ENERGY AND WATER UTILITIES REGULATORY AUTHORITY (EWURA)

THE TANZANIAN GRID CODE

The Information Exchange Code

6 of 8 Code Documents

28th January 2014

Enquiries: EWURA, Tanzania

Table of Contents

Paragraph No./Title **Page Number**

1. Introduction

(1) The Information Exchange Code defines the reciprocal obligations of parties with regard to the provision of information for the implementation of the *Grid Code*. The information requirements, as defined for the *service providers*, the Energy and Water Utilities Regulatory Authority *(*EWURA) and *customers,* are necessary to ensure non-discriminatory access to the *transmission system (TS)* and the safe, reliable provision of *transmission* services.

(2) The information requirements are divided into planning information, operational information and post-dispatch information.

(3) Information criteria specified in the Information Exchange Code are supplementary to the other codes within the *Grid Code*. In the event of inconsistencies between other codes and the Information Exchange Code with respect to information exchange, the requirements of the Information Exchange Code shall prevail.

2. Information exchange interface

(1) The *parties* shall identify the following for each type of information exchange:

- The name and contact details of the person(s) designated by the *information owner* to be responsible for provision of the information
- The names, contact details of, and the parties represented by persons requesting the information
- The purpose for which the information is required.

(2) The *parties* shall agree on appropriate procedures for the transfer of information.

3. System planning information

(1) *Customers* shall provide such information as *TANESCO* may reasonably request on a regular basis for the purposes of planning and developing the TS. *Customers* shall submit the information to TANESCO without unreasonable delay. Such information may be required so that TANESCO can plan and develop the TS, monitor current and future power system adequacy and performance, and fulfil its statutory or regulatory obligations.

(2) *Customers* shall submit to TANESCO and to all relevant *service providers* the information listed in Appendix 2 (for *distributors* or *end-use customers*) or Appendix 3 (for *generators*) and Appendix 9. *TANESCO* may request additional information reasonably required.

(3) Transmission shall provide the *generators* with information about equipment and systems installed in *HV yards* as defined in Appendix 10.

(4) *TANESCO* shall keep an updated technical database of the *IPS* for purposes of modelling and studying the behaviour of the *IPS*.

(5) *TANESCO* shall provide *customers* or potential *customers*, upon any reasonable request, with any relevant information that they require to properly plan and design their own networks/installations or comply with their other obligations in terms of the *Grid Code.*

(6) *TANESCO* shall make available all the relevant information related to network planning as described in the Network Code, section 7.

(7) *Customers* shall, upon request to upgrade an existing connection or when applying for a new connection, provide Transmission with information relating to the following:

Commissioning	Projected or target commissioning test date
Operating	Target operational or on-line date
Reliability of connection requested	Number of connecting circuits, e.g. one or two feeders, or firm/non-firm supply required (subject to Network and Tariff Code requirements)
Location map.	Upgrades: name of existing point of supply to be upgraded and supply voltage New connections: provide a 1:50 000 or other agreed scale location map, with the location of the facility clearly marked. In addition, co-ordinates of the point of connection to be specified
Site plan	Provide a plan of the site (1:200 or 1:500) of the proposed facility, with the proposed point of supply, and where applicable, the transmission line route from the facility boundary to the point of supply, clearly marked
Electrical single-line diagram	Provide an electrical single-line diagram of the customer intake substation

(8) *TANESCO* may estimate any system planning information not provided by a *customer* as specified in Appendix 2 or 3. *TANESCO* shall take all reasonable steps to reach agreement with the *customer* on estimated data items. *TANESCO* shall indicate to the *customer* any data items that have been estimated. The obligation to ensure the correctness of data remains with the *customer*.

(9) *Generators* shall submit weekly to Transmission and the *System Operator* all the maintenance planning information detailed in Appendix 4 with regard to each *unit* at each *power station*.

(10)Transmission shall provide the *generators* with a monthly rolling maintenance schedule for all planned work in *HV yards* for a period of one year in advance. Log books on all vessels under pressure for receivers installed in *HV yards* shall be made available on request from the *generator*.

4. Operational information

4.1 Pre-commissioning studies

(1) *Customers* shall meet all system planning information requirements before the commissioning test date. (This will include confirming any estimated values assumed for planning purposes or, where practical, replacing them with validated actual values and with updated estimates for the future.)

(2) The *System Operator* shall perform pre-commissioning studies prior to sanctioning the final connection of new or modified plant to the TS, using data supplied by *customers* in accordance with section 3, to verify that all control systems are correctly tuned and planning criteria have been satisfied.

(3) The *System Operator* may request adjustments prior to commissioning should tuning adjustments be found to be necessary. The asset owner shall ensure that all system planning information records are maintained for reference for the duration of the operational life of the plant. Information shall be made available within a reasonable time on request from the *System Operator* upon notification of such a request.

4.2 Commissioning and notification

(1) All *participants* shall ensure that exciter, turbine governor, *FACTS* and *HVDC* control system settings are implemented and are as finally recorded by the *System Operator* prior to commissioning.

(2) *Participants* shall give the *System Operator* notice, as defined in the System Operation Code, of the time at which the commissioning tests will be carried out. The *System Operator* and the *participant* shall agree on the timeout provision of operational data items as per Appendix 5.

(3) Records of commissioning shall be maintained for reference by the asset owner for the operational life of the plant and shall be made available, within a reasonable time, to the *System Operator* upon notification of such request.

(4) The asset owner shall communicate changes made during an outage to commissioned equipment, to the *System Operator and Transmission*, before the equipment is returned to service. *TANESCO* shall keep commissioning records of operational data as per Appendix 5, for the operational life of the plant connected to the TS.

4.3 General data acquisition information requirements

(1) Measurements and indications to be supplied by *customers* and *Transmission* to the *System Operator* shall include the formats defined in Appendix 5. Where required signals become unavailable or do not comply with applicable standards for reasons within the control of the provider of the information, such participant shall report and restore or correct the signals and/or indications as soon as reasonable.

(2) The *System Operator* shall notify the *participant*, where the *System Operator*, acting reasonably and in consultation with the *customer*, determines that additional measurements and/or indications in relation to a *participant's* plant and equipment are needed to meet a TS requirement. The costs related to the participant's modifications for the additional measurements and/or indications shall be for the account of the providing *participant*.

(3) On receipt of such notification from the *System Operator* the *participant* shall promptly ensure that such measurements and/or indications are made available at the *unit's communications Gateway equipment*.

(4) The data formats to be used and the fields of information to be supplied to the *System Operator* by the various *participants* are defined in Appendix 5.

(5) Transmission shall provide periodic feedback to customers regarding the status of equipment and systems installed in *the substations where they are connected to the TS*. The feedback shall include results from tests, condition monitoring, inspections, audits, failure trends and calibration. The frequency of the feedback shall be determined in the operating agreement, but will not exceed one year.

(6) Plant status reports provided by Transmission will also include contingency plans where applicable.

(7) The *System Operator* needs to inform *customers* where in the network out-of-step relays are installed, and how the relays are expected to operate. Furthermore, the characteristics of such an islanded network shall be provided, based on the most probable local network configuration at such a time.

(8) The cost of the installation of the data terminal equipment will be paid for by the *participant*.

(9) The *participant* shall decide on the location of the data terminal equipment (DTE).

(10) The *participant* will be responsible for the maintenance of communications links between the generating plant *Gateway* and the data terminal equipment.

(11) The *System Operator* shall be responsible for the maintenance, upkeep and communications charges of the DTE.

4.4 *Unit* scheduling

(1) The *System Operator* shall provide the data defined in Appendix 6 to relevant *Participants*.

4.4.1 Schedules

(1) The *System Operator* shall provide the relevant *Participants* with the next day's twenty-four (24) hours day-ahead energy schedule not later than 21h40 each day. The energy schedule shall be made available hourly on the day, 10 minutes before each hour. The *System Operator* shall import the energy schedule hourly, at five (5) minutes to the hour, for dispatch.

(2) The *System Operator* shall provide the relevant *Participants* with the daily twenty-four (24) hours day-ahead *ancillary service* schedule before 21h40 each day. The *ancillary service* schedule shall be made available hourly thereafter to ensure the transfer of a new schedule owing to a reschedule by the *System Operator*. The *System Operator* shall import the *ancillary service* schedule hourly, at five (5) minutes to the hour, for dispatch.

(3) All information exchange requirements for *ancillary services* that are contracted annually shall be included in the contract between the *parties*.

4.4.2 File transfers

(1) The format of the file used for data transfer through file transfers shall be decided by the *System Operator*. The data shall be made available in a common, electronically protected directory.

File	Description	Trigger event	Frequency
Dispatch schedule	The combined 24-hour day-ahead energy and *ancillary services* schedules. Hourly day-ahead energy and other schedules that identify the unit with the next 24 hourly values for it.	Generation dispatch schedule	Daily

4.5 Inter *control centre* communication

(1) *Customers* shall ensure that their *control centres* provide the *System Operator* with network information that is considered reasonable for the security and integrity of the TS on request. The *System Operator* shall communicate network information as requested to the *customer control centres*, as required for safe and reliable operation. The information exchange between *control centres* shall be electronic and/or paper-based, and within the time frame agreed upon between the participants.

(2) The *participants* shall optimise redundant control centre facilities where required for the safe operation and control of the TS.

4.6 Communication facilities requirements

(1) The minimum communication facilities for voice and data that are to be installed and maintained between the *System Operator* and *participants* shall comply with the applicable *IEC* standards for *SCADA* and communications equipment.

(2) The communication facilities standards shall be set and documented by the *System Operator*, acting reasonably, in advance of design. Any changes to communication facility standards impacting on customer equipment shall be designed in consultation with *customers* and shall be informed by a reasonable business motivation.

4.6.1 Telecontrol

(1) The *participant's* plant shall support data acquisition to and from the plant *Gateway*. The *System Operator* shall be able to monitor the state of the *IPS* via telemetry from the *Gateway* connected to the *participant's* plant.

(2) The signals and indications required by the *System Operator* are defined in Appendix 5, together with such other information as the *System Operator* may from time to time reasonably require by notice to the *participant*.

(3) *Participants* shall interface via the standard digital interfaces, as specified by the *System Operator*. Interface cabinets shall be installed in the *participant's* plant and equipment room if required. The provision and maintenance of the wiring and signalling from the *participant's* plant and equipment to the interface cable shall be the responsibility of the *participant*.

(4) *Participants* shall comply with such telecontrol requirements as may be applicable to the primary *control centre* and, as reasonably required, to the emergency *control centre* of the *System Operator*. Any changes to telecontrol requirements impacting on *customer* equipment shall be designed in consultation with *customers* and shall be informed by a reasonable business motivation.

4.6.2 Telephone/facsimile

(1) Each *participant* shall be responsible for the provision and maintenance of no fewer than one telephone and one facsimile unit on separate lines that shall be reserved for operational purposes only, and shall be continuously attended to and answered without undue delay.

(2) The *System Operator* shall use a voice recorder for historical recording of all operational voice communication with participants. These records shall be available for at least three (3) months. The *System Operator* shall make the voice records of an identified incident in dispute available within a reasonable time period after such a request from a participant and/or the *EWURA*.

4.6.3 Electronic mail

(1) The *participants* shall provide the *System Operator* with the electronic mailing address of the contact person as defined in this Information Exchange Code and vice versa. The provider of this service shall be selected to meet the real-time operational requirements of the *System Operator*

4.7 SCADA and communication infrastructure at *points of supply*

4.7.1 Access and security

(1) The *System Operator* shall agree with *participants* the procedures governing security and access to the *participants*' *SCADA*, computer and communications equipment. The procedures shall allow for adequate access to the equipment and information by the *System Operator* or its nominated representative for purposes of maintenance, repair, testing and the taking of readings.

(2) Each *participant* shall designate a person with delegated authority to perform the duties of *information owner* in respect of the granting of access to information covered in this code to third parties, and shall disclose that person's name and contact details to EWURA. A *party* may, at its sole discretion, designate more than one person to perform these duties.

4.7.2 Time standards

(1) All information exchange shall be *GPS* satellite time signal referenced. The *System Operator* shall ensure broadcasting of the standard time to relevant telecommunications devices in order to maintain time coherence.

4.7.3 Integrity of installation

(1) Where the electrical plant does not belong to TANESCO, TANESCO shall enter into an agreement with the *customer* for the provision of reliable and secure facilities for the housing and operation of *TANESCO* equipment. This includes access to, at no charge to TANESCO, an uninterruptible power supply with an eight-hour standby capacity.

4.8 Data storage and archiving

(1) The obligation for data storage and archiving shall lie with the *information owner*.

(2) The systems that store the data and/or information to be used by the *parties* shall be of their own choice and for their own cost.

(3) All the systems must be able to be audited by *EWURA*. The systems must provide for clear and accessible audit trails on all relevant operational transactions. All requests that require an audit on a system shall be undertaken with reasonable notice to the *parties*.

(4) The *information owner* shall store the information in a manner that will allow for such information to be retrieved on request and shall ensure that the contents remain unaltered from its original state. The information shall be retained for a period of at least five (5) years (unless otherwise specified in the *Grid Code*) commencing from the date the information was created.

(5) *Parties* shall ensure reasonable security against unauthorised access, use and loss of information (i.e. have a backup strategy) for the systems that contain the information.

(6) *Parties* shall store *outage* planning information as defined in clause 3(9) and clause 3(10) electronically for at least five (5) years. Other system planning information as defined in section 3 shall be retained for the life of the plant or equipment concerned, whichever is the longer.

(7) The *System Operator* shall archive operational information, in a historical repository sized for three (3) years' data. This data includes

- *GS* time-tagged status information, change of state alarms, and event messages
- hourly scheduling and energy accounting information
- operator entered data and actions.

(8) An audit trail of all changes made to archived data should be maintained. This audit trail shall identify every change made, and the time and date of the change. The audit trail shall include both before and after values of all content and structure changes.

5. Post-dispatch information

5.1 Dispatch information

(1) The *System Operator* and TANESCO shall provide participants, with the information specified in the Scheduling and Dispatch Code.

5.1.1 Generation settlement

(1) The *Marketing Group* shall request all data required for settlement of the energy from *System Operator*. The System Operator shall make this information available, within an agreed time period. Should this information be classified as confidential, both parties shall treat it accordingly.

5.1.2 *Ancillary services* settlement

(1) The ***Marketing Group*** shall request all data required for settlement of the *ancillary services* from TANESCO. The *TANESCO* shall make this information available, within an agreed time period. Should this information be classified as confidential, both parties shall treat it accordingly.

5.1.3 Additional *unit* post dispatch information

(1) The *System Operator* shall provide operational information regarding *unit* dispatch and overall dispatch performance as specified in Appendix 7.

5.1.4 Hourly demand *metering* data

(1) The *TANESCO* shall provide participants with hourly-metered data pertaining to their installations.

5.2 File transfers

(1) The format of the files used for data transfer shall be negotiated and defined by the supplier and receiver of the information. The file transfer media shall be negotiated and defined by both *parties* involved.

(2) The *parties* shall keep the agreed number of files for backup purposes so as to enable the recovery of information in the case of communication failures.

File	Description	Trigger Event	Frequency
AGC pulses	The total pulses sent to a unit by the AGC system to move the set-point up or down	Ongoing, file created at end of hour	Hourly
Power Pool Performance and settlement data	As required by relevant Power Pool Rules	Ongoing, file appended at end of hour	Daily
System near real-time data	Historic near real-time system data files on readings as required for post-dispatch	Communication failure	To be agreed
Unit near real-time data	Historic near real-time unit data files on readings as required for post dispatch	Communication failure	To be agreed

5.3 Performance data

5.3.1 *Generator* performance data

(1) *Generators* shall provide the *System Operator* monthly with performance indicators in relation to each *unit* at each *power station* in respect of availability, reliability, etc., as detailed in Appendix 8.

(2) *Generators* shall report significant events, such as catastrophic failures, to the *EWURA* within one (1) week of occurrence of such event.

5.3.2 *Distributor* and *end-use customer* performance

(1) The performance measurement of all *distributors* and *end-use customers* shall be supplied to Transmission in accordance with the operating agreement requirements as defined in the Network Code, section 3.2.

(2) Distributors shall report periodic testing of under-frequency load shedding relays in the following format:

Distributor: Date: Substation: Fed from *transmission substation* (directly or indirectly):				
	Activating frequency		Timer setting	
	Required	As tested	Required	As tested
Stage 1				
Stage 2				
Stage 3				
	Feeders selected (required)		Feeders selected (as tested)	
Stage 1				
Stage 2				
Stage 3				

5.3.3 *TANESCO* and *Transmission* performance

(1) *TANESCO* shall make the following TS performance indicators available monthly to the *EWURA* and *customers:*

Indicator	Month	Year to date	12 MMI	Unit
System minutes lost				minutes
No. of interruptions				
No. of statutory voltage transgressions				
Mandatory under-*frequency* load shedding				
Customer voluntary load shedding				
GS losses				%

(2) Transmission shall provide *customers* with all performance indicators at each *point of supply* in accordance with the Network Code, section 3.2.

5.3.4 System operational performance information

(1) The following *IPS* operational information shall be *published* by the *System Operator* to all *participants*:

Daily:
- The hourly actual demands of the previous day (*MW*)
- The reserve amounts over the morning and evening peaks of the previous day (*MW*)

Monthly:
- MW generated, Imports, exports, available for distribution/sale and transmission losses.
- Generation Plant availability
- Regulating reserve Hours deficit over total hours
- No of frequency excursions > 50.05 or <49.5
- For each abnormal network condition the action taken by the SO to restore normal operations.
- Network constraints (details to be defined by EWURA)

Annually:
- Annual peak (MW), date and hour
- Annual minimum (MW), date and hour

(2) Transmission shall make available all information collected via recorders installed at substations, to the *System Operator* for analyses. The *System Operator* shall make this information available to affected *customers* on request.

6. Confidentiality of information

(1) Information exchanged between *parties* governed by this code shall not be confidential, unless otherwise stated.

(2) Confidential information shall not be transferred to a third party without the written consent of the *information owner*. *Parties* shall observe the proprietary rights of third parties for the purposes of this code. Access to confidential information within the organisations of *parties* shall be provided as reasonably required.

(3) *Parties* receiving information shall use the information only for the purpose for which it was supplied.

(4) The *information owner* may request the receiver of information to enter into a confidentiality agreement before information, established to be confidential, and is provided. A pro forma agreement is included in Appendix 1.

(5) The *parties* shall take all reasonable measures to control unauthorised access to confidential information and to ensure secure information exchange. *Parties* shall report any leak of information that is governed by a confidentiality agreement as soon as practicable after they become aware of the leak, and shall provide the *information owner* with all reasonable assistance to ensure its recovery or destruction (as deemed appropriate by the *information owner).*

APPENDIX 1: Information confidentiality

SAMPLE CONFIDENTIALITY AGREEMENT FOR INFORMATION TRANSFER TO THIRD PARTIES

CONFIDENTIALITY AGREEMENT

BETWEEN

…….

(HEREINAFTER REFERRED TO AS THE INFORMATION OWNER)

AND

…….

(HEREINAFTER REFERRED TO AS THE RECIPIENT)

IN RESPECT OF INFORMATION SUPPLIED TO PERFORM THE FOLLOWING WORK:

……
……

(HEREINAFTER REFERRED TO AS THE WORK)

ON BEHALF OF

……..

(HEREINAFTER REFERRED TO AS THE CLIENT).

1. The Recipient agrees to treat all information (hereinafter referred to as the Information) received from the Information Owner, whether in hard copy or electronic format, as strictly confidential.

2. The Recipient agrees to disclose the Information only to persons who are in his permanent employ, and who require access to the Information to perform their duties in respect of the Work on behalf of the Client.

3. Persons other than those described in Clause 2 above, including but not restricted to temporary employees, subcontractors, and sub-consultants, shall enter into separate Confidentiality Agreements with the Information Owner prior to receiving the Information.

4. The Recipient undertakes to use the Information only to perform the Work on behalf of the Client, and for no other purpose whatsoever.

5. On completion of the Work, the Recipient shall at his expense return to the Information Owner all hard copy material and electronic media containing the Information supplied to him by the Information Owner. The Recipient shall furthermore ensure that all duplicate copies of the Information in his or his employees' possession (electronic as well as hard copy format) are destroyed.

6. The Recipient shall take all reasonable measures to protect the security and integrity of the Information.

7. If requested to do so by the Information Owner, the Recipient shall forthwith at his expense return to the Information Owner all hard copy material and computer disks containing

the Information supplied to him by the Information Owner. The Recipient shall furthermore ensure that all duplicate copies of the Information in his or his employees' possession (electronic as well as hard copy format) are destroyed.

8. The Recipient shall report any leak of the Information, howsoever caused, to the Information Owner as soon as practicable after he/she becomes aware of the leak, and shall provide the Information Owner with all reasonable assistance to ensure its recovery or destruction (as deemed appropriate by the Information Owner).

Signed at …… on this the …… day of

…… by (full name) ……..in his/her capacity

as …… on behalf of ……, the

Information Owner

……

Signed at …… on this the …… day of

…… by (full name) ……..in his/her capacity

as …… on behalf of ……, the

Recipient

……

APPENDIX 2: Distributor and end-use customer data

Unless otherwise indicated, the following information shall be supplied to TANESCO prior to connection and then updated as and when changes occur.

(a) Demand and network data

Connection capacity	Connection capacity required (MW)
Measured and forecast data (annually)	For each point of supply, the information required is as follows: • A 10-year demand forecast (see Appendix 9) • A description setting out the basis for the forecast • The season of peak demand • Quantification of the estimated impact of embedded generation (see Appendix 9)
User network data	• Electrical single-line diagram of user network to a level of detail to be agreed with the service providers, including the electrical characteristics of circuits and equipment (R, X, B, R0, X0, B0, continuous ratings) • Contribution from customer network to a three-phase short-circuit at point of connection • Information pertaining to the network connecting shunt capacitors, harmonic filters, reactors, SVC's, etc., to the point of supply for the purposes of conducting harmonic resonance studies. • Electrical characteristics of all circuits and equipment at a voltage lower than secondary voltage levels of the customer connected the TS that may form a closed tie between two connection points on the TS
Standby supply data (annually)	The following information is required for each distributor and end-use customer that can take supply from more than one supply point: • Source of standby supply (alternative supply point(s)) • Standby capacity required (MW)
General information	For each new connection from a distributor or end-use customer, the following information is required: • Number and type of switch bays required • Load build-up curve (in the case of new end-user plant) • Supply date (start of load build-up) • Temporary construction supply requirements • Load type (e.g. arc furnaces, rectifiers, rolling mills, residential, commercial, etc.) • Annual load factor • Power factor (including details of harmonic filters and power factor correction equipment) • Special requirements (e.g. quality of supply) • Other information reasonably required by the service providers to provide the customer with an appropriate supply (e.g. pollution emission levels for insulation design)
Disturbing loads	Description of any load on the power system that could adversely affect the System Operator target conditions for power quality and the variation in the power quality that can be expected at the point connected to the TS. (The areas of concern here are, firstly, motors with starting currents referred back to the nominal voltage at the point of supply exceeding 5% of the fault level at the point of supply; and

	secondly, arc furnaces likely to produce flicker levels at the point of supply in excess of the limits specified in NRS048. The size limit for arc furnaces is subject to local conditions in respect of fault levels at the point of supply and background flicker produced by other arc furnaces and other equipment that will produce harmonics and/or negative and zero sequence current components, such as large AC/DC rectification installations.)

(b) Transmission system connected transformer data

	Symbol	Units
Number of windings		
Vector group		
Rated current of each winding		A
Transformer rating		MVA
Transformer tertiary rating		MVA
Transformer nominal LV voltage		kV
Transformer nominal tertiary voltage		kV
Transformer nominal HV voltage		kV
Tapped winding		HV/MV/LV/None (Delete what is not applicable)
Transformer ratio at all transformer taps		
Transformer impedance (resistance R and reactance X) at all taps	R+jX	% on rating MVA
• For three-winding transformers, where there are external connections to all three windings, the impedance (resistance R and reactance X) between each pair of windings is required, measured with the third set of terminals open-circuit	Z_{HVMV}, Z_{HVLV}, & Z_{MVLV}	% on rating MVA % on rating MVA % on rating MVA
Transformer zero sequence impedances at nominal tap		
• Zero phase sequence impedance measured between the HV terminals (shorted) and the neutral terminal, with the LV terminals open-circuit	$Z_{HT\,0}$	Ohm
• Zero phase sequence impedance measured between the HV terminals (shorted) and the neutral terminal, with the LV terminals short-circuited to the neutral	$Z_{HL\,0}$	Ohm
• Zero phase sequence impedance measured between the LV terminals (shorted) and the neutral terminal, with the HV terminals open-circuit	$Z_{LT\,0}$	Ohm
• Zero phase sequence impedance measured between the LV terminals (shorted) and the neutral terminal, with the HV terminals short-circuited to the neutral	$Z_{LH\,0}$	Ohm
• Zero phase sequence leakage impedance measured between the HV terminals (shorted) and the LV terminals (shorted), with the Delta winding closed	$Z_{L\,0}$	Ohm
Earthing arrangement, including LV neutral earthing resistance and reactance core construction (number of limbs, shell or core type)		
Open-circuit characteristic		Graph

Transformer test certificates, from which actual technical detail can be extracted as required, are to be supplied on reasonable request.

(c) Shunt capacitor or reactor data requirements

For each shunt capacitor or reactor or power factor correction equipment or harmonic filters with a rating in excess of 1 MVAr connected to or capable of being connected to a customer network, the customer shall inform TANESCO and, if required, shall provide TANESCO with the specific shunt capacitor or reactor data as well as network details necessary to perform primarily harmonic resonance studies. The customer shall inform TANESCO of his intention to extend or modify this equipment.

If any participant finds that a capacitor bank of 1 MVAr or less is likely to cause harmonic resonance problems on the TS, he shall inform TANESCO. The 1 MVAr minimum size limit shall thereafter be waived in respect of the affected network for information reporting purposes in respect of this code, and TANESCO shall inform the affected participants of this fact and request the additional data. If the affected network is modified or reinforced to the extent that capacitor banks of 1 MVAr or less no longer cause harmonic resonance problems on the TS, TANESCO shall inform the affected participants that information reporting requirements have returned to normal.

Any party to this code investigating a complaint about harmonic distortion shall have the right to request such additional information (including, but not restricted to, data from harmonic distortion measuring devices) from parties in the vicinity of the source of the complaint as may reasonably be required to complete the investigation.

Shunt capacitor or reactor rating	Rating (MVAr)
Reactor/capacitor/harmonic filter	(delete what is not applicable)
Location (station name)	
Voltage rating	kV
Resistance/reactance/susceptance of all components of the capacitor or reactor bank	Ohm values or p.u. on 100MVA base (specify)
Fixed or switched	
If switched	Control details (manual, time, load, voltage, etc.)
If automatic control	Details of settings. If under FACTS device control (e.g. SVC), which device?

(d) Series capacitor or reactor data requirements

Series capacitors are installed in long transmission lines to increase load transfer capability.

Series reactors are installed to limit fault levels, or to balance load sharing between circuits operated in parallel that would otherwise not share load equitably, or to balance load sharing on an interconnected network.

Reactor/capacitor	(Delete what is not applicable)
Location (specify substation bay where applicable)	
Voltage rating	kV
Impedance rating	Ohm or MVAr
Current rating (continuous and emergency, maximum times for emergency ratings)	Continuous: A Hours A Hours A Hours A

Note: if a series capacitor or reactor is located in a dedicated reactor or capacitor station (i.e. a substation built to hold only the series reactor or capacitor), the lines or cables linking it to each remote end substation must be specified as separate circuits under line or cable data.

(e) FACTS devices and HVDC data

FACTS devices

FACTS devices enable system parameters (voltage, current, power flow) to be accurately controlled in real time. Because of their cost, they are generally used only if cheaper, more conventional, solutions cannot deliver the required functionality.

Applications requiring rapid control capability include the following:

- Voltage regulation following loss of a system component, generation, large load, or HVDC link disturbance
- Arc furnace voltage flicker mitigation
- Negative phase sequence voltage compensation
- SSR (sub-synchronous resonance) damping
- Machine transient stability enhancement
- System load transfer capability enhancement
- Load sharing control in interconnected, deregulated, networks
- Master power controller for HVDC schemes

The most commonly used FACTS device is the SVC (static Var compensator). Other FACTS devices made possible by advances in power electronics and control systems include STATCOM (static compensator), TCSC (thyristor controlled series capacitor), thyristor controlled tap changer, thyristor controlled phase shifter, BES (battery energy storage), and UPFC (unified power flow controller). The common factor is rapid control capability.

Because FACTS devices are purpose-designed for their specific applications, the following data is required:

Name	Station, HV voltage, device number
Type	(SVC, STATCOM, TCSC, etc.)
Configuration: provide a single line diagram showing all HV components and their MVA/MVAr and voltage ratings, with all controlled components identified as such	
Control system: provide a block diagram of the control system suitable for dynamics modelling	
Primary control mode	Voltage control, arc furnace flicker mitigation, negative phase sequence voltage control, etc.

Customers are required to perform, or cause to be performed, harmonic studies to ensure that their installation does not excite harmonic resonance, and that harmonic distortion levels at the PCC with the TS do not exceed the limits specified in NRS048.

HVDC

Strictly speaking, HVDC is a form of FACTS device because of the rapid control capabilities. However, HVDC is treated separately because its primary function is the transmission of real power.

HVDC is used to connect two systems that are not necessarily interconnected via the AC network (and thus in synchronism), or even at the same nominal frequency.

Customers wishing to connect HVDC systems to the TS shall supply a single line diagram showing all HV plant (including valve bridges) forming part of the HVDC system, plus additional HV plant required for its proper operation, e.g. harmonic filters, synchronous condensers, FACTS devices, etc. Customers and TANESCO shall co-operate in performing, or causing to be performed, studies to determine network strengthening requirements needed to accommodate the HVDC system without violating the planning criteria specified in the Network Code. In addition, customers shall thereafter perform, or cause to be performed, studies to demonstrate that the proposed HVDC system does not contravene the QOS parameters specified in NRS048, and where applicable shall specify what additional HV plant will be required to ensure compliance with NRS048.

(f) Information on customer networks

If a customer will have two or more points of supply from the TS, including the one applied for, the customer shall specify the amount of load to be transferred from existing points of supply to the new one under normal conditions as well as under contingencies. The same requirement applies to any embedded generators within the customer's network, since they affect fault levels as well as net load on the system.

The customer shall also specify whether he intends to interconnect two or more transmission points of supply via his network. In such circumstances the customer shall provide detailed information on the lines and cables used.

Where a circuit consists of two or more segments of different characteristics (different overhead line tower and/or conductor bundle types and/or underground cable types), each section shall be specified separately.

Overhead line data

	Units
Line description	Name ("from" busbar, "to" busbar, circuit number and, where applicable, line section number numbered from the "from" busbar end)
Line voltage (specify separately for dual voltage multi-circuit lines)	kV
Single/double/multiple circuit	
Standard suspension tower information (to confirm impedance): supply copy of tower drawing, or sketch drawing showing co-ordinates of shield wire and phase conductor bundle attachment points relative to tower centre line and ground level at nominal tower height	
Phase sub-conductor type (per circuit)	
Number of sub-conductors per phase conductor bundle	
Sub-conductor spacing, if applicable (supply sketch showing phase conductor bundle geometry and attachment point)	mm
Number of earth wires	
Earthwire description	
Line length	Km
Conductor parameters (R, X, B, R0, X0, B0)	Ohm values or p.u. on 100MVA base (specify)
Conductor normal and emergency ratings	Ampere or 3-phase MVA at nominal voltage

Cable data

Cable description	Name (“from” busbar, “to” busbar, circuit number, and where applicable, line section number numbered from the “from” busbar end)
Voltage rating	kV
Type (copper/aluminium)	(Delete what is not applicable)
Size	mm^2
Impedance (R, X, B, R_0,X_0,B_0)	Ohms or p.u. on 100MVA base (specify)
Length	Km
Continuous and (where applicable) emergency current rating and time limit	Amp or MVA at nominal voltage (specify), hours maximum at emergency rating

APPENDIX 3: Generator planning data

Unless otherwise indicated, the following information shall be provided to TANESCO prior to connection and then updated as and when changes occur.

(a) Power station data

Generator name	
Power station name	
Number of units	
Primary fuel type/prime mover	For example, gas, hydro, fossil or nuclear
Secondary fuel type	For example, oil
Capacity requirement	Generation sent-out connection capacity required (MW)
"Restart after station blackout" capacity	Provide a document containing the following: Start-up time for the first unit (time from restart initiation to synchronise) and each of the following units assuming that restarting of units will be staggered
Black starting capacity	A document stating the number of units that can be black started at the same time, preparation time for the first unit black starting, restarting time for the first unit, and restarting time for the rest of the units
Partial load rejection capability	A description of the amount of load the unit can automatically govern back, without any restrictions, as a function of the load at the point of governing initiation
Multiple unit tripping (MUT) Risks	A document outlining all systems common to more than one unit that is likely to cause a MUT; discuss the measures taken to reduce the risk of MUT

(b) Unit data

Unit number	
Capacity	Unit capacity (MW)

Description	Units
Maximum continuous generation capacity:	MW
Maximum continuous sent out capacity	MW
Unit auxiliary active load	MW
Unit auxiliary reactive load	MVAr
Maximum short term output	MW
Minimum continuous generating capacity	MW
Minimum continuous sent out capacity	MW
Generator rating	MVA
Maximum lagging power factor	-
Maximum leading power factor	-
Governor droop	
Forbidden loading zones	MW
Terminal voltage adjustment range	KV
Short-circuit ratio	
Rated stator current	Amp
Time to synchronise from warm	Hour
Time to synchronise from cold	Hour
Minimum up-time	Hour
Minimum down-time	Hour
Loading rate	MW/min
Deloading rate	MW/min
Can the generator start on each fuel?	
Ability to change fuels on-load	

Available modes (lean burn etc.)	
Time to change modes on-load	
Control range for secondary frequency regulation operation	MW
Partial load rejection capability	% MW name plate rating
Minimum time unit operates in island mode	Hour
Maximum time unit operates in island mode	Hour

Description	Data
Capability chart showing full range of operating capability of the generator, including thermal and excitation limits	Diagram
Systems that are common and can cause a multiple unit trip	Description
Open-circuit magnetisation curves	Graph
Short-circuit characteristic	Graph
Zero power factor curve	Graph
V curves	Diagram

Documents	Description
Protection settings document	A document agreed and signed by the System Operator containing the following: • A section defining the base values and per unit values to be used • A single line diagram showing all the protection functions and sources of current and voltage signals • Protection tripping diagram(s) showing all the protection functions and associated tripping logic and tripping functions • A detailed description of setting calculation for each protection setting relevant to the TS connection, discussion on protection function stability calculations, and detailed dial settings on the protection relay in order to achieve the required setting • A section containing a summary of all protection settings on a per unit basis • A section containing a summary for each of the protection relay dial settings/programming details • An annex containing plant information data (e.g. OEM data) on which the settings are based • An annex containing OEM information sheets or documents describing how the protection relays function
Excitation setting document	A document agreed and signed by the System Operator containing the following: • A section defining the base values and per unit values to be used • A single line diagram showing all the excitation system functions and all the related protection tripping functions • An excitation system transfer function block diagram in accordance with IEEE or IEC standard models • A detailed description of setting calculation for each of the excitation system functions, discussion on function stability calculations, and detailed dial settings on the excitation system in order to achieve the required setting • A section containing a summary of all settings on a per unit basis • A section containing a summary for each of the excitation system dial settings/programming details. • An annex containing plant information data (e.g. OEM data) on which the settings are based • An annex containing OEM information sheets or documents describing the performance of the overall excitation system and each excitation function for which a setting is derived
Unit model document	The document shall include models of the turbine, boiler, engine, reactor, penstock and the relevant controls, which together can be used by the SO to simulate the dynamic performance of the unit, specifically load ramping and frequency support within the normal operating range of the unit. The generator may obtain guidance about the modelling requirements from IEEE documentation or any other standard agreed to by the SO. The document, to be agreed and signed by the SO, will contain the following: • The operating parameters on which the model is based, with the per unit and corresponding base values • A governor (turbine controller) single-line diagram showing all the governor system functions • A model for the dynamic response of the unit in block diagram form, in accordance with IEEE standard models or

	any other model standard agreed to by the SO • A detailed list of gains, constants and parameters, with explanations of the derivations for each of the modeled functions of the governor system model • Plant test data from which the model was derived

(c) Reserve capability

The generator shall provide the System Operator with the reserve capability of each unit at each power station. The reserve capability shall be indicated as per each reserve category: spinning reserve, standby reserve and regulation reserve.

(d) Unit parameters

	Symbol	Units
Direct axis synchronous reactance	X_d	% on rating
Direct axis transient reactance saturated	$X'_{d_{sat}}$	% on rating
Direct axis transient reactance unsaturated	$X'_{d_{unsat}}$	% on rating
Sub-transient reactance unsaturated	$X''_d = X''_q$	% on rating
Quad axis synchronous reactance	X_q	% on rating
Quad axis transient reactance unsaturated	$X'_{q_{unsat}}$	% on rating
Negative phase sequence synchronous reactance	X_2	% on rating
Zero phase sequence reactance	X_{0q}	% on rating
Turbine generator inertia constant for entire rotating mass	H	MW s/MVA
Stator resistance	Ra	% on rating
Stator leakage reactance	X_L	% on rating
Poiter reactance	X_P	% on rating
Generator time constants: • Direct axis open-circuit transient • Direct axis open-circuit sub-transient • Quad axis open-circuit transient • Quad axis open-circuit sub-transient • Direct axis short-circuit transient • Direct axis short-circuit sub-transient • Quad axis short-circuit transient • Quad axis short-circuit sub-transient	 Tdo' Tdo'' Tqo' Tqo'' Td' Td'' Tq' Tq''	 sec sec sec sec sec sec sec sec
Speed damping	D	
Saturation ratio at 1 pu terminal voltage	S(1.0)	
Saturation ratio at 1.2 pu terminal voltage	S(1.2)	

(e) Excitation system

The generator shall fill in the following parameters or supply a Laplace domain control block diagram in accordance with IEEE or IEC standard excitation models (or as otherwise agreed with the System Operator) completely specifying all time constants and gains to fully explain the transfer function from the compensator or unit terminal voltage and field current to unit field voltage. Customers shall perform, or cause to be performed, small signal dynamic studies to ensure that the proposed excitation system and turbine governor do not cause dynamic instability. The criteria for such dynamic instability shall be supplied by the System

Operator. Where applicable, a PSS (power system stabiliser) shall be included in the excitation system to ensure proper tuning of the excitation system for stability purposes.

	Symbol	Units
Excitation system type (AC or DC)		Text
Excitation feeding arrangement (solid or shunt)		Text
Excitation system filter time constant	Tr	Sec
Excitation system lead time constant	Tc	Sec
Excitation system lag time constant	Tb	Sec
Excitation system controller gain	Ka	
Excitation system controller lag time constant	Ta	Sec
Excitation system maximum controller output	Vmax	p.u.
Excitation system minimum controller output	Vmin	p.u.
Excitation system regulation factor	Kc	
Excitation system rate feedback gain	Kf	
Excitation system rate feedback time constant	Tf	Sec

(f) Control devices and protection relays

The generator should supply any additional Laplace domain control diagrams for any outstanding control devices (including power system stabilisers) or special protection relays in the unit that automatically impinge on its operating characteristics within 30 seconds following a system disturbance and that have a minimum time constant of at least 0,02 seconds.

(g) Pumped storage

	Symbol	Units
Reservoir capacity		MWh pumping
Max pumping capacity		MW
Min pumping capacity		MW
Efficiency (generating/pumping ratio)		%

(h) Unit step-up transformer

	Symbol	Units
Number of windings		
Vector group		
Rated current of each winding		Amps
Transformer rating		MVA_{Trans}
Transformer nominal LV voltage		KV
Transformer nominal HV voltage		KV
Tapped winding		
Transformer ratio at all transformer taps		
Transformer impedance at all taps (for three winding transformers the HV/LV1, HV/LV2 and LV1/LV2 impedances together with associated bases shall be provided)		% on rating MVA_{Trans}
Transformer zero sequence impedance at nominal tap	Z_0	Ohm
Earthing arrangement, including neutral earthing resistance and reactance		
Core construction (number of limbs, shell or core type)		
Open-circuit characteristic		Graph

(i) Unit forecast data

The generator shall provide TANESCO with expected maintenance requirements, in weeks per annum, for each unit at a power station.

(l) Mothballing of generating plant:

Mothballing of generating plant is the withdrawal of plant from commercial service for six months or longer, with the intention of returning it to commercial service at a later date. Mothballing can have a profound impact on the operation and integrity of the TS. Customers wishing to mothball generating plant shall supply TANESCO with the following information:

Generator name	
Power station name	
Unit number	
Date withdrawn	Date unit is to be withdrawn from commercial service
Return to commercial service	Envisaged return to service date (recommissioning tests completed and unit available for commercial service)
Auxiliary power requirements	

(k) Return to service of mothballed generating plant:

Once the customer has decided to return mothballed generating plant to service, TANESCO requires the information specified for new connections.

(l) Decommissioning of generating plant:

Decommissioning of plant is the permanent withdrawal from service of generating plant. The TANESCO requires the following with a one-year notice period:

Generator name	
Power station name	
Unit number	
Date to be removed from commercial service	
Auxiliary supplies required for dismantling and demolition	kVA, point at which supply is require, duration

APPENDIX 4: Generator maintenance plan

a) The 52-weeks-ahead maintenance plan per week per generator shall be supplied weekly to the System Operator.

Generator:

DATE (week starting) WEEK NUMBER:	n	n+1	…	n+51

MAINTENANCE (MW)

WEEKEND OUTAGES	0	0	0	0
Power Station 1	0	0	0	0
Power Station 2	0	0	0	0
Power Station 3	0	0	0	0
Power Station n	0	0	0	0
TOTAL MAINTENANCE				
FUTURE KNOWN UNPLANNED:	0	0	0	0

MAJOR CHANGES SINCE LAST WEEK:

Notes:	
FUTURE KNOWN UNPLANNED:	a) b)

b) The annual maintenance/outage plan per generator, looking five years ahead, shall be supplied to the System Operator.

The format shall be as per the 52-weeks-ahead outage plan per week per generator**,** but extending for five years.

c) A monthly variance report, explaining the differences between the above two reports, shall be supplied to the System Operator.

Variance Report Template							
Station and	MW	Start Date	Outage Completion Date				
Outage Code	Cap	Official	Official	Revised	Urg	Outage Description	Reason for Difference

APPENDIX 5: Operational data

This appendix specifies the data format to be used by the SCADA system for the mapping of *Gateway* data into the SCADA database. The database has a definition for each bay in the HV yard. Each bay definition specifies a different bay type, e.g. transformers, units, feeders, etc., and is accompanied by a picture showing the bay and all its associated devices as they would be indicated on the *system operator* operational one-line displays. In each instance, the picture defines the primary devices and is followed by the points belonging to each device.

Description of table column headings used in this section:

Device	01_State	10_State	Category	Type	Control

Device : Gives the name of the device and acts as a collector of all point information belonging to the device. The System Operator shall define the requirements where grouping is used.

Each binary status point can be mapped to one or two binary bits. In the case of a breaker or isolator, the state is reported via two bits. In the case of single-bit alarm points, only one bit is used to report the state of the indication.

In the following sections, the TYPE column indicates the number of bits used to report the state of the point in question. The column headings indicate two bits but for single-bit points ignore the left-hand 0 or 1 value in the headings “01-State” and “10-State”.

1_state This is the **alarm** state of the point.
0_state This is the **normal** state of the point.

Double bit Where an indication uses two bits to report the state, the right-hand bit is used report that the state is OPEN and the left-hand bit to report the state when it is CLOSED. Thus an open condition will be “01” and a closed state will be “10”.

It is thus illogical for a device to have a permanent value of either “00” or “11”. However, if the device is in transit between “01” and “10” then a temporary value of “00” is possible. The SCADA system reports a state of “00” as “In transit”, which will normally only be seen on slow-moving devices such as isolators.

Category Defines the category the point belongs to: Health, Main Protection, Back-up Protection or Information.

Classical alarm systems attempt to set priorities on alarm points. However, the priority of a point changes as the system changes, which means having a fixed priority is not useful. As an alternative, the approach used here is to assign the point to the area that is affected by the indication. In this case we have four areas, namely:

Health	All alarm indications that refer to the health of the primary or secondary plant are assigned to this category.
Main Protection	All protection activity that is triggered by the Main 1 protection circuits is assigned to this category.
Backup Protection	Where backup protection is installed, such as on transformers, or where Main 2 protection is used, these alarms are assigned to this category.
Information	Pure state change data such as the state of a breaker or isolator are assigned to this category. As such, no alarming is associated with

	these points – the data presented is pure information.

Type Indicates the type of point – single-bit, double-bit, analogue or binary change detection.

Control Indicates if there is a supervisory control associated with the point

A5.1 Generator

The generator shall install operational measurements to specification from the System Operator so as to provide continuous operational information for both real-time and recording purposes in relation to each unit at each power station in respect of the following:

Data Acquisition from *generator* to Gateway
Measurements of MW, MW set point and Mvar analog shall update the SCADA value from the source to the Gateway if the value changes by more than 0.5 MW or 0.5 Mvar. The maximum delay in this update shall be no longer than one second as shown in Figure 1 - Data collection time frame
.

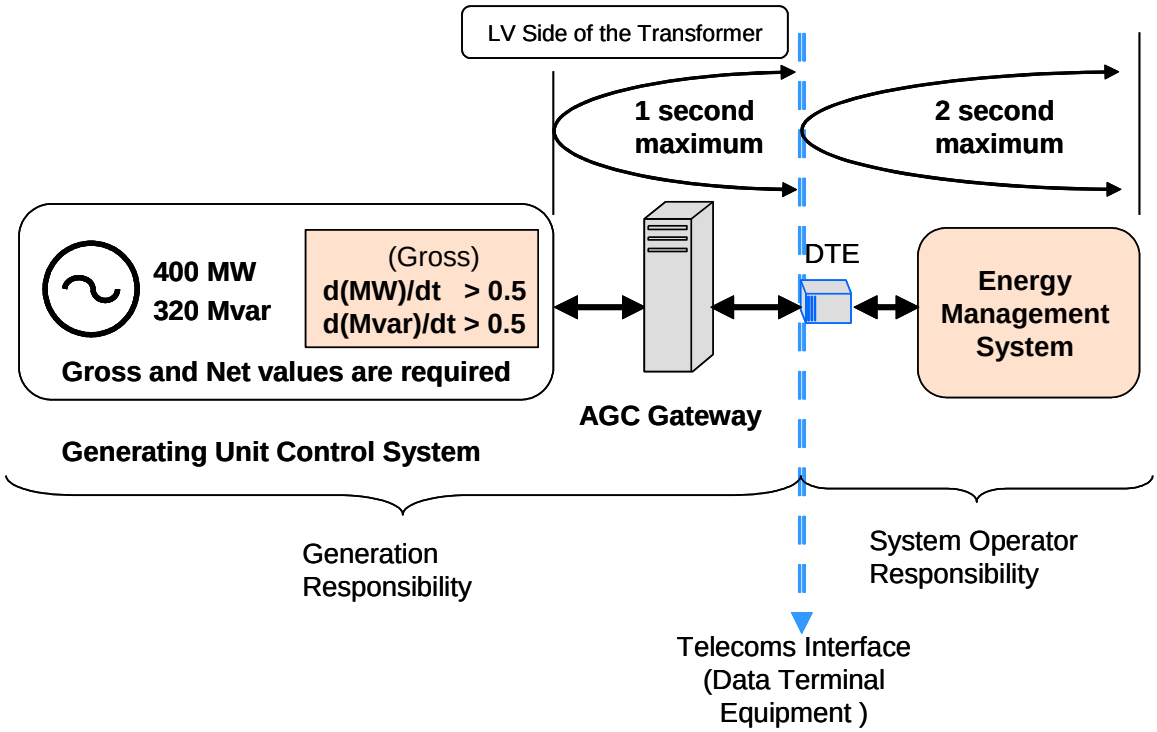


Figure 1 - Data collection time frame

Data Acquisition

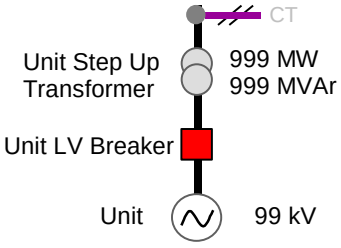
The *participant* is responsible for the provision of communications facilities between the plant and the data terminal equipment as shown in Figure 1. See section 4 above for additional clarity related to the *participant's* communication obligations.

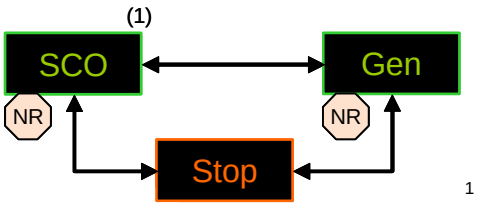
The maximum delay for updating the Energy Management System shall be no longer than two seconds as shown in Figure 1.

The *generator* will provide the facility to set the jitter value of the measured data to a value between 1 and 5 bits to prevent the unnecessary messages being sent whilst maintaining the

0,5 MW or 0,5 Mvar accuracy required above. The *System Operator* will determine the exact number of bits required to be set for jitter tolerance for every installation.

(a) Gas turbines, gas engines and heavy fuel engines





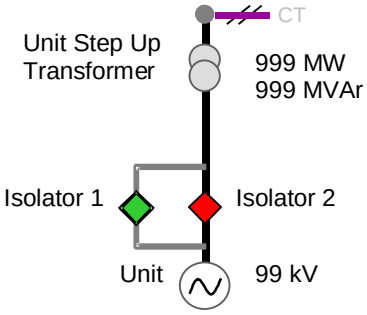
[1]

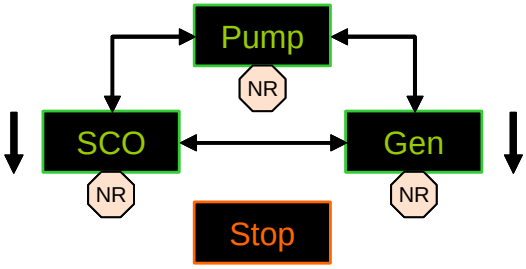
Unit Analogs			Category	Type	Control
Frequency			Info	Analog	
Gross MW			Info	Analog	
Gross Mvar			Info	Analog	
Net MW			Info	Analog	
Net Mvar			Info	Analog	
Rotor RPM			Info	Analog	
Stator kV			Info	Analog	

Unit Status Points	01_State	10_State	Category	Type	Control
Engine A	Ready	Not ready	Health	Single	
Engine B	Ready	Not ready	Health	Single	
GEN to SCO mode	Active	Off	Info	Single	True
SCO to GEN mode	Active	Off	Info	Single	True
Remote control	On	Off	Info	Single	True
SCO start not ready	Alarm	Normal	Health	Single	
GEN start not ready	Alarm	Normal	Health	Single	
Under-frequency start	Armed	Off	Health	Single	
Unit at Standstill	Yes	No	Info	Single	
Unit auto load to base	Yes	No	Info	Single	True
Unit auto load to minimum	Yes	No	Info	Single	True
Unit in GEN mode	Yes	No	Info	Single	
Unit in SCO mode	Yes	No	Info	Single	
Unit load rate	Fast	Slow	Info	Single	True
Unit to GEN mode	Yes	No	Info	Single	True
Unit to SCO mode	Yes	No	Info	Single	True
Unit to Standstill	Yes	No	Info	Single	True
Unit tripped and locked out	Alarm	Normal	Info	Single	
Unit under-frequency start	Initiate	No	Info	Single	
Unit islanded	Alarm	No	Health	Single	

(b) Hydro units

[1] Note that where modes or functions are not available, such as *SCO,* the associated signals are not required.





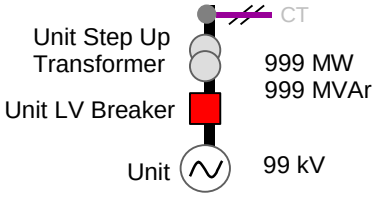
2

Unit Analogs			**Category**	**Type**	**Control**
Frequency			Info	Analog	
Gross MW			Info	Analog	
Gross Mvar			Info	Analog	
Net MW			Info	Analog	
Net Mvar			Info	Analog	
Stator kV			Info	Analog	
Rotor RPM			Info	Analog	

Unit Status Points	01_State	10_State	Category	Type	Control
Auto load	Active	Normal	Info	Single	True
Automatic power factor regulator	On	Off	Info	Single	True
Emergency Shutdown	Operated	Normal	Info	Single	
GEN start not ready	Alarm	Normal	Health	Single	
GEN to PUMP mode	Active	Off	Info	Single	
GEN to SCO mode	Active	Off	Info	Single	
Pump start not ready	Alarm	Normal	Health	Single	
Pump to GEN mode	Active	Off	Info	Single	
Pump to SCO mode	Active	Off	Info	Single	
SCO start not ready	Alarm	Normal	Health	Single	
SCO to GEN mode	Active	Off	Info	Single	
SCO to PUMP mode	Active	Normal	Info	Single	
Turning in gen direction	Yes	No	Info	Single	
Turning in motor direction	Yes	No	Info	Single	
Under-frequency start	Armed	Off	Health	Single	
Unit at standstill	Yes	Normal	Info	Single	
Unit in GEN mode	Yes	No	Info	Single	
Unit in PUMP mode	Yes	No	Info	Single	
Unit in SCO mode	Yes	No	Info	Single	
Unit synchronising	Yes	No	Info	Single	
Unit to GEN mode	Active	Off	Info	Single	True
Unit to PUMP mode	Active	Off	Info	Single	True
Unit to SCO mode(1)	Active	Off	Info	Single	True
Unit to Standstill	Active	Off	Info	Single	True

[2] Note that where modes or functions are not available, such as *SCO*, the associated signals are not required.

(c) Steam units



Unit LV Breaker	01_State	10_State	Category	Type	Control
Unit breaker state	Closed	Tripped	Info	Double	False

Unit Signals	**01_State**	**10_State**	**Category**	**Type**	**Control**
Gross MW			Info	Analog	
Gross Mvar			Info	Analog	
Net MW			Info	Analog	
Net Mvar			Info	Analog	
Unit islanded	Alarm	No	Health	Single	

(e) AGC signals

All generating units providing *AGC* shall provide and receive the following signals

AGC signals from generator	01_State	10_State	Category	Type	Control
High regulating limit			Health	Analog	
Low regulating limit			Health	Analog	
Ramp rate			Info	Analog	
Set-point active power			Info	Analog	True
AGC – unit Status	On	Off	Info	Single	
Frequency Bias	On	Off	Info	Single	
Raise Block (optional)	High	Normal	Health	Single	
Lower Block (optional)	Low	Normal	Health	Single	

AGC signals to generator	01_State	10_State	Category	Type	Control
AGC Setpoint Command			Info	Analog	True

Signal description

High regulating limit
This value gives the maximum allowable output *AGC* can raise the active power output. This is set at the *generator*. The high regulating limit can either be net active power or gross active power

Low regulating limit
This value gives the minimum allowable output *AGC* can lower the *generator*. The low regulating limit can either be net active power or gross active power.

Maximum Unit Gradient
This is the maximum rate in (MW/min) which the unit can change whilst on *AGC*.

Setpoint Value
The setpoint value comes from the control equipment of the *generator*. To change the active power output of the generator, the output setpoint has to be adjusted. *AGC* controls the setpoint when *AGC* is on. The setpoint can either be net active power or gross active power.

AGC – *Generator* Status – (Set by the Power Station staff)
This signal indicates if the *generator* is allowing *AGC*. Only when signal is "on" can the *System Operator* select the generator to *AGC* operation. When this signal is "off", all raise/lower commands from *System Operator* should be ignored.

Frequency Bias On
This indicates that primary governing is "on".

Raise Block
In the event that the generator chooses not to allow *AGC* raise commands then the Raise Block is set. When this indication is set, all raise commands from the *System Operator* should be ignored.

Lower Block
In the event that the *generator* wants to prevent *AGC* lower commands then the Lower Block is set. When this indication is set, all lower commands from *System Operator* should be ignored.

AGC Setpoint Command
The AGC Setpoint command consists of a message from the *System Operator*'s *AGC* program instructing a particular unit to a particular active power output.

(f) Unmanned *unit* or *System Operator* remote operation signals

All units that are not manned for full or portion of the day or if it is agreed that the generator must be capable of remote operation by the *System Operator*, then the following signals shall be provided and facilitated.

Signals from *generator*	**01_State**	**10_State**	**Category**	**Type**	**Control**
Under frequency start ready	Yes	No	Info	Double	
Under frequency start armed	Yes	No	Info	Double	
Generator MW Setpoint (Gross or Nett)			Info	Analog	
Regulation MW High Limit			Info	Analog	
Regulation MW Low Limit			Info	Analog	
Generator Mvar Setpoint			Info	Analog	
Generator kV Setpoint			Info	Analog	
Voltage or Q control mode	V - Mode	Q - Mode	Info	Double	
Unit Controller status	Yes	No	Info	Double	
Unit Load Limit [3]			Info	Analog	
Unit local AGC status	AGC	Local	Info	Double	

Signals to generator	**01_State**	**10_State**	**Category**	**Type**	**Control**
AGC Generator Status on	on	off	Info		True
Regulation High Limit			Info	Analog	True
Regulation Low Limit			Info	Analog	True
Generator MW Setpoint			Info	Analog	True
Generator Mvar Setpoint			Info	Analog	True
Generator kV Setpoint			Info	Analog	True
Voltage or Q control mode	V - Mode	Q - Mode	Info		True
Primary Governing	On	Off	Info		True

[3] Maximum Load limit setting

A5.2 Distributor and end-use customer

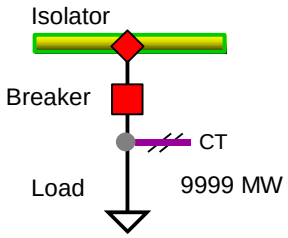
(a) Transmission equipment

The Customer shall provide operational information for both real-time and recording purposes in relation to each feeder, transformer and compensation device at each substation required for the full functionality of an SVC, as well as full control by the System Operator.

(b) Interruptible load

All interruptible loads shall meet the minimum requirements. The System Operator shall negotiate and integrate the conditions as presented in bilateral agreements and additional contracts without reducing the requirements as defined in this Grid Code.

The interruptible load shall install operational measurements to specification so as to provide operational information for both real-time and recording purposes in relation to each controllable energy block in respect of the following minimum requirements for operation and control of an interruptible load:



Isolator	01_State	10_State	Category	Type	Control
Pole	Disagree	Normal	Health	Single	False
Isolator state	Closed	Open	Info	Double	False
Breaker	01_State	10_State	Category	Type	Control
Unit breaker state	Closed	Tripped	Info	Double	True
Current Transformer	01_State	10_State	Category	Type	Control
SF6 gas critical (CT)	Alarm	Normal	Health	Single	False
SF6 non-critical (CT)	Alarm	Normal	Health	Single	False
Load	01_State	10_State	Category	Type	Control
Load reduction acknowledged	No	Yes	Info	Single	True
Load interrupt acknowledged	No	Yes	Info	Single	True
Block load reduction acknowledged	No	Yes	Info	Single	True
Return to service acknowledged	No	Yes	Info	Single	True
Load active power			Info	Analogue	False

The availability of the interruptible load shall be integrated into the ancillary service schedules by the System Operator.

APPENDIX 6: Schedule information

The System Operator shall provide the following minimum day-ahead schedule information for each hour of the following day in relation to each unit at each power station:

No	Data description	Format	Size	Unit
1	Unit energy schedule	Real	999,9	MW
2	Unit spinning reserve schedule	Real	999,9	MW
3	Unit standby reserve schedule	Real	999,9	MW
4	Unit regulation reserve schedule	Real	999,9	MW
5	AGC	Integer		on / off

APPENDIX 7: Post-dispatch information

The System Operator shall provide the following minimum operational information in near real time and as historic data in relation to each unit at each power station:

No	Data description	Format	Size	Unit
1	Unit high limit	Real	999,99	MW
2	Unit low limit	Real	999,99	MW
3	Unit AGC mode BP(0,2,3)/EX(0,1,2,3)	Character	3	
4	Unit AGC status AUT/OFF/MAN	Character	3	
5	Unit set-point	Real	999,9	MW
6	AGC set-point	Real	999,9	MW
7	Unit sent out	Real	999,99	MW
8	Unit auxiliary	Real	999,99	MW
9	Unit schedule	Real	999,9	MW
10	Unit spinning reserve	Real	999,9	MW
11	Unit standby reserve	Real	999,9	MW
12	Unit regulation reserve	Real	999,9	MW
13	32-bit flag on AGC settings	Integer		32 bits

The system operator shall provide the following minimum operational information in near real time in relation to the overall dispatch performance:

No	Data description	Format	Size	Unit
1	ACE area control error	Real	999,99	MW
2	Average ACE previous hour	Real	999,99	MW
3	HZ system frequency	Real	99,999	MW
4	Frequency distribution current hour	Real	999,99	MW
5	Frequency distribution previous hour	Real	999,99	MW
6	System total generation	Integer	99999	MW
7	Control area total actual interchange	Integer	99999	MW
8	Control area total scheduled interchange	Integer	99999	MW
9	System operating reserve	Integer	99999	MW
10	System sent out	Integer	99999	MW
11	System spinning reserve	Integer	99999	MW
12	AGC regulating up	Integer	99999	MW
13	AGC regulating down	Integer	99999	MW
14	AGC regulating up assist	Integer	99999	MW
15	AGC regulating down assist	Integer	99999	MW
16	AGC regulating up emergency	Integer	99999	MW
17	AGC regulating down emergency	Integer	99999	MW
18	AGC mode	Char	TLBC /CFC	
19	AGC status	Char	ON/ OFF	
20	Area control error output	Real	999.99	MW
21	System transmission losses	Real	999.99	MW
22	Relevant international tie-line flows	Integer	99999	MW
23	AGC performance indicators			

APPENDIX 8: Generator performance data

Measurement of availability

The Unipede/Eurelectric standard for the measurement of plant availability must be used. Availability is measured with the use of an indicator known as the energy availability factor (EAF).

EAF represents the network point of view.

The EAF has the same conceptual content as the equivalent availability factor used by USA operators, e.g. the NERC-GADS data bank.

Energy availability factor is defined as the ratio of the available energy generation (b) over a given time period (PH) to the reference energy generation over the same period, expressed as a percentage. Both of these energy generation terms are determined relative to reference ambient conditions.

Available energy generation (b) for the purpose of calculating EAF is the energy that could have been produced under reference ambient conditions considering limitations within and beyond the control of the plant management.

- $b = Pd \times PH$

Reference energy generation (Y) is the energy that could be produced during a given time period if the unit were operated continuously at reference unit power (PM) under reference ambient conditions throughout the period.

- $Y = PM \times PH$

Reference ambient conditions are environmental conditions representative of the annual mean (or typical) ambient conditions for the unit.

Alternative definition: The "energy availability factor" (f), over a specified period, is the ratio of energy (b) that the available capacity (Pd) could have produced during this period to the energy (Y) that the net maximum electrical capacity (PM) could have produced during the same period.

The energy produced (b) (or capable of being produced) by the available capacity (Pd) may also be calculated as the difference between the energy (Y) (the maximum electrical capacity – PM – that could have been produced) and the unavailable energy (c) (which was not produced or not able to be produced) by the total unavailable capacity (Pit).

- $f = \frac{b}{Y} = \frac{Y - c \times 100\%}{Y}$

Note: For the Eskom reporting systems c is calculated from a summation of unavailable MWh due to outages and restrictions (planned, unplanned, external and non-engineering) occurring throughout the period from MW capacity loss x duration (hr) of the loss.

Components of the energy availability factor (EAF)

$$EAF = UCF - OCLF$$

Unplanned capability loss factor (UCLF)
The purpose of this indicator is to monitor industry progress in minimising outage time and power reductions that result from unplanned equipment failures or other conditions. This indicator reflects the effectiveness of plant programmes and practices in maintaining systems available for safe electrical generation.

Other capability loss factor (OCLF)
Other capability loss factor is an indicator to monitor outage time and power reductions due to causes beyond the control of plant management.

Planned capability loss factor (PCLF)
Planned capability loss factor is defined as the ratio of the planned energy losses during a given period of time to the reference energy generation expressed as a percentage.

Planned energy loss is energy that was not produced during the period because of planned shutdowns or load reductions due to causes under plant management control. Energy losses are considered to be planned if they are scheduled at least four weeks in advance.

Unit capability factor (UCF)
Note: UCF represents the *GENERATOR'S* POINT OF VIEW

The purpose of this indicator is to monitor progress in attaining high unit and industry energy production availability. This indicator reflects effectiveness of plant programmes and practices in maximising available electrical generation and provides an overall indication of how well plants are operated and maintained.

$$UCF = 100 - PCLF - UCLF$$

Measurement of availability and reliability
The Unipede/Eurelectric standard for the measurement of plant reliability must be used.

Reliability is measured with the use of two specific indicators, namely unplanned automatic grid separations (UAGS) and successful start-up rate (SSUR)

Unplanned automatic grid separations per 7 000 operating hours (UAGS/7000h)
The purpose of this indicator is to enable monitoring of an important aspect of the reliability of service supplied to the electrical grid. It takes into account success in improving reliability by reducing the number of turbo generator trips. It also provides an indication of plant operation and maintenance performance.

Taking account of the number of operating hours when the turbo generator set is connected to the electrical grid enables assessment of required reserves. Furthermore, using a common standard for all grid separation data for each unit provides a uniform basis for comparison among units with values for the industry as a whole.

Intentional (manual) grid separations are not taken into account since operators should not be discouraged from taking action to protect equipment.

This indicator may be defined as corresponding to the number of unplanned (unintentional) automatic grid separations of internal origin that occur per 7 000 operating hours. This definition can be clarified as follows:

"Unplanned" means that grid separation is not an anticipated part of a planned test, nor part of an operating programme designed to adjust output to demand (e.g. a controlled shutdown). Controlled shutdowns of units where the line circuit breaker is manually or automatically opened at loads equal to or below the first automatic synchronising load should not be considered when computing this indicator.

"Grid separation" means the opening of the generator breaker or HV yard breaker where no generator breaker exists. This could be an opening signal actuated by overshooting of a safety threshold, or a spurious trip. Grid separation can only occur during grid service of the units. Grid service is obtained when the start-up is successful for requested start-ups or when loads in excess of the first synchronising load are reached for “contracted” or “other start-ups” (i.e. house or block load as programmed into the automatic synchronising equipment).

“Automatic” (unintentional) means that the grid separation is not the result of an action by the operator either on one of the switches to trigger a unit trip or grid separation or to simulate operation of a protection system.

Trips caused by the operator in error, e.g. opening the wrong switch leading to a trip, are excluded from the “manual” category. Controlled shutdowns of units where the line circuit breaker is manually or automatically opened at loads equal to or below the first automatic synchronising load should not be considered when computing this indicator.

“Operating" means that the turbo generator set is connected to the off-site grid (*transmission* of generated power) even if the alternator is operating in synchronous motor mode owing to exceptional circumstances.

"Of internal origin" means that the trip is due to an unspecified internal installation failure resulting in a loss of reliability – even if the initial event can be traced to an off-site cause. The signal that triggered grid separation must originate from one of the sensors (or protection logic) for monitoring unit parameters (turbo generator set and power *transmission*, up to and including the generator transformer HV breaker, and boiler). Grid separations actuated by protection systems for the physical parameters of the grid are not included unless they were incorrectly controlled.

The selected figure of 7 000 hours represents the typical number of on-line hours for most plants operating at base load or semi-base load. The indicator thus represents an approximate value of the actual number of grid separations occurring in one year.

The following data are required to determine the value for this indicator:

- The number of unplanned automatic grid separations (U) with the generator circuit breaker (or HV breaker where no generator breaker exists) in initially closed position
- The number of operating hours (OPH)

All automatic trips are counted for the UAGS indicator, including those auto trips occurring within +30 minutes of all requested start-ups that comply with the ±15-minute time limit for synchronisation.

$$\frac{UAGS}{7000h} = \frac{U \times 7000}{OPH}$$

Data for new units is included in the calculation of industry values beginning January 1 of the first calendar year following the start of commercial operation. However, in order to be included in the industry value, the unit must have at least 1 000 operating hours per year. This minimum operating period requirement reduces the effects of plants that are shut down for long periods of time and for which limited data may not be statistically valid.

Summarised definition of UAGS per 7 000 hours: This indicator tracks the average grid separation rate per 7 000 operating hours (approximately one year of operation) for units having at least 1 000 operating hours during the year. Only trips of internal origin to the installation are included and trips for the physical parameters of the grid are not included unless they were incorrectly controlled.

Successful Start-up Rate (SSUR)

The "successful start-up rate" is the ratio of the number of successful start-ups to the number of contracted start-ups over a given period of time. It measures the reliability of the service that is rendered to the *customers*.

$$SSR = \frac{NumberOfSuccessfulStartUps \times 100\%}{NumberOfContractedStartUps}$$

Start-up comprises the set of operations that enable the unit to be connected to the off-site power grid. Connection of the unit to the grid (closing the line circuit breaker) is the purpose of the first start-up phase, before loading and stabilisation at the required power level. Only this initial start-up phase, the success of which results in sustained grid connection, is considered here.

The contracted start-up refers to an agreement between the grid administrator (through any medium, e.g. verbally, telephonically, etc.) and the station, following a request from the grid administrator or the station. This forms part of a grid management schedule (hereafter referred to as the “real” National Control programme) for the full range of power generation resources (excluding tests). The request for a start-up in advance of the synchronising time corresponds to the technical delay due to equipment start-up times. This delay time can be reduced to almost zero in the case of start-up of peak-supply gas turbines with centralised, automatic control systems. For any given start-up contract, a precise time for grid connection and an implementation schedule are required (except for peak-load gas turbines). In the event of a sudden modification by the grid administrator of the grid connection contract time, within the start-up capabilities of the unit, a new contract needs to be entered into.

APPENDIX 9: Planning schedules

Schedule 1: Ten-year demand forecast

	Demand = Total Demand + Distribution Losses – Embedded Generation					
			Maximum demand		Expected minimum demand	
Year		GWh	MW	MVAr	MW	MVAr
Measured (year 0)						
Year 1						
Year 2						
Year 3						
Year 4						
Year 5						
Year 6						
Year 7						
Year 8						
Year 9						
Year 10						

Schedule 2: Embedded generation > 5MVA

Generator	Tx substation name at closest connection point	Operating power factor	Installed capacity (MW)	Plant type	On-site usage		Net sent out		Generation net sent out contribution at peak									
					Normal	Peak	Normal	Peak	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10

APPENDIX 10: Generator HV yard information

Transmission shall provide the following information to *generators* about equipment and systems installed in HV yards from TANESCO. The *TANESCO* shall provide the stability criteria.

Equipment	Requirement
Circuit breaker	MCR rating, peak rating, operating time, OEM, installation date
CT and VT	CT and VT ratings, classes of equipment, burdening, OEM, installation date
Surge arrestor	OEM, age, installation date, number of operations
Protection	Description of protection philosophy for all protection schemes and functions installed, including ARC; protection reliability information shall be available annually
Power consumption	List the power consumption requirement by equipment requiring supply from power station, including from AC, DC and UPS
Link	MCR rating, peak rating, OEM, installation date
Outgoing feeder	MCR rating, peak rating, erection date, length, impedance, transposition characteristics, thermal limits, installed protection, shielding
Transformer	Transformer specifications for coupling transformers in HV yards; the records of coupling transformers in HV yards must be available on request
Compressed air system	Compressed air system specifications including schematic drawings
Fault recorder	Fault recorder specifications including resolution, record time, triggering criteria, data format shall be provided on request; TANESCO shall review the fault levels and impedance to network centre from HV yard, annually