the responsibility of the scheduler to co-ordinate and schedule plant that affects international customers.

(4) The System Operator shall in real time be responsible for finally sanctioning (or alternatively refusing) an outage and ensuring that the relevant operating instructions are issued.

15.2.2 Outage scheduling process

(1) When the need for an outage is first identified, it shall be requested by the TNSP.

(2) The TNSP shall optimise the outages for which it is responsible in terms of resources and minimising risk, and ensure that necessary resources are available and that customer negotiations have taken place.

(3) Outages shall be negotiated by the TNSP with customers and then booked at least 14 days prior to the date of outage. Planned interruptions should be negotiated with relevant parties at least 35 days prior to the interruption.

(4) The TNSP shall ensure that the relevant contingency plans are in place and are updated as required. The contingency plans will include but not be limited to

- Re-configuration of the network and security linking prior to or during an outage to ensure minimal risk to customers
- Re-configuration of the network after a further contingency to optimise system security and customer restoration
- Returning the plant that is on outage back to service as soon as possible
- Restoring supply to customers by utilising by-pass schemes
- Load shedding if necessary (load profiles shall be made available by the customer)
- Listing of contact persons.

(5) During the development of the contingency plans, the following responsibilities are realised:

- The System Operator and relevant distributor control centres shall be responsible for the security linking instructions in the said contingency plan.
- It shall be the responsibility of the TNSP to supply the information related to returning the plant to service.
- The TNSP shall develop by-pass schemes with assistance from the System Operator and the customer control centre.
- The System Operator and relevant distributor control centres shall be responsible for identification of the load at risk and load shedding in the said contingency plan.

(6) The System Operator shall assess the risk associated with the outage. If there is no unreasonable risk posed to IPS parties or if he is satisfied that adequate information regarding the risk has been communicated to customers, the outage will be allowed to go ahead.

(7) The System Operator shall publish an updated outage schedule on a weekly basis for a rolling month ahead. This will reflect the status of all booked outages.

(8) Conflicting outages shall be negotiated between the various parties concerned and optimised according to risk and financial impact.

(9) The System Operator has, in real time, the final right of veto or sanction of an outage, based on the state of the network at the time the outage is to be taken and any other risks which may be envisaged for the duration of the outage.

15.3 Co-ordination of outages between TNSP and generators

(1) Certain outages will affect both the TNSP and generators. Examples include busbars, links and lines emanating from power stations. As far as possible, TNSP outages will be planned to coincide
with the generator outages due to the financial impact associated with constraining generators off or moving generation outages.

(2) This will not apply to emergency or forced outages. Generators are required to adhere to their planned outage dates and may only deviate from their plan with agreement from the System Operator.

(3) Optimal reliability of the IPS shall be achieved by the System Operator co-ordinating scheduled outages of generators, TNSP’s, distributors, end-use customers, and associated metering, communication and control facilities affecting IPS operation.

16 Communication of system conditions, operational information and IPS performance

(1) The System Operator shall monitor and/or determine system conditions from time to time, and communicate these, or changes from a previous determination, to all participants.

(2) The System Operator shall be responsible for providing participants with operational information as may be agreed with the affected participants. This shall include information regarding planned and forced outages on the IPS as determined by the market rules.

(3) The System Operator shall inform participants of any network condition that is likely to impact the short and long-term operation of that participant.

(4) The System Operator shall timeously communicate any changes or modifications to the TS to the relevant participant.

(5) The System Operator shall report on both technical and energy aspects of IPS performance monthly and annually. This reporting shall include daily demands, energies, losses, interruptions and QOS aspects as detailed in the Information Exchange Code. This information shall be available to all participants on request.

(6) The System Operator shall annually publish expected fault levels, including the rupturing capacity of relevant NTC equipment, for each point of supply.

17 Telecontrol

(1) Where telecontrol facilities are shared between the System Operator and other participants, the System Operator shall ensure that operating procedures are established in consultation with the participants.