JAMAICA ELECTRIC UTILITY SECTOR TRANSMISSION CODE

DISCLAIMER

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The data, conclusions and recommendations will remain draft until the documents have gone through the review process and is approved by the legally authorized entities.

TC 1 SCOPE

TC 1.1 Objectives

This Transmission Code sets out the procedures and principles governing the operation of the Jamaica Transmission System and applies to the conveyance of electricity by means of the Transmission System, which includes electric power lines operating at 69kV and higher, including the secondary circuit breakers and up to the outgoing Isolators at Transmission Substations transforming to 24kV, 13.8kV and 12kV. The Code provides the guidelines controlling the development, maintenance and operation of an efficient, co-ordinated and economic *Transmission System* in Jamaica.

TC 1.1.1 This Transmission Code sets out the procedures and principles governing the System Operators relationship with all Users of the System Operators Transmission System.

TC 1.1.2 The Transmission Code shall be complied with by the System Operator and existing and potential Generators and Users connected to or seeking to connect to the System.

TC 2.0 GENERAL REQUIREMENTS

TC 2.1.1 This Transmission Code contains the procedures to provide an adequate, safe and efficient service to all parts of Jamaica, taking into account a wide range of operational circumstances. It is however necessary to recognise that the Transmission Code cannot address every possible situation. Where such unforeseen situations occur the System Operator shall act as a reasonable and prudent operator in the pursuance of any or a combination of the following General Requirements:

a. To protect the safety of the public and employees;
b. The need to preserve the integrity of the System;
c. To prevent damage to the System;
d. Compliance with conditions under its Licence;
e. Compliance with the Act;
f. Compliance with the Distribution Code; and
g. Compliance with the Generation Code.

TC 2.1.2 Users shall provide such reasonable co-operation and assistance as the System Operator reasonably request in pursuance of the General Requirements.

TC 3 LONG-TERM TRANSMISSION NETWORK PLANNING

TC 3.1 Purpose and Scope

TC 3.1.1 The EA section 7 provides that the Minister shall be responsible for planning the development of the system, which planning shall include:

(a) integrated resource plan:.1ing;
(b) the collection of data from electricity sector participants;
(c) consultations with the Office, the Single Buyer and other electricity sector participants; and
(c) the conduct of any relevant forecast.

This provision further requires that the planning process for transmission and distribution, consider the location of renewable and other generation sources, taking into account the potential for electrification of rural areas. The provision also requires that all *License* holders must comply with a request made by the Minister for information for the purposes of executing his planning responsibility under this section and failure to comply with a request under this subsection, without reasonable cause, shall be an offence.

TC 3.1.2 This chapter of the Transmission Code specifies the criteria and procedures governing the collection of data from electricity sector participants to support the Minister's planning activities. These provisions have been established with the guidance of the Ministry, after consultation with electricity sector stakeholders. Consistent with *License* obligations, this chapter provides for accountability for Transmission System planning and development targets established in Ministry plans and sets the required standards and targets. It also specifies the reciprocal obligations and interactions between Users of the Transmission System in respect of the planning process.

TC 3.1.3 The development of the Transmission System may occur for a number of reasons, including but not limited to:

a. changes to customer requirements or networks;
b. the introduction of a new transmission substation or point of connection or the modification of an existing connection between a User and the Transmission System;
c. the cumulative effect of a number of developments as referred to above;
d. the need to reconfigure, decommission or optimise parts of the existing network.

TC 3.1.4 The time required for the planning and development of the Transmission System will depend on the type and extent of the necessary reinforcement and/or extension work, the need or otherwise for statutory planning consent, the associated possibility of the need for public participation and the degree of complexity involved in undertaking the

new work while maintaining satisfactory security and quality of supply on the existing Transmission System.

TC 3.1.5 This Section of the Code applies to the following:

a. The System Operator;
b. Generators, in addition to and consistent with the provisions of the Generation Code, and
c. Users connected to the Transmission System including JPS in its capacity as operator of the Distribution System.

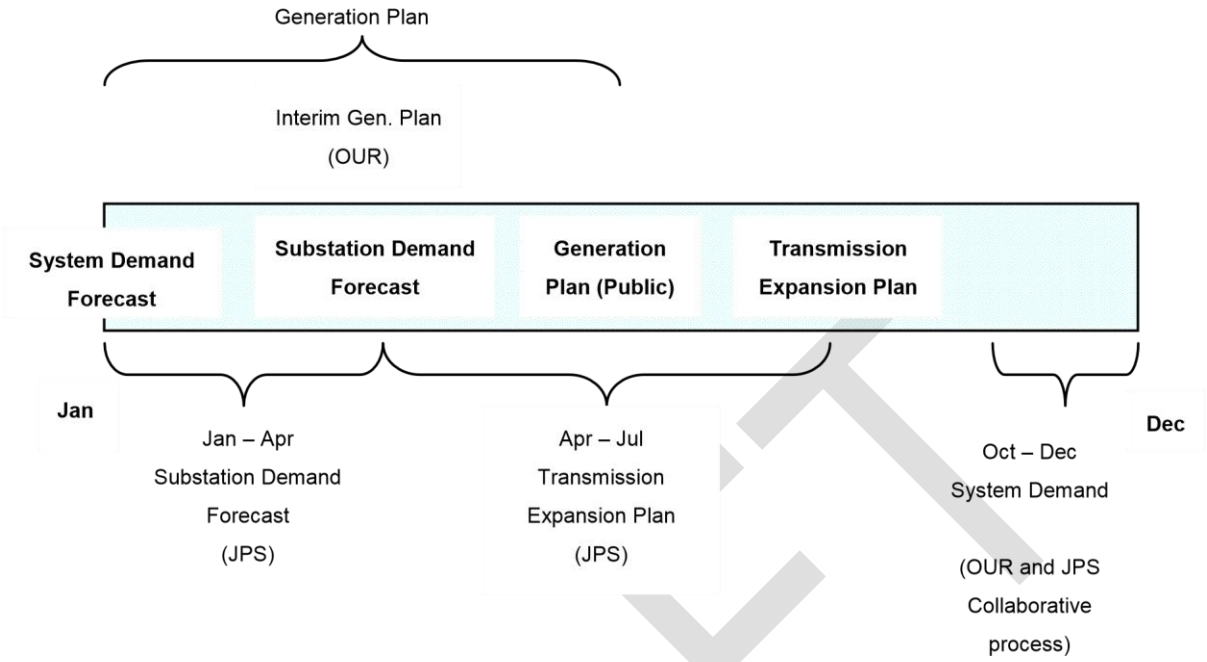
TC 3.2 Planning Process

TC 3.2.1 The System Operator shall follow a planning process divided into major activities as follows:

a. Identification of the need for expansion or modification of the Transmission System;
b. Formulation of alternative options to meet this need;
c. Study of these options to ensure compliance with agreed technical limits and justifiable reliability and quality of supply standards;
d. Costing of these options and determination of the preferred option on the basis of procedures consistent with Prudent Utility Practice;
e. Approval of the preferred option in line with OUR tariff, JPS Business Plan, and *License* authorisation levels and initiation of execution.

TC 3.3 Planning Timescales

TC 3.3.1 The planning process above should operate on an annual cycle. The cycle commences with the development of the system demand forecast in Q4 (year n), then the development of the Substation Demand Forecast in Q1 (year n+1), and is completed with the production of the Least Cost Expansion Plan in Q3 (year n+1).



TC 3.3.2 Connection Related Planning Studies shall be undertaken outside the above process, but new load information will be used to inform the demand forecasts. The timescales required to undertake the new connection studies necessary to plan the system vary depending on the driver for the studies and the ability to obtain consented routes.

TC 4 TRANSMISSION SYSTEM SECURITY STANDARDS

TC 4 of this Code sets out the Transmission Security Standards against which the System Operator will plan the Transmission System.

TC 4.1 Normal Conditions

TC 4.1.1 The System Operator shall plan, design and operate the Transmission System such that under normal steady state conditions, prior to any fault, there shall not be:

a. Equipment loadings exceeding the pre-fault rating;
b. Voltages outside – 5% of nominal values on all 69 kV and 138 kV buses;
c. Voltages outside – 5% of nominal values on Generator buses; or
d. System instability.

TC 4.2 Contingency Conditions

The System Operator shall plan, design and operate the Transmission System such that the system is secured against the following contingencies:

TC 4.2.1 Single Forced Outage

The loss of any single transmission element or interbus transformer, except in cases of radial lines, shall not affect the system s ability to adequately supply the required demand of its sub-station(s).

TC 4.2.2 Generator Outage

The loss of any single transmission element connecting a Generator to the Transmission System shall not result in a loss of generation greater than 60 MW. This implies that connection for Generators of greater than 60 MW shall be designed on the N-1 principle.

TC 4.2.3 Voltages

TC 4.3.1 Under contingency conditions voltages shall be maintained as follows:

Voltages at all Generator terminal buses are to be within – 5% of nominal voltage; and

a. Voltages at all 69 kV and 138 kV buses are to be within – 10% of nominal voltages.

TC 4.4 Load Power Factor

TC 4.4.1 The system will be planned for a normal load power factor of 0.95 with a voltage planning criteria of –5% for normal operation and –10% for contingency conditions.

TC 4.5 Thermal Loadings

TC 4.5.1 Under contingency conditions, transmission line loading of up to 110% of rated continuous rating for 30 minutes (Emergency Rating) may be used.

138/69 kV Interbus Transformer loadings may not exceed nominal rating.

TC 4.6 Spinning Reserve

TC 4.6.1 The System Operator shall have in place a Spinning Reserve policy, subject to review by the OUR, at all times. The policy shall seek to ensure that the spinning reserve margin is adequate to cover the loss of a small generator without the loss of load. Loss of large generators could result in loss of demand, which under these circumstances shall not be deemed to be a breach of the transmission security standards. For further details of the

Spinning Reserve Policy refer to the **System Operator s System Operation Policy No 8.** Loss of demand under these circumstances shall not be deemed to be a breach of the Transmission Code.

TC 4.7 Fault Levels

TC 4.7.1 The maximum fault levels in the system should be below 80% of the rated interrupting capacity of the circuit breakers determined using the generators transient impedances.

TC 4.8 Frequency Criteria

TC 4.8.1 Maintain frequency within the limit of 50 Hz ± 0.2 Hz, with a deadband of 30 mHz. In case of outage of some elements, the system may resort to under frequency load shedding scheme to control the frequency, as outlined in Schedule B of the Generation Code.

TC 4.8.2 Generator Frequency Requirements

Under extreme system fault conditions all GENERATOR units must be disconnected at a frequency greater than 52.5 Hz. At a frequency less than 48.0 Hz the generator may be disconnected (in accordance with Table TC 4.8.1 (below). Where under and over frequency relays are installed, these relays shall be set such that the automatic removal of the GENERATOR from the Transmission Network meets the requirements shown in Table TC 4.8.1 System Operator however may specify slightly different tripping points for the various GENERATOR in order to avoid having all generators on the Transmission Network trip at the same time in a frequency constraint

Table TC 4.8.1 - Frequency Relaying Requirements

50.5 Hz < Freq	.5s
49.5 Hz ≤ Freq ≤ 50.5 Hz	**Continuous Operation**
48.0 Hz < Freq <49.5 Hz	20s
Freq ≤ 48.0 Hz	.5s

Additionally:

i) GENERATORs must remain connected to the Transmission System during rate of change of Transmission System Frequency of values at least up to and including **0.5 Hz** per second

ii) No additional GENERATOR shall be started while the Transmission System Frequency is above 50.2 Hz.

iii) The operational characteristics of the relay operation must be coordinated with other control systems of the GENERATOR (such as excitation, frequency (speed) governor response, and other controls where applicable).

TC 4.8.3 Generator Governor – Primary Frequency Response (PFR)

Generator that have capacity available to either increase output or decrease output in real-time must provide PFR, which may make use of that available capacity response to System frequency deviations. The PFR shall be similar to the droop characteristic of the governor system used by conventional steam generators. The governor droop shall be set by System operator and be in the range of 0% to 5%, with a default of 5%.

The GENERATOR resource automatic control system design shall have an adjustable dead band that defaults at +/- **0.03 Hz**. This dead band means that until frequency error is beyond a threshold, the governor ignores it. When frequency error exceeds the threshold **(0.03 Hz, or 30 mHz by convention)** the governor becomes active.

In Primary Frequency Response mode, the PFR control system shall have the capabilities as displayed in the Power-Frequency Response Curve in **Figure TC 6.1**, where the power and frequency ranges required for points A, B, C, D, and E shall be defined by JPS.

All GENERATORs in operation must reduce their instantaneous active power output when the system frequency is more than 50.03 Hz as shown in Figure TC 6.1. Points A, B, C, D and E on Figure TC 6.1 depend on a combination of the Transmission System Frequency, Active Power and Active Power Control Set-point settings, and may be different for each GENERATOR depending on system conditions and GENERATOR location. Points A, B, C, D and E therefore may be adjusted by System Operator to accommodate requirements for system reliability which will be communicated to and agreed upon with the GENERATOR on a case by case basis. In this figure the only defined power output point is maximum available power (100%) of the GENERATOR; the Active Power Set Point could be in any value between 100% and down to 10%. The Active Power Set Point shall correspond to System Operator's operator designation of this value.

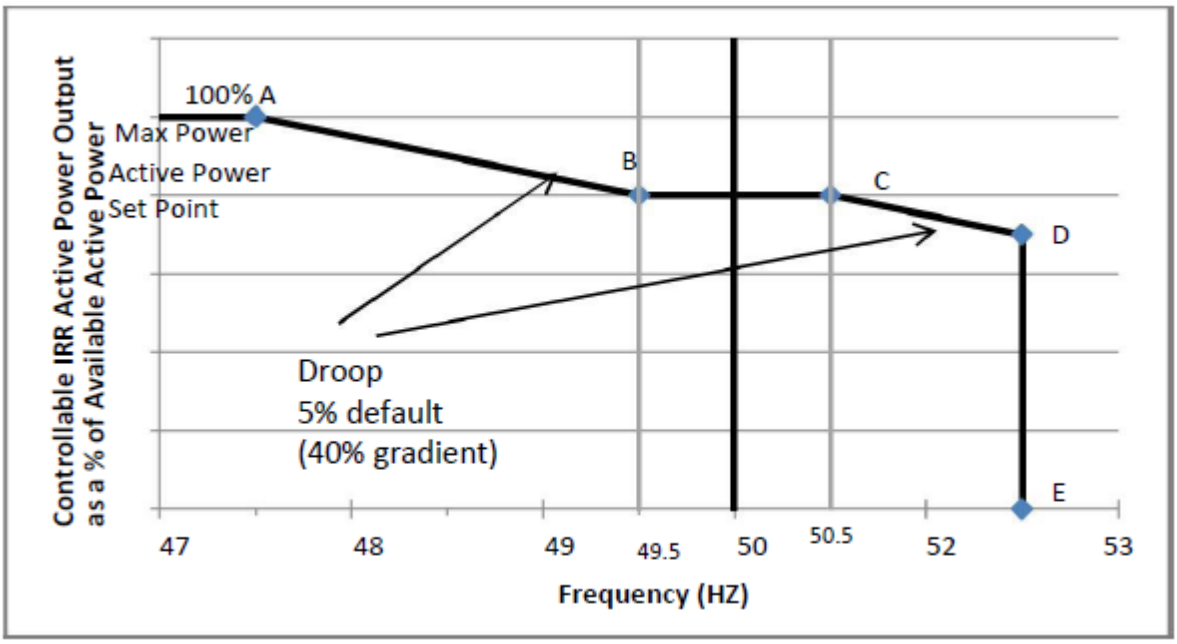


Figure TC 4.8.1 –Curve 1 Power-Frequency Response Curve

Controllable GENERATOR Frequency Response and Governor Droop shall be calculated with respect to the GENERATOR registered capacity (generally being the same as the rated nameplate capacity). A controllable GENERATOR can provide low frequency support only if the Active Power Control set-point is less than the Available Active Power.

Alterations to the Active Power Control Set-point may be requested in real-time by System Operator and the implementation of the set-point shall commence within 10 seconds of receipt of the signal from JPS/System Operator.

Alterations to the Active Power output, triggered by Transmission System Frequency changes, shall be achieved by proportionately altering the Active Power output of all available GENERATOR units as opposed to switching individual units on or off, where possible.

No time delay other than those necessarily inherent in the design of the Frequency Response System and communications shall be introduced. The Frequency Response System shall continuously monitor the Transmission System Frequency in order to continuously determine the GENERATOR's appropriate Active Power output.

If the Transmission System Frequency rises to a level above 'D'-'E', as defined by the Power-Frequency Response Curve in Figure TC 6.1, the GENERATOR will not be required to provide frequency response service and shall disconnect in accordance with the time delays set in Table TC 6.1. Any GENERATOR which has

disconnected shall be brought back in collaboration with the System operator as fast as technically feasible (provided the Transmission System Frequency has fallen below 50.5 Hz).

TC 4.9 Network Stability

TC 4.9.1 The Transmission system should remain stable when subjected to severe system disturbances, such as the loss of a large generating plant, or s Short Circuit condition.

TC 4.9.2 Fault Clearing Time

The Fault Clearance Time for a Short Circuit fault, shall not be longer than:

a 100 ms for 138 kV; and
b 120 ms for 69 kV.

TC 4.10 Transmission System Resiliency

How to best minimize and mitigate System damage and outages due to extreme weather events and how to best assure rapid restoration of power following any unavoidable outages.

TC 5 PLANNING PROCEDURES

TC 5.1 General

TC 5.1.1 The System Operator shall conduct Transmission System planning studies consistent with the planning process and established planning criteria to ensure the Safety, Reliability, Security, and Stability of the Transmission System for the following:

a. Preparation of the Transmission Least Cost Expansion Plan for submission to the OUR;
b. Evaluation of Transmission System reinforcement projects; and
c. Evaluation of any proposed User Development, which is submitted to the System Operator in accordance with an application for an Interconnection Agreement or an Amended Interconnection Agreement.

TC 5.1.2 The Transmission System planning studies shall be conducted to assess the impact on the Transmission System of any Demand Forecast or any proposed addition or change of Equipment or facilities in the Transmission System and to identify corrective measures to eliminate the deficiencies in the Transmission System.

TC 5.1.3 The Transmission System planning studies shall be conducted periodically as required to assess:

a. The behaviour of the Transmission System during normal and Outage contingency conditions; and
b. The behaviour of the Transmission System during the electromechanical or electromagnetic transient induced by disturbances or switching operations.

TC 5.1.4 Power system analysis studies shall be conducted by JPS or third party consultant pre-approved by JPS, according to the Study Guidelines outlined in the Transmission Code (TC), and using a suitable power system software such as PSS/E and DIgSILENT. The final results and the used models, including the validated user model have to be handed over to the System. The studies must demonstrate the capability of the plant to meet all the grid code requirements outlined in this the Transmission Code. The model shall comprise all facilities necessary for the generation of power from the generating plant to be integrated in the system model.

TC 5.2 Load Flow Studies

TC 5.2.1 Load flow studies shall be performed to evaluate the behaviour of the Transmission System for the existing and planned Transmission System facilities under forecasted maximum and minimum Load conditions over a planning horizon of up to 10 years. These studies will determine the impact on the Transmission System of the connection of new Generating Plants, Loads, or transmission lines.

TC 5.2.2 Load/power flow simulations shall be conducted in line with the planning criteria, to include both normal and contingency conditions. The results of the studies will provide, information regarding equipment loading (lines or transformers) and bus voltages together with any deficiencies in reactive support.

TC 5.2.3 Sensitivity analyses shall also be carried out to determine the impact that any proposed changes will have on the operation of the Transmission System at other times than peak and minimum loads.

TC 5.2.4 For new transmission lines, any condition within the planning criteria that produces the maximum power flows through the existing and new lines shall be identified and evaluated in order to determine any remedial measures necessary.

TC 5.3 Short Circuit Studies

TC 5.3.1 Short circuit studies shall be performed to evaluate the effect on Transmission System Equipment associated with the connection of new Generating Plants, transmission lines, and other facilities that will result in increased fault duties for Transmission System Equipment. These studies shall identify the Equipment, such as switchyard devices and substation buses, that could be permanently damaged when the current exceeds the

Equipment design limit. The studies shall also identify the circuit breakers, which may fail when interrupting possible short circuit currents.

TC 5.3.2 Short Circuit studies are also required to allow for the correct setting of protection relays on which depends the stability of the Transmission System under fault conditions.

TC 5.3.3 Short-circuit studies shall be performed for all busbars on the Transmission System for different feasible generation, load, and system circuit configurations. These studies shall identify the most severe conditions that the Transmission System Equipment may be exposed to. Alternative Transmission System circuit configurations shall be studied to reduce the short circuit currents within the limits of existing Equipment. Such changes in circuit configuration shall be subjected to load flow and stability analysis to ensure that the changes do not cause steady-state load flow or stability problems.

The fault type to be consider, should include but not limited to the various fault type listed below:

a) Three Phase
b) Double Line
c) Double Line to Ground and
d) Single Line to Ground

TC 5.3.4 The results shall be considered satisfactory when, at the planning stage, the short-circuit currents are within 80% of the design limits of Equipment and the proposed Transmission System configurations are suitable for flexible and safe operation.

TC 5.4 Transient Stability Studies

TC 5.4.1 Transient Stability studies shall be performed to verify the impact of the connection of new Generating Plants, transmission lines, and substations and changes in Transmission System circuit configurations on the ability of the Transmission System to seek a stable operating point following a transient disturbance. Transient Stability studies shall simulate the outages of critical Transmission System facilities such as major transmission lines and large Generating Units. The studies shall demonstrate that the Transmission System performance is satisfactory if:

a. The Transmission System returns to a stable condition after any Single
b. Outage Contingency for all forecasted Load conditions; and
c. The Transmission System remains controllable by other means, such as operator intervention and automatic tripping of demand or generation after multiple outage contingencies within the planning criteria.

TC 5.4.2 Transient Stability studies shall be conducted for all new transmission lines or substations and for the connection of new Generating Units equal to or larger than [60] MW

connected to the Transmission System. In other cases, the System Operator shall determine the need to perform transient Stability studies.

TC 5.5 Steady-State Stability Analysis

TC 5.5.1 Transient stability is the inherent ability of a power system to remain stable and maintain network synchronism when subjected to **severe disturbances**. The starting point of the stability studies is the steady-state conditions (determined by the load flow study). System parameters that can be derived from a steady-state stability study includes the rotor (stability phase) angle of Generators, real (MW) and reactive (MVAR) power flows, and bus voltages.

TC 5.5.2 Stability Studies shall be carried out to check the dynamic performance of the Transmission System in the following circumstances:

a. load shedding by under-frequency relays following tripping of large Generators:
   i. Normal system operation with the network intact, for both the day and evening peak;
   ii. After system separation occurs, and iii) System minimum load condition.

b. slow clearance of faults due to mal-operation of the protection systems, and
c. the loss of strategic Transmission circuits including transformers.

TC 5.5.3 The ability of the system to withstand the most severe fault shall be tested. The most onerous fault is defined as the application of a solid three phase fault or a single line to ground fault close to the main generating stations. The Critical Fault Clearing Time (CFCT) should also be examined to determine the response of the system to a prolonged fault.

TC 5.5.4 The stability studies shall identify solutions, such as the installation of power system stabilizers or the identification of safe operating conditions.

TC 5.6 Voltage Stability Analysis

TC 5.6.1 Periodic studies shall be performed to determine if the Transmission System is vulnerable to voltage collapse under heavy loading conditions. A voltage collapse can proceed very rapidly if the ability of System s Reactive Power supply to support system voltages is exhausted. The studies shall identify solutions such as the installation of dynamic and static Reactive Power compensation devices to avoid vulnerability to voltage collapse. In addition, the studies shall identify safe Power System operating conditions where vulnerability to voltage collapse can be avoided until solutions are implemented.

TC 6 DATA REQUIREMENTS

TC 6.1 General

TC 6.1.1 A critical part of all the studies mentioned above is the large volume of input data that is required by each study. This data set is necessary for the development of accurate mathematical models that can mimic the system real-time response.

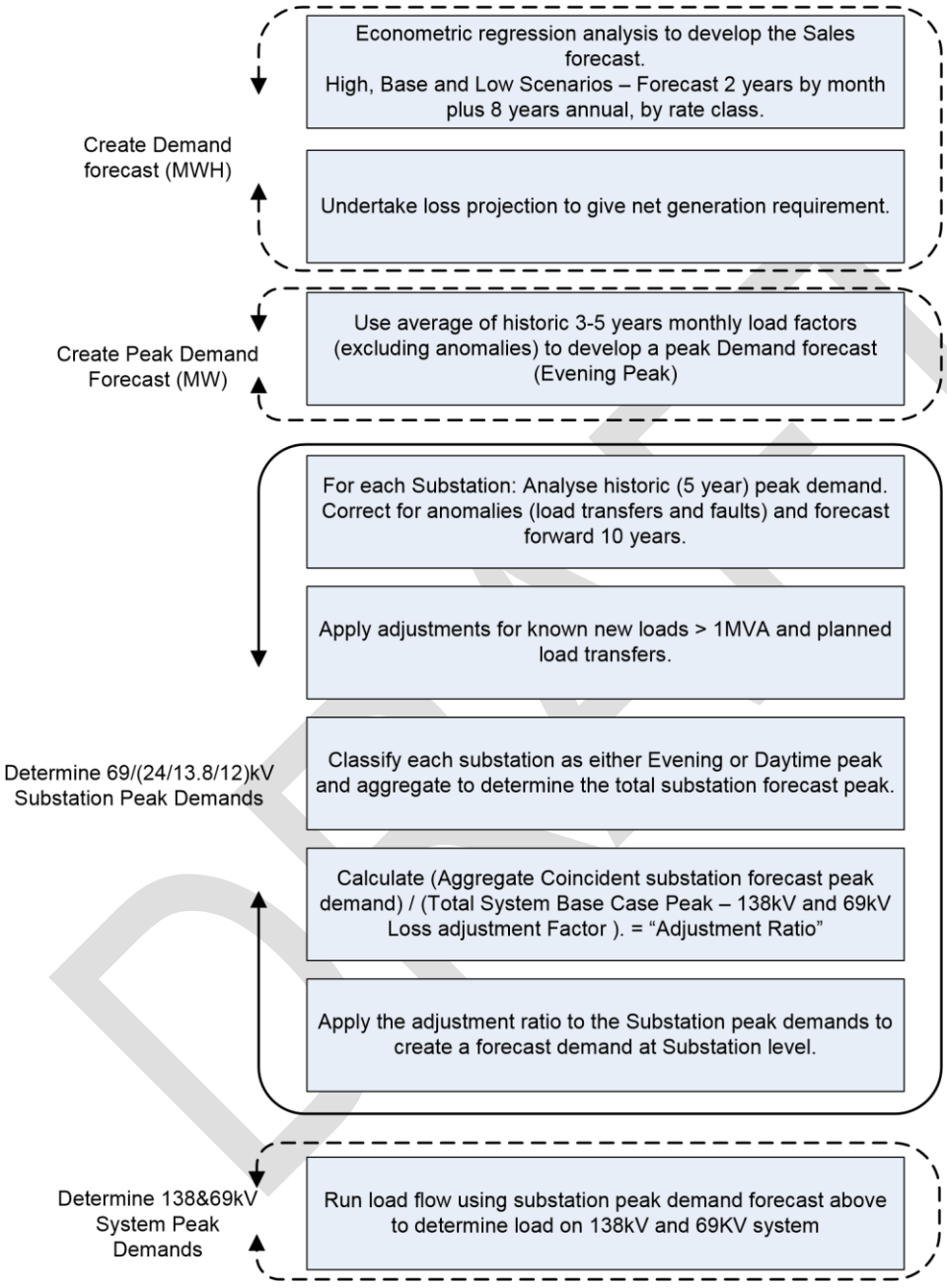
TC 6.2 Demand forecast

TC 6.2.1 In order to carry out load flow studies, substation loads can be represented by their constant real (MW) and reactive (MVAR) power requirements. However, voltage and transient stability studies require complex models for substation loads. In the absence of these complex models the System Operator shall continue to use the constant power model for its transient and voltage stability studies

TC 6.2.2 Demand forecast are required to enable the network to be developed in a coordinated and economic manner. A consumption forecast using an econometric regression methodology is considered suitable for this. This forecast of unit consumption is then to be developed into a peak demand forecast for each substation: this demand data shall then be used in the system studies outlined in TC 4 above.

TC 6.2.3 The overall process for development of the grid wise forecast is illustrated below. This process is undertaken on an annual basis.

System and Substation Demand Forecast Process



TC 7.0 Maintenance Standards

All Plant and Apparatus on the System shall be operated and maintained in accordance with Prudent Utility Practice and in a manner that shall not pose a threat to the safety of employees or the public.

The System Operator shall establish a Transmission System Maintenance Policy which shall be reviewed and approved by the OUR.

TC 7.1 Competency of Staff

TC 7.1.1 The System Operator shall have in place training polices that serve to ensure that persons operating, maintaining, testing and controlling the System Operator Transmission and Distribution Systems are competent for the tasks to be undertaken. The policies shall include refresher training at appropriate intervals to maintain the currency of the training.

TC.7.1.2 All persons operating, maintaining, testing and controlling the System Operator Transmission and Distribution Systems, shall have received appropriate training to ensure competency for the tasks that they will be undertaking and refresher training at appropriate intervals to maintain the currency of the training.

TC 7.1.3 The System Operator shall maintain records of training given and issue certificates indicating the areas of competency of the persons trained.

TC 7.2 Requirement for Inspection

TC 7.2.1 All Plant and Apparatus that will form part of the Transmission System will only become part of the Transmission System following inspection and approval by the Government Electrical Inspectorate.

TC 8 TRANSMISSION CONNECTION

TC 8.1 General

TC 8.1.1 This Transmission Connection Section specifies the normal method of connection to the Transmission System and the minimum technical, design and operational criteria which must be complied with by any User or prospective User. For the purpose of the Transmission Connection Code, User refers to both Generators and Large Customers connected to the Transmission System.

TC 8.1.2 In addition, details specific to each User's connection may be set out in a separate Connection Agreement/Interconnection Agreement or in some cases a Power Purchase

Agreement. The Connection Conditions set out in this Transmission Connection Code are complementary to these Agreements.

Conditions of PPAs established before the Code shall control over a conflicting Code provision.

TC 8.1.3 All interconnection costs and responsibility shall normally be borne by the User connected to the Transmission System, unless specified otherwise by an Interconnection Agreement, or policy, or as dictated by the OUR.

TC 8.2 Objective

TC 8.2.1 The objective of the Transmission Connection Code is to ensure that by specifying minimum technical, design and operational criteria the basic rules for connection to the Transmission System shall provide guidance for all System Users and shall enable JPS in its capacity as System Operator and System Users to comply with its statutory and Licence obligations.

TC 8.2.2 This Connection Code applies to JPS in its capacity as System Operator and to the following:

a. Generators connected to the Transmission System;
b. JPS in its capacity as Distribution System operator at the Connection Points to the Transmission System;
c. Large Customers directly connected to the Transmission System, and

TC 9 METHOD OF CONNECTION

TC 9.1 General

TC 9.1.1 The System Operator in consultation with the User shall determine the optimum connection method on the basis of several technical and economic factors including:

a. Geographical considerations including proximity to the Transmission System;
b. Generating Facility MW capacity and/or maximum Demand to be supplied;
c. Supply voltage;
d. Reliability considerations;
e. Standby or auxiliary power requirements;
f. Substation configuration; and
g. Costs.

TC 9.1.2 It should be noted that it will not be technically or economically practicable to achieve uniformity of the method of connection. In all cases however, Prudent Utility Practice will guide the method adopted.

TC 9.1.3 The provisions relating to connecting to the Transmission System are contained in each Connection Agreement and Power Purchase Agreement with a User and include

provisions relating to both the submission of information and reports relating to compliance with the relevant Connection Agreement and Power Purchase Agreement for that User, Safety Rules, commissioning programmes, Operation Diagrams and approval to connect.

TC 9.1.4 Prior to the Completion Date under the Connection Agreement, the following are to be submitted by the User:

a. updated Planning Code data with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for items such as Demand;
b. details of the protection arrangements and settings including a Protection and Control Single Line Diagram;
c. copies of all Safety Rules and Local Safety Instructions applicable at Users Sites which shall be used at the System Operator/User interface;
d. information to enable the System Operator to prepare Site Responsibility Schedules on the basis of the provisions set out in Appendix A;
e. an Operation Diagram for all HV Apparatus on the User side of the Connection Point;
f. the proposed name of the User Site (which shall not be the same as, or confusingly similar to, the name of any JPS Site or of any other User Site);
g. a list of Safety Co-ordinators;
h. a list of the telephone numbers for Joint System Incidents at which senior management representatives nominated for the purpose can be contacted and confirmation that they are fully authorised to make binding decisions on behalf of the User;
i. a list of managers who have been duly authorised to sign Site Responsibility Schedules on behalf of the User; and
j. information to enable System Operator to prepare Site Common Drawings.

TC 9.2 Variable Renewable Power Plant Connection Condition

Although this code is for all Variable Renewable Plants, the code addresses in greater detail Wind and Photovoltaic technical aspects, which were prevalent at the time of writing this code. The code will be updated as needed to address concerns of other technologies.

TC 9.2.1 VRPP Automatic Voltage Regulation (AVR) & Fast Voltage Control

VRPP must be capable of operating in a voltage control mode to maintain the voltage at the Point of Interconnection to stay at a set point provided by SYSTEM OPERATOR to the VRPP. The voltage setting requirement shall be within the normal operating range of the system (+/- 10% of nominal). The following is a guideline of possible specifications of the AVR, however SYSTEM OPERATOR will dictate the specifications to the VRPP based on their technology and location.

VRPP must respond to a sudden voltage decrease/increase with the corresponding fast positive sequence fundamental frequency reactive current output controllers. However, to fulfil these requirements at the Point of Interconnection, is at the discretion of the System operator and based on the appropriate system studies whether other VAr equipment like STATCOM close to the Point of Interconnection are installed for VAr generation with fast voltage control of dynamic nature.

TC 9.2.2 VRPP Grid Connected Transformer Configuration

VRPPs shall provide on-load tap-changing (OLTC) facilities the VRPP Plant central Grid Connected power transformer. All VRPPs shall coordinate with JPS on the design specification for the performance of the tap-changing facility of the Grid Connected Transformer.

The VRPP Grid Connected Transformers connection configuration must be pre-approved in writing by JPS.

Tap changing steps shall be proposed to JPS and pre-approved for the project, and shall be designed to ensure that the VRPP units can comply with section TC 6 of the TC requirements.

TC 9.2.3 VRPP Reactive Power Requirements

It must be possible to operate the VRPP plant in reactive power control mode, and follow any operating point within the range cos ϕ = 0.95 leading under-excited (inductive) to cos ϕ = 0.9 lagging over-excited (capacitive) at the Interconnection point as shown in Figure TC 9.2

For active power supply below the nominal power, Figure 6.4 indicates the minimum reactive power and power factor requirements.

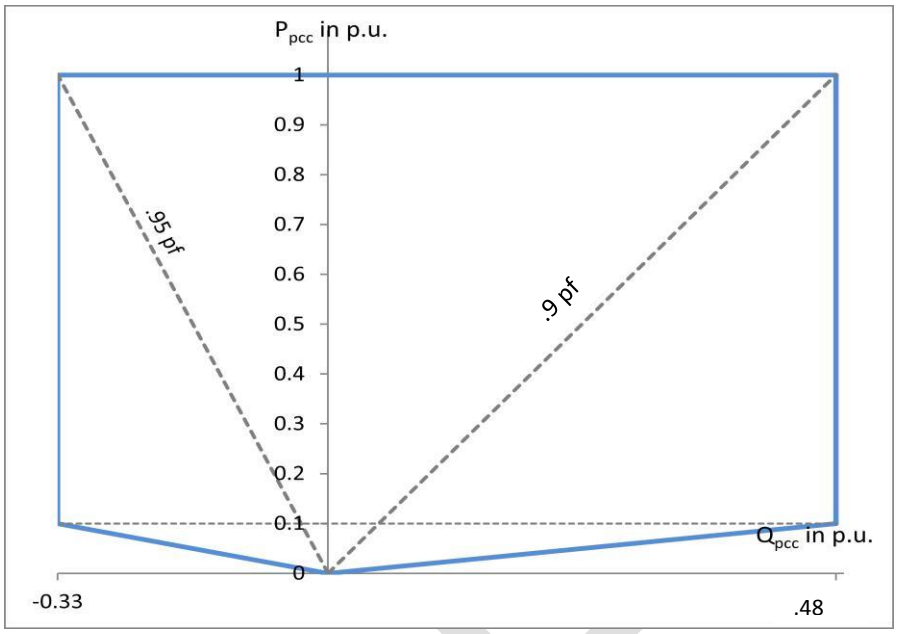


Figure TC 9.2 - Minimum PQ Diagram to be Fulfilled by VRPP plant

Additionally the full lagging reactive capability of 0.9 pf of the VRPP registered capacity (generally being the same as the rated nameplate capacity) shall be made available at 100% to 90% of the nominal voltage. The full leading reactive capability of 0.95 pf of the rated VRPP capacity shall be made available at 100% to 110% of the nominal voltage. The reactive support must be dynamic in nature for the equivalent of the rated plant (sum of VRPP) capacity, and the rest of the reactive support may be provided by automatically switched capacitors or better at the point of interconnection.

TC 9.2.4 Voltage Flicker

Voltage Flicker is the rapid change in voltage that distorts or interferes with the normal sinusoidal voltage waveform of the Transmission Network. Such interference is a product of a relatively large current inrush when Apparatus, such as a large motor, is suddenly switched on, or resulting from the sudden increased Demand from for example welding equipment.

The current inrush acting over the Network impedance results in a voltage dip (sudden fall) and/or voltage swell (sudden rise), therefore the Voltage Flicker, as well as when the Apparatus concerned is off-loaded. VRPPs are not allowed to introduce significant Voltage Flicker on the Transmission Network as measured at the Point of Interconnection. In setting and analysing Voltage Flicker limits, the appropriate standards should be applied.

TC 9.2.5 VRP Harmonic Distortion

Harmonics are waveforms that distort the fundamental 50 Hz wave. The limits, assessment, planning, testing and measurement for harmonic distortion levels are well defined and be found in a number of internationally accepted standards such as the IEEE and IEC . Table TC 9.2 gives the acceptable total harmonics distortion levels for 69 kV and 138 kV for the Transmission system

Table TC 9.2 –Total Harmonic Voltage Distortions

Voltage Level	**Acceptable Voltage Harmonic Distortion Levels**
69 kV	a Total Harmonic Distortion of 6.5% with no individual harmonic greater than 5%
138 kV and higher	a Total Harmonic Distortion of 2% with no individual harmonic greater than 1.5%

If harmonics that exceed above listed standards result from the operation of the VRPPs electrical equipment which are verified by testing, the VRPP system shall be disconnected until the harmonics are mitigated by the VRPP in accordance with the above listed standards.

In the situation where current harmonic measurements are required, the current harmonic limits shall be derived from the harmonic voltage limits in accordance with the appropriate standards.

Additionally, and in instances where several VRPPs are located in the vicinity of each other, the total harmonic contribution shall not exceed the above requirements.

TC 9.2.6 VRPP Phase Imbalance & Negative Sequence Handling

The negative sequence current control would enable the reduction or even total elimination of the negative sequence short circuit current in many modern wind turbines/solar inverters. During unbalanced faults, e.g. line-to-line fault, full negative sequence current suppression control would lead to a line-to-line short circuit current in the range of the current of the loads connected to the grid or even to zero under no load conditions. The conventional protection devices would thus have difficulty to sense and clear the fault.

In order to overcome this problem, VRPP are to be required to inject a certain level of inductive negative sequence short circuit current proportional to the negative sequence voltage. This will result not only in higher short circuit current but also in the reduction of the negative sequence voltage and thus better phase voltage symmetry.

Under normal operation, the maximum negative phase sequence component of the phase voltage of the power system should remain below 1%. A control measures can be implemented to support this requirement, while adhering to the relevant standards, should be applied.

TC 9.2.7 VRPP Data Requirements& Studies

In addition to the studies outlined in TC 4.

In addition to the studies outlined in TC 4 above and due to the intermittent nature of the VRPP, additional power system studies as outline below but not limited to should be done:

- Voltage Flicker
- Harmonic Analysis
- Phase Imbalance

TC 9.2.8 VRPP Resource Forecasts

Resource forecasts shall be provided by the VRPP. These forecasts, if required, shall be provided in a format and timescale as specified by JPS, and by means of an electronic interface in accordance with the reasonable requirements of JPS's data system.

JPS may also require, and VRPP accommodate, that forecasting be provided through one central forecasting provider of JPS choice in order to improve the quality of the forecast.

VRPPs shall engage fully with JPS to ensure that the necessary information is available to JPS for the production of wind or solar generation forecasts with the appropriate level of accuracy by JPS.

i. VRPPs shall submit their MW availability declarations whenever changes in VRPP availability occur or are predicted to occur. These declarations shall be submitted by means of an electronic interface in accordance with the reasonable requirements of JPS's data system.

TC 9.2.9 VRPP Signals, Communications and Controls

Signals from Controllable VRPP to JPS shall be provided for all the following groups, and shall be divided and provided accordingly

Signals List #1 - applies to all VRPPs and includes the following:

a) Active Power output (MW) at the lower voltage side of the Grid Connected Transformer;

b) Reactive Power output/demand (+/-MVAr) at the lower voltage side of the Grid Connected Transformer;

c) Voltage (in kV) at the lower voltage side of the Grid Connected Transformer;

On/off status indications for all Reactive Power devices that support the transmission system.

Signals List #2 - Availability Data;

Signals List #3 - Active Power Control Data;

Signals List #4 - Frequency Response System Data

Signals List #5 - Meteorological Data, applies to PV and WF;

TC 10 POWER QUALITY STANDARDS

TC 10.1 Power Quality

TC 10.1. 1 For the purpose of this Connection Code, Power Quality shall be defined as the quality of the voltage, including its frequency and the resulting current, that are measured in the Transmission System during normal conditions. The standards applicable to Power Quality are set out in the System Operator s Power Quality Policy, and JPS System Operation Policy No 2 Operational Standards of Security of Supply which shall be approved by the OUR and amended from time-to-time. For ease of reference sections of the JPS System Operation No 2 are summarised below.

TC 10.1.2 A Power Quality problem exists when at least one of the following conditions is present and significantly affects the normal operation of the System:

a. The System Frequency has deviated outside the acceptable tolerance of the nominal value of 50 –0.2 Hz

b. Voltage magnitudes are outside their allowable range of variation;
c. Harmonic Frequencies are present in the System;
d. The Magnitude of the phase voltages are unbalanced.
e. The phase displacement between the voltages is not equal to 120 degrees;
f. Voltage Fluctuations cause Flicker that is outside the allowable Flicker Severity limits; or
g. High-frequency Over-voltages are present in the Transmission System.

TC 10.2 Frequency Variations

TC 10.2.1 The frequency of the Transmission System shall be nominally 50 – 0.2 Hz and consistent with JPS System Operation Policy No 2. The System Operator may reset the target frequency based on system conditions between 49.5 Hz and 50.5 Hz.

TC 10.2.2 Under some conditions the System frequency could rise to 52.5 Hz or fall to

48.0 Hz and this shall be taken into account in the design of Plant and Apparatus.

TC 10.3 Voltage Variations

TC 10.3.1 The voltage on the Transmission System at each Connection Site with a User shall normally remain within –5% of the nominal value. The minimum voltage is -10% and the maximum voltage is +10% but voltages between +5% and +10% shall not last longer than 15 minutes unless abnormal conditions prevail.

TC 10.3.2 The voltage on the lower voltage side of transformers at Connection Sites with Users shall normally remain within the limits –5% of the nominal value unless abnormal conditions prevail.

TC 10.4 Voltage Waveform Quality

TC 10.4.1 All Plant and Apparatus connected to the Transmission System, and that part of the Transmission System at each Connection Site, should be capable of withstanding distortions as outlined in the System Operator s Power Quality Policy

TC 10.5 Exceptional Conditions

TC 10.5.1 Some events such as system faults which involve the HV network

(Transmission System) or a generating plant or faults that lead to loss of more than one generating set in the System or where a Significant Incident has occurred or during constrained operating conditions such as light load conditions and shortage of Active/Reactive power, can result in variations outside the normal power quality

standards as outlined in sections TC 10 and its sub-sections. During these events, the System Operator shall be relieved of its obligation to comply with the System conditions referenced in the aforementioned sections, subject to the approval or the OUR.

TC 11 PLANT AND APPARATUS RELATING TO CONNECTION SITES

TC 11.1 General Requirements

TC 11.1.1 All Plant and Apparatus relating to the User/System Operator at the Connection Point, shall be compliant with the conditions in TC 11 and its sub-sections

The design of connections between any Generating Unit and the Transmission System shall be as set out in Section 1 Connection Conditions of the Generation Code. The design of connections between the Transmission System and Large Customers shall be in accordance with Condition 24 of the Licence and this Code.

TC 11.2 Substation Plant and Apparatus

TC 11.2.1 All circuit breakers, switch disconnectors, Earthing Devices, power transformers, Voltage Transformers, reactors, Current Transformers, surge arresters, bushings, neutral Equipment, capacitors, line traps, coupling devices, external insulation and insulation co- ordination at the User/JPS Connection Point shall be constructed, installed and tested in accordance with the current edition at the time of construction of the following codes and standards, or their international equivalents and Prudent Utility Practice:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASCE	American Society for Civil Engineers
ASME	American Society for Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASTM	American Society for Testing Materials
AWS	American Welding Society
BSJ	Bureau of Standards Jamaica
IEC	International Electromechanical Commission
IEEE	Institute of Electrical and Electronic Engineers

ISO	International Organization for Standardization
NBCJ	National Building Code of Jamaica
NEC	National Electric Code
NEMA	National Electric Manufacturers Association
NEPA	National Environment and Planning Agency (Jamaica)
NESC	National Electric Safety Code
NETA	National Electric Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratory

TC 11.2.2 Plant and Apparatus shall be designed, manufactured and tested in premises certified in accordance with the quality assurance requirements of ISO 9001 or equivalent.

TC 11.3 Generator Interconnection Connection Points

TC 11.3.1 The requirements for the design of Connection Points between Generators and the Transmission System are set out in the Generation Code. For information the following two sections are extracted from the Generation Code.

TC 11.3.2 The voltage level at which the Generating Unit(s) are connected to the Transmission or Distribution System shall be dependent on but not limited to the size and number of units and the other factors that determine the

Connection Point. Subject to other technical considerations, Generating Units with a Rated Capacity of 10 MW or above shall be connected to the Transmission System at 69 kV or 138 kV. Generating Units with a Rated

Capacity of below 10 MW may be connected to either the Transmission System at 69 kV or 138 kV or the primary Distribution System at 24 kV or less. The chosen method of connection shall be determined by the System Operator on the grounds of System security, stability and safety.

TC 11.3.3 All Substations shall have the capability to disconnect or separate, from the Transmission System, any transmission line and/or Generating Unit which is interconnected to the Substation. For reasons of ensuring safety and reliability of

operation, generating substations with more than three transmission lines or Generating Units interconnected to them shall be of a "breaker and a half' configuration. The Substation shall be equipped with all requisite protection measures necessary to meet the System Operator's System protection standards as set out in Section 1.2.4. of the Generation Code.

TC 11.4 Connection Points to Distribution System or Large Customers

TC 11.4.1 Protection Arrangements

Protection of Distribution Systems and Large Customers directly supplied from the Transmission System must meet the minimum requirements referred to below:

TC 11.4.2 The clearance times for faults on the Transmission System or equipment directly connected to the Transmission System from fault inception to circuit breaker arc extinction, shall be set out in a Connection Agreement where applicable but shall not be slower than:

a. 100 ms for faults cleared by busbar protection at 69 kV and 138kV; and
b. 100 ms for faults cleared by ultra-high speed directional comparison protection on 69 kV and 138 kV overhead lines. Slower fault clearance times for faults may be agreed but only if System requirements permit.

TC 11.4.3 For the event of failure of the protection systems provided to meet the above fault clearance time requirements, back-up protection shall be provided by the User. The System Operator shall also provide back-up protection on the System, which shall result in a fault clearance time slower than that specified for the User back-up protection so as to provide discrimination.

TC 11.4.4 For connections with the Transmission System, the back-up protection shall be provided by the User with a fault clearance time not slower than 350ms for faults on the User Apparatus.

TC 11.4.5 Fault Disconnection Facilities

Where no System Operator circuit breaker is provided at the User Connection Point, the User must provide the System Operator with the means of tripping all the User circuit breakers necessary to isolate faults or System abnormalities on the Transmission System. In these circumstances, for faults on the User System, the User protection should also trip higher voltage System Operator circuit breakers.

TC 11.4.6 Automatic Switching Equipment

Where automatic reclosure of circuit breakers controlled or operated by the System Operator is required following faults on the User System, automatic switching equipment shall be provided as necessary.

TC 11.4.7 Relay Settings

Protection and relay settings shall be co-ordinated across the Connection Point to ensure effective disconnection of faulty Apparatus. The process for the coordination of relay settings shall be defined by the System Operator.

TC 11.4.8 Work on Protection Equipment

Where the System Operator owns the busbar at the Connection Point, no busbar protection, AC or DC wiring (other than power supplies or DC tripping associated with the Users Apparatus) shall be worked upon or altered by User personnel in the absence of a representative of the System Operator.

TC 11.4.9 Neutral Earthing

At 138 kV the higher voltage windings of three phase transformers and transformer banks connected to the Transmission System must be star connected with the star point suitable for connection to earth. The earthing and lower voltage winding arrangement shall be such as to ensure that the Earth Fault Factor requirement shall be met on the Transmission System.

TC 11.4.10 Under Frequency Relays

As required under the Operations Code, suitable arrangements shall be made to facilitate automatic low frequency disconnection of Demand. Technical requirements relating to Under Frequency Relays are listed in Appendix D.

TC 11.4.11 Configuration of Substations

All Substations shall have the capability to disconnect or separate from the Transmission System, any transmission line and/or Generating Unit which is interconnected to the Substation.

For reasons of ensuring safety and reliability of operation, Substations with more than three transmission lines or Generating Units interconnected to them shall be of a "breaker and a half' configuration. The Substation shall be equipped with all requisite protection measures necessary to meet the System Operator's System protection standards as set out in TC 11.6 and in the document Protective Relaying Philosophy and Practices issued by JPS Protection and Control Department.

TC 11.5 Protection Requirements

TC 11.5.1 The protective systems to be applied to Generating Units are set out in the Generation Code. and shall, as a minimum, have protection against the following incidents unless specifically agreed with the System Operator:

a. Loss of excitation;
b. Under excitation;
c. Unbalanced load operation;
d. Stator phase faults and earth faults;
e. Reverse power protection;
f. Main Generating Unit Step-up Transformer (GSU) phase and earth faults, HV and LV;
g. Station service transformer phase and earth faults, HV and LV;
h. Transformer tank sudden pressure;
i. Backup protection in the event that external phase and earth faults are not cleared by remote protection system;
j. Backup protection in the event of circuit breaker failure to operate;
k. Generating Unit over and under frequency;
l. Generator over speed;
m. Stator over temperature;
n. Rotor over temperature; and
o. Restricted earth fault;

TC 11.5.2 The Protective systems to be applied to the User s Equipment at the Connection Point shall be designed, coordinated, and tested to achieve the desired level of speed, sensitivity, and selectivity in fault clearing and to minimize the impact of faults on the Transmission System.

TC 11.5.3 The System Operator and the User shall be solely responsible for the protection systems of electrical equipment and facilities at their respective sides of the Connection Point.

TC 11.5.4 The Fault Clearance Time shall be specified in the Connection Agreement.

The Fault Clearance Time for a fault on the Transmission System where the User s Equipment is connected, or on the User System where the System Operator s Equipment is connected, shall not be longer than: a. 100 ms for 138 kV; and 120 ms for 69 kV.

TC 11.5.5 Where the User s Equipment is connected to the Transmission System and a circuit breaker is provided by the User (or by the System Operator) at the Connection Point to interrupt fault currents at any side of the Connection Point, a circuit breaker fail protection shall also be provided by the User (or the System Operator).

TC 11.5.6 The circuit breaker fail protection shall be designed to initiate the tripping of all the milliseconds, in the event that the primary protection System fails to interrupt the fault current within the prescribed Fault Clearance Time.

TC 11.5.7 Where the automatic reclosure of a circuit breaker is required following a fault on the User System, automatic switching Equipment shall be provided in accordance with the requirements specified in the Connection Agreement.

TC 11.5.8 The reliability of the protection scheme to initiate the successful tripping of the circuit breakers that are associated with the faulty Equipment shall be consistent with Prudent Utility Practices

TC 11.5.9 The System Operator may require specific Users to provide other protection schemes, designed and developed to maintain Grid Security, or to minimize the risk and/or impact of disturbances on the Grid.

TC 12 SITE RELATED CONDITIONS

TC 12.1 General

TC 12.1.1 In the absence of agreement between the parties to the contrary, construction, commissioning, control, operation and maintenance responsibilities for the Plant and/or Apparatus follow ownership.

TC 12.2 Responsibilities For Safety

TC 12.2.1 Before connection to the Transmission System the System Operator and the User shall enter into a written agreement as to the Safety Rules to be used for work on Plant and/or Apparatus at the Connection Point.

TC 12.3 Site Responsibility Schedules

TC 12.3.1 In order to inform site operational staff and the System Operator s Control Engineers of agreed responsibilities for Plant and/or Apparatus at the Operational Interface, a Site Responsibility Schedule shall be produced for System Operator and Users with whom they interface.

TC 12.3.2 The format, principles and basic procedure to be used in the preparation of Site Responsibility Schedules are set down in Appendix A.

TC 12.4 Operation Diagrams

TC 12.4.1 An Operation Diagram shall be prepared by the User for each Connection Site at which a Connection Point exists in accordance with Appendix B.

TC 12.4.2 The Operation Diagram shall include all HV Apparatus and the connections to all external circuits and incorporate numbering, nomenclature and labelling, as set out in the Operations Code. At those Connection Sites where SF6 gas-insulated metal enclosed switchgear and/or other SF6 gas-insulated HV Apparatus is installed, those items must be depicted within an area delineated by a chain dotted line which intersects SF6 gas-zone

boundaries. The nomenclature used shall conform with that used on the relevant Connection Site and circuit.

TC 12.4.3 The Operation Diagram (and the list of technical details) is intended to provide an accurate record of the layout and circuit interconnections, ratings and numbering and nomenclature of HV Apparatus and related Plant.

TC 12.5 SF6 Gas Zone Diagrams

TC 12.5.1 An SF6 Gas Zone Diagram shall be prepared for each Connection Site at which a Connection Point exists where SF6 gas-insulated switchgear and/or other SF6 gas-insulated HV Apparatus is utilised. They shall use, where appropriate, the graphical symbols shown in Appendix B. The nomenclature used shall conform with that used in the relevant Connection Site and circuit.

TC 12.6 Preparation of Operation and SF6 Gas Zone Diagrams

TC 12.6.1 Each party shall provide to the other Party an Operation Diagram and details of the SF6 Gas Zones on its side of the Connection Point. The Party owning the Connection Site is then responsible for the preparation of a composite Operation Diagram and SF6 Gas Zone diagrams for the site.

TC 12.7 Changes to Operation and SF6 Gas Zone Diagrams

TC 12.7.1 When either Party has decided that it wishes to install new HV Apparatus or it wishes to change the existing numbering or nomenclature of its HV Apparatus at a Connection Point it shall one month prior to the installation or change, send to the other Party a revised Operation Diagram of that Site, incorporating the new HV Apparatus to be installed and its numbering and nomenclature or the changes, as the case may be.

TC 12.8 Validity

TC 12.8.1 The composite Operation Diagram prepared by the System Operator or the User shall be the definitive Operation Diagram for all operational and planning activities associated with the Connection Site. If a Dispute arises as to the accuracy of the composite Operation Diagram, a meeting shall be held at the Connection Site, as soon as reasonably practicable, between System Operator and the User, to endeavour to resolve the matters in dispute.

TC 12.9 Site Common Drawings

TC 12.9.1 Site Common Drawings shall be prepared for each Connection Site and shall include Connection Site layout drawings, electrical layout drawings, common protection/control drawings and common services drawings.

TC 12.9.2 In the case of a User Connection Site, the System Operator shall prepare and submit to the User, Site Common Drawings for the System Operator side of the Connection Point in accordance with the requirements of the Connection Agreement.

TC 12.9.3 The User shall then prepare, produce and distribute, using the information submitted by the System Operator Site Common Drawings for the complete Connection Site in accordance with the requirements of the Connection Agreement.

TC 12.9.4 In the case of a System Operator Site, the User shall prepare and submit to the System Operator Site Common Drawings for the User side of the Connection Point in accordance with the requirements of the Connection Agreement.

TC 12.9.5 The System Operator shall then prepare, produce and distribute, using the information submitted by the User, Site Common Drawings for the complete Connection Site in accordance with the requirements of the Connection Agreement.

TC 12.10 Changes to Site Common Drawings

TC 12.10.1 When the System Operator or a User becomes aware that it is necessary to change any aspect of the Site Common Drawings at a Connection Site it shall notify the other Party and amend the common site drawings in accordance with the procedure set out in TCC 5.9

TC 12.10.2 If the change can be dealt with by notifying the other Party in writing of the change and for each party to amend its copy of the Site Common Drawings then each party shall so amend.

TTC 12.11 Validity of Site Common Drawings

TC 12.11.1 The Site Common Drawings for the complete Connection Site prepared by the User or the System Operator as the case may be, shall be the definitive Site Common Drawings for all operational and planning activities associated with the Connection Site. If a Dispute arises as to the accuracy of the Site Common Drawings, a meeting shall be held at the Site, as soon as reasonably practicable, between the System Operator and the User, to endeavour to resolve the matters in dispute.

TC 12.12 Access

TC 12.12.1 The provisions relating to access to System Operator Sites by Users, and to User Sites by the System Operator shall be set out in each Connection Agreement with the System Operator and each User.

TC 12.12.2 In addition to those provisions, where a System Operator Site contains exposed HV conductors, unaccompanied access shall only be granted to individuals holding an Authority for Access issued by the System Operator.

TC 12.13 Maintenance Standards

TC 12.13.1 All Plant and Apparatus at the Connection Point shall be operated and maintained in accordance with Prudent Utility Practice and in a manner that shall not pose a threat to the safety of any personnel or cause damage to the Plant and Apparatus of the System Operator or the User.

TC 12.13.2 The User shall maintain a log containing the test results and maintenance records relating to its Plant and Apparatus at the Connection Point and shall make this log available when requested by the System Operator.

TC 12.13.3 The System Operator shall maintain a log containing the test results and maintenance records relating to its Plant and Apparatus at the Connection

Point and shall make this log available when requested by the User.

TC 12.14 Site Operational Procedures

TC 12.14.1 The System Operator and Users at a Connection Point shall make available staff to take necessary Safety Precautions and carry out operational duties as may be required to enable work/testing to be carried out and for the Operation of Plant Connected to the Transmission System.

TC 13 COMMUNICATIONS AND CONTROL

TC 13.1.1 In order to ensure control of the Transmission System, telecommunications between Users and the System Operator must be established if required by the System Operator.

TC 13.1.2 Control Telephony is the method by which a User Responsible

Engineer/Operator and the System Operator s Control Engineers speak to one another for the purposes of control of the Transmission System in both normal and emergency operating conditions.

TC 13.1.3 At any Connection Point where the User telephony equipment is not capable of providing the required facilities or is otherwise incompatible with the System Operator s control telephony, the User shall install appropriate telephony equipment to the specification of the System Operator. Details of and relating to the control telephony required shall be set out in the Connection Agreement.

TC 13.1.4 The System Operator shall provide Supervisory Control and Data Acquisition (SCADA) outstation interface equipment. The User shall provide such voltage, current, frequency, Active Power and Reactive Power measurement outputs and plant status indications and alarms to the System Operator SCADA outstation interface equipment as required by the System Operator in accordance with the terms of the Connection Agreement. The manner in which information is required to be presented to the outstation equipment is set out in Appendix C.

APPENDIX A

SITE RESPONSIBILITY SCHEDULES

TC APPENDIX A - SITE RESPONSIBILITY SCHEDULES

At all Connection Sites the following Site Responsibility Schedules shall be drawn up using the pro-forma attached or with such variations as may be agreed between the System Operator and Users, and in the absence of agreement the pro-forma attached shall be used: i) Schedule of HV Apparatus ii) Schedule of Plant, LV Apparatus, services and supplies; iii) Schedule of telecommunications and measurements Apparatus.

Other than at Generating Unit and Power Station locations, the schedules referred to in (ii) and (iii) above may be combined.

Each Site Responsibility Schedule for a Connection Site shall be prepared by the System Operator in consultation with other Users at least 2 weeks prior to the Completion Date under the Connection Agreement for that Connection Site. Each User shall, in accordance with the timing requirements of the Connection Agreement, provide information to the System Operator to enable it to prepare the Site Responsibility Schedule.

Each Site Responsibility Schedule shall detail for each item of Plant and Apparatus;

i. Item of Equipment Using the agreed Numbering and Nomenclature in accordance with TC 15.
ii. Equipment Owner This identifies the party that owns the Equipment under common law;
iii. Safety Rules This identifies whether the System Operator s or User s Safety Rules shall be applied to the Equipment.
iv. Operational Procedures This identifies whether System Operator or Users personnel shall be responsible for Operations on the Equipment. Note that if this is System Operator, it does not preclude the System Operator from authorising Users personnel from acting on it behalf and vice versa.
v. Control Responsibility This identifies whether the System Control used shall be the System Operators or the Users.
vi. Maintenance Responsibility This identifies whether the System Operator or the User is responsible for the inspection and maintenance of the Equipment.

vii. Access and Security This identifies whether the System Operator or the User shall be responsible for the establishment and maintenance of perimeter fencing and any manned access security for the protection of the public and to prevent malicious entry. Access to operational areas of the site shall be restricted to persons duly authorised in accordance with the prevailing Safety Rules.

The HV Apparatus Site Responsibility Schedule for each Connection Site must include lines and cables emanating from the Connection Site.

Every page of each Site Responsibility Schedule shall bear the date of issue and the issue number.

When a Site Responsibility Schedule is prepared it shall be sent by System Operator to the Users involved for confirmation of its accuracy.

The Site Responsibility Schedule shall then be signed on behalf of System Operator by the Manager responsible for the area in which the Connection Site is situated and on behalf of each User involved by its Responsible Manager, by way of written confirmation of its accuracy. Once signed, two copies shall be distributed by System Operator, not less than two weeks prior to its implementation date, to each User which is a party on the Site

Responsibility Schedule, accompanied by a note indicating the issue number and the date of implementation.

Attachment to Appendix A: PRO FORMA for SITE RESPONSIBILITY SCHEDULE

COMPANY ..

CONNECTION SITE

Item of Equipment	Equipment Owner	Safety Rules	Operational Procedures	Control Responsibility	Maintenance Responsibility	Access and Security	Comments

Signed on behalf of the System Operator Date ..

Signed on behalf of the User

APPENDIX B

PROCEDURES RELATING TO OPERATION DIAGRAMS

TC APPENDIX B - PROCEDURES RELATING TO OPERATION DIAGRAMS

Basic Principles

a. Where practicable, all the HV Apparatus on any Connection Site shall be shown on one Operation Diagram. Provided the clarity of the diagram is not impaired, the layout shall represent as closely as possible the geographical arrangement on the Connection Site.

b. Where more than one Operation Diagram is unavoidable, duplication of identical information on more than one Operation Diagram must be avoided.

c. The Operation Diagram must show accurately the current status of the Apparatus, e.g. whether commissioned or decommissioned. Where decommissioned, the associated switchbay shall be labelled "spare bay".

d. Provision shall be made on the Operation Diagram for signifying approvals, together with provision for details of revisions and dates.

Apparatus to be shown on Ownership Diagrams

1. Busbars
2. Circuit Breakers
3. Disconnector (Isolator) and Switch Disconnectors (Switching Isolators)
4. Disconnectors (Isolators) - Automatic Facilities
5. Bypass Facilities
6. Earthing Switches
7. Maintenance Earths
8. Overhead Line Entries
9. Overhead Line Traps
10. Cable and Cable Sealing Ends
11. Generating Unit
12. Generator Transformers
13. Generating Unit Transformers, Station Transformers, including the lower voltage circuit-breakers

14. Synchronous Compensators
15. Static Var Compensators
16. Capacitors (including Harmonic Filters)
17. Series or Shunt Reactors
18. Grid Transformers
19. Tertiary Windings
20. Earthing and Auxiliary Transformers
21. Three Phase VTs
22. Single Phase VT & Phase Identity
23. High Accuracy VT and Phase Identity
24. Surge Arrestors/Diverters
25. Neutral Earthing Arrangements on HV Plant
26. Fault Throwing Devices
27. Quadrature Boosters
28. Arc Suppression Coils
29. Current Transformers (where separate Plant items)
30. Wall Bushings

Use of Approved Graphical Symbols

All graphical symbols to be used in the Operation Diagrams shall be approved by the System Operator.

APPENDIX C

SCADA INTERFACING

TCC APPENDIX C- SCADA INTERFACING

This Appendix sets out the technical requirements for connections to the System Operator s Supervisory Control and Data Acquisition system outstation in terms of electrical characteristics.

GENERAL REQUIREMENTS

In all cases signals shall be arranged such that the level of electrical interference does not exceed those defined in IEC 870-2-1: "Telecontrol Equipment and Systems - Operating Conditions - Power Supply and Electromagnetic Compatibility" and IEC870-3: "Telecontrol Equipment and Systems - Specification for Interfaces (Electrical Characteristics)".

Digital Inputs

Digital inputs cover both single and double points for connection to digital input modules on the System Operators outstation equipment. The Equipment contacts shall be free of potential, whereas the input circuitry of the outstation are common to the negative 48 volt potential.

Single Points

Single point inputs must be used for alarms and where single contact indications are available. The off (contact open or 0) state is considered to be the normal state and the on (contact closed or 1) state the alarm condition.

Double Points

Double points are used to indicate primary plant states by the use of complementary inputs for each plant item. Only the "10" and "01" states are considered valid with the "00" and "11" states considered invalid. The "10" state is considered to be the normal or closed state.

Energy Meter Inputs

Energy meter input pulses for connection to pulse counting input modules on the System Operator s outstation equipment must operate for a minimum of 100ms to indicate a predetermined flow of MWh or MVArh. The contact must open again for a minimum of 100ms. The normal state of the input must be open.

Analogue Inputs

Analogue inputs for connection to analogue input modules on the System Operator s outstation equipment must all be electrically isolated with a two wire connection required. Signals shall be in the form of 4-20mA (or other range to be agreed between the User and the System Operator) for both unidirectional and bi-directional measured values. Signal converters shall be provided as necessary to produce the correct input signals.

Command Outputs

All command outputs for connection to command output modules on the System Operator s outstation equipment switch both the 0 volts and -48 volts for a period of 2.5 seconds at a maximum current of 1 amp. All outputs shall electrically isolated with a two wire connection to control interposing relays on the plant to be operated.

APPENDIX D

TECHNICAL REQUIREMENTS FOR UNDER FREQUENCY RELAYS

TCC APPENDIX D - TECHNICAL REQUIREMENTS FOR UNDER FREQUENCY RELAYS

The Connection Agreement shall specify the manner in which Demand at the User s Site, subject to Automatic Load Disconnection (separate from the System Operator s under frequency load shedding scheme), shall be actuated by Under-frequency Relays.

[1] Under Frequency Relays shall have a frequency setting range of 46.0 to 52.0Hz and be suitable for operation from a nominal AC input of 63.5, 110 or 240V.

[2] The following general parameters on the requirements of approved Frequency Relays for automatic installations is given as an indication to the provisions that may be included in a Connection Agreement:

a. Frequency settings: 46-52Hz in steps of 0.01Hz;
b. Measurement period: Within a minimum selectable settings range of 3 to 7 cycles;
c. Operating time: Between 100 and 160ms dependent on measurement period setting;
d. Voltage lock-out: 20 to 90% of nominal voltage;
e. Facility stages: Four stages of frequency operation;
f. Output contacts: Two output contacts per stage.

[3] The voltage supply to the Under Frequency Relays shall be derived from the Transmission System at the supply point concerned so that the frequency of the Under Frequency Relays input voltage is the same as that of the primary System. This requires either:

a. the use of a secure supply obtained from voltage transformers directly associated with the Transmission System interconnection transformer(s) concerned, the supply being obtained where necessary via a suitable automatic voltage selection scheme; or

b. the use of the substation 110V phase-to-neutral selected auxiliary supply, provided that this supply is always derived at the Connection Point concerned and is never derived from a standby generator or from another part of the User System.

[4] The tripping facility should be engineered in accordance with the following reliability considerations:

a. Dependability: Failure to trip at any one particular demand shedding point shall not harm the overall operation of the scheme. However, many failures would have the effect of reducing the amount of Demand under low frequency control. An overall reasonable minimum requirement for the dependability of the Demand shedding scheme is 96%, i.e. the average probability of failure of each Demand shedding point should be less than 4%. Thus the Demand under low Frequency control shall not be reduced by more than 4% due to relay failure.

b. Outages: Low frequency Demand shedding schemes shall be engineered such that the amount of Demand under control is as specified by the System Operator and is not reduced unacceptably during equipment outage or maintenance conditions.

TC 14 NUMBERING AND NOMENCLATURE OF HV APPARATUS

TC 14.1 Introduction

TC 14.1.1 This Section sets out the requirement that:

a. Transmission Apparatus on Users' Sites ; and
b. User Apparatus on Transmission Sites ;

shall have numbering and nomenclature in accordance with the System used from time to time by the System Operator.

TC 14.1.2 The numbering and nomenclature of each item of Apparatus shall be included in the Operation Diagram prepared for each Connection Site. Further provisions on Operation Diagrams are contained in the Connection Code.

TC 14.1.3 The term Apparatus includes any associated SF6 Gas Equipment

TC 14.2 Objective

TC 14.2.1 The overall objective is to ensure, so far as possible, the safe and effective operation of the Total System and to reduce the risk of human error by requiring, in certain circumstances, that the numbering and nomenclature of User's Apparatus shall be in accordance with the system used from time to time by the System Operator.

TC 14.3 Transmission Apparatus on Users' Sites

TC 14.3.1 Transmission Apparatus on Users' Sites shall have numbering and nomenclature in accordance with the system used from time to time by the System Operator.

TC 14.3.2 When the System Operator is to install its Apparatus on a User's Site , the System Operator shall notify the relevant User of the numbering and nomenclature to be adopted for that Apparatus at least eight months prior to proposed installation.

TC 14.3.3 The notification shall be made in writing to the relevant User and shall consist of both a proposed Operation Diagram incorporating the proposed Transmission Apparatus to be installed, its proposed numbering and nomenclature, and the date of its proposed installation.

TC 14.3.4 The relevant User shall respond in writing to the System Operator within one month of the receipt of the notification, confirming receipt and confirming either that any other Apparatus of the relevant User on such User Site does not have numbering and/ or nomenclature which could be confused with that proposed by the System Operator, or, to the extent that it does, that the relevant other numbering and/ or nomenclature shall be changed before installation of the Transmission Apparatus.

TC 14.3.5 The relevant User shall not install, or permit the installation of, any Apparatus on such User Site which has numbering and/ or nomenclature which could be confused with Transmission Apparatus which the System Operator has advised the User to be installed on that User Site or is already on that User Site shall.

TC 14.4 User Apparatus on Transmission Sites

TC 14.4.1 User Apparatus on Transmission Sites shall have numbering and nomenclature in accordance with the system used from time to time by the System Operator.

TC 14.4.2 When a User is to install its Apparatus on a Transmission Site, or it wishes to replace existing Apparatus on a Transmission Site and it wishes to adopt new numbering and nomenclature for such Apparatus, the User shall notify the System Operator of the details of the Apparatus and the proposed numbering and nomenclature to be adopted for that Apparatus, at least eight months prior to proposed installation.

TC 14.4.3 The notification shall be made in writing to the System Operator and shall consist of both a proposed Operation Diagram incorporating the proposed new Apparatus of the User to be installed, its proposed numbering and nomenclature, and the date of its proposed installation.

TC 14.4.4 The System Operator shall respond in writing to the User within one month of the receipt of the notification stating whether or not the System Operator accepts the User's proposed numbering and nomenclature and, if they are not acceptable, it shall give details of the numbering and nomenclature which the User shall adopt for that Apparatus.

TC 14.5 Changes

TC 14.5.1 Where the System Operator in its reasonable opinion has decided that it needs to change the existing numbering or nomenclature of Transmission Apparatus on a User Site or of User Apparatus on a Transmission Site :

a. The provisions of paragraph TC 14.4 shall apply to such change of numbering or nomenclature of Transmission Apparatus with any necessary amendments to those provisions to reflect that only a change is being made; and

b. in the case of a change in the numbering or nomenclature of User Apparatus on a Transmission Site, the System Operator shall notify the User of the numbering and/ or nomenclature the User shall adopt for that Apparatus (the notification to be in a form similar to that envisaged under TOC10.4) at least eight months prior to the change being needed and the User shall respond in writing to the System Operator within one month of the receipt of the notification, confirming receipt.

In either case the notification shall indicate the reason for the proposed change

TC 14.5.2 Users shall be provided upon request with details of the System Operator's then current numbering and nomenclature system in order to assist them in planning the numbering and nomenclature for their Apparatus on Transmission Sites.

TC 14.5.3 When a User installs Apparatus in accordance with TC 14, the User shall be responsible for the provision and erection of clear and unambiguous labelling showing the numbering and nomenclature.

Where a User is required by TC 14 to change the numbering and/ or nomenclature of Apparatus, the User shall be responsible for the provision and erection of clear and unambiguous labelling by the required date.

TC 14.5.4 When the System Operator installs Apparatus which is the subject of TC 14, the System Operator shall be responsible for the provision and erection of a clear and unambiguous labelling showing the numbering and nomenclature. Where the System Operator changes the numbering and / or nomenclature of Apparatus which is the subject of TC 14, the System Operator shall be responsible for the provision and erection of clear and unambiguous labelling showing the numbering and nomenclature by the required date.

TC 15. TESTING, MONITORING AND INVESTIGATION

TC 15.1 Introduction

TC 15.1.1 TC 15 sets out the authorization required and the procedures to be followed by the System Operator, and Users wishing to conduct Operational Tests or Site Investigations involving Plant and Apparatus connected to or part of the Transmission System.

TC 15.1.2 The Code stipulates that prior authorisation from the System Operator is required before conducting Operational Tests or Site Investigations.

TC 15.2 Objective

TC 15.2.1 The objectives are to ensure that Operational Tests and Site Investigations;

a. are authorized by the System Operator and are carried out in accordance with appropriate procedures;
b. are carried out in a coordinated manner to avoid unnecessary risk or damage to Plant and to minimise costs to the System Operator and affected Users;
c. do not threaten the safety of personnel or the general public;
d. do not threaten the security or stability of the Transmission System; and
e. are properly evaluated on completion and, where appropriate, subject to predefined reporting arrangements.

TC 15.2.2 A further objective is to allow sufficient tests to be conducted to enable predictive fault finding.

TC 15.3 Categories of tests

TC 15.3.1 This Code covers the following categories of test:

a. Operational tests to commission or test the compliance of Generating Units with the requirements of a Power Purchase Agreement or for other purposes specified in the Generation Code.
b. Site Investigation tests in relation to Plant, Apparatus and operational procedures at Generator and User sites.
c. Other tests required, in certain circumstances, whether by means of a formal test or verification by inspection, to ascertain whether Operating Parameters and/or the Connection Code are being complied with in respect of the User s Plant and Apparatus.

TC 15.4 Authorisation and test procedures

TC 15.4.1 Prior authorisation from the System Operator is required before conducting an Operational Test, Site Investigation or other test.

TC 15.4.2 Users seeking to conduct an Operational Test or Site Investigation shall submit a Test Request to the System Operator giving at least 8 weeks minimum notice before the date of the proposed test. A Test Request shall include a detailed test proposal including:

a. a brief description of the proposed test;
b. the preferred time or times for the test and the potential duration;
c. the reason for the proposed test indicating whether the test is required for compliance with Licence conditions, statutory regulations or Safety Rules. This shall assist in determining the priority to be given to the test;
d. an indication of any potential adverse effects if the Test is cancelled at short notice or delayed; and

e. an indication of any Dispatch Instructions or operational switching required to facilitate the test.

TC 15.4.4 The System Operator shall consider the following factors when evaluating a Test Request:

a. The impact of the requested test on Transmission System stability and security;
b. the impact of the requested test on Transmission System economics;
c. the impact of the requested test on other Users; and
d. the effect of the requested test on the continuity and quality of electricity Supply.

TC 15.4.5 If the System Operator approves a Test Request, it shall inform the test proposer accordingly in writing.

TC 15.4.6 If the System Operator requests additional information from the test proposer to evaluate the impact of a Test Request the System Operator shall stipulate the time within which the information shall be provided. If the information is not provided in the timescale indicated by System Operator the Test Request shall automatically lapse.

TC 15.4.7 If the System Operator does not approve a Test Request, it shall set out its reasons for rejecting the application and consult with the Test proposer on any changes to the Test proposal required to secure approval for the Test. The Test proposer may update a Test proposal in accordance with guidance provided by the System Operator and submit a revised Test Request.

TC 15.4.8 The System Operator shall not withhold approval of a Test Request unless it considers it has reasonable grounds for doing so. If a User is not satisfied that a Test Request was rejected on reasonable grounds it can refer the matter to the OUR for determination.

TC 15.4.9 The System Operator shall not disclose any information received as part of a Test Request application without the consent of the User who submitted the Test Request if it reasonably believes the information to be commercially sensitive or otherwise potentially sensitive.

TC 15.5 Test Panel

TC 15.5.1 If a Test Request is approved, the System Operator shall decide if a Test Panel is required. If the System Operator decides that a Test Panel is required, the test proposer shall convene a Test Panel, subject to the approval of the System Operator.. The number of Test Panel members shall be kept to the minimum number of persons compatible with affected User representation.

TC 15.5.2 The Chairman of a Test Panel shall be appointed by the System Operator. . The System Operator and all directly affected Users shall be represented on the Test Panel.

TC 15.5.3 The duties and responsibilities of the Test Panel are as follows:

a. to prepare a detailed programme for the conduct of the test, including the start and end date of the test, and any Dispatch

requirements and operational switching required to facilitate the test;

b. to identify the detailed management requirements of the test;
c. to ensure that all affected parties are properly informed of and have access to all relevant information;
d. to schedule the resources required to conduct the test; and
e. to prepare a Test Document that shall include all the elements listed above.

TC 15.5.4 The Test Document shall be copied to all members of the Test Panel at least 2 weeks before the start date of the test. Members of the Test Panel may provide comments on the Test Document to the Chairman of the Test Panel no later than 1 week before the scheduled start date of the Test.

TC 15.5.5 The test shall proceed only on the condition that the Test Panel has approved the Test Document. If a member of the Test Panel is not satisfied with the test proceeding and they have fully discussed the issues within the Test Panel, they may make representation to the OUR.

TC 15.5.6 The System Operator shall not disclose information provided to a Test Panel without the consent of the person who submitted the information if it reasonably believes the information to be commercially sensitive or otherwise potentially sensitive.

TC 15.6 Post test reporting requirements

TC 15.6.1 At the conclusion of an Operational Test or Site Investigation the test proposer shall prepare a written report on the test that shall be available within 4 weeks of the conclusion of the Operational Test. The report shall be copied to the System Operator and the OUR.

TC 15.6.2 The Test Report shall not be submitted to any other person who is not a representative of the System Operator or the test proposer unless the System Operator and the test proposer having reasonably considered the confidentiality issues arising, and shall have unanimously approved such submission.

TC 15.6.3 The Test Report shall include a detailed description of the completed Test, the Plant or Apparatus to which the Test relates, together with the results, conclusions and recommendations as they relate to the Test proposer, System Operator and all Users operationally affected by the Test, where applicable.

TC 15.6.4 The Test Panel shall be disbanded after the final test report has been approved

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TC 15.7 Operational tests

TC 15.7.1 The System Operator shall cooperate with the implementation of all Operational Tests.

TC 15.7.2 Where the System Operator considers the impact of an Operational Test to be significantly greater than originally estimated, the System Operator may at any time contact the Test proposer to discuss a revised Test procedure or schedule.

TC 15.7.3 The System Operator shall, where it considers it necessary to do so, cancel, interrupt, or postpone an Operational Test at any time.

TC 15.7.4 If the Test proposer wishes to cancel an Operational Test before commencement of the Test or during the Test, the Test proposer must notify the System Operator immediately and the notice must be confirmed in writing within 1 hour by facsimile or other electronic means.

TC 15.8 Operational tests required by the System Operator

TC 15.8.1 The System Operator may from time to time need to conduct Operational Tests in order to maintain and develop operational procedures, to train staff, and to acquire information in respect of Transmission System behaviour under abnormal System conditions.

TC 15.8.2 The System Operator shall endeavour to keep the frequency of occurrence, scope, and impact of Operational Tests to the minimum necessary.

TC 15.8.3 Where the System Operator intends to carry out an Operational Test and in the System Operator s reasonable opinion, such a test will or may have an Operational Effect on a User s System, the System Operator shall give [8] weeks notice and provide sufficient information to the affected Users to enable the affected Users to assess any risks to their Systems.

TC 15.8.4 The information provided by System Operator shall include;

a. a brief description of the Operational Test;
b. the probable effects of the Operational Test; and
c. the scheduled time and duration of the Operational Test.

TC 15.8.5 Affected Users may contact the System Operator to request additional time or information to consider the impact of the Operational Test on their Systems and shall respond to the System Operator within 2 weeks of receipt of the System Operator s notice of the test.

TC 15.9 Operational tests required by Users

TC 15.9.1 Operation of Users Plant and Apparatus in accordance with Prudent Utility Practice requires testing to maintain and develop operational procedures, develop and measure

Plant performance, comply with statutory or other industry obligations and contracts, and to train staff.

TC 15.9.2 Each User shall endeavour to limit the frequency of occurrence of Operational Tests and to limit the effects of such Operational Tests on the Transmission System.

TC 15.9.3 Users shall submit a Test Request to the System Operator in accordance with the requirements of TC 15.5

TC 15.10 Operational tests of Generating Units

TC 15.10.1 The procedure to be adopted for the Operational testing of Generating Units is set out in the Generation Code and summarised below:

TC 15.10.2 The Generator shall provide to the System Operator a timetable and list of all tests to be performed on the Generating Units, and such tests shall be subject to approval by the System Operator. The System Operator shall be given five (5) days notice of any testing and shall reserve the right to have a representative present during any such tests.

TC 15.10.3 Testing and monitoring of Generating Units is generally performed for the purpose of determining available Capacity and, if relevant, operating characteristics in accordance with the commercial and technical conditions of Power Purchase Agreements.

TC 15.10.4 Prior to the Synchronization of each new Generating Unit, the Generator shall carry out a number of tests as set out in the Generation Code. These tests cover such aspects as Automatic Voltage Regulator Setting, governor control checks, open and short circuit tests etc.

TC 15.10.5 After the Pre-Synchronization tests as defined in TC 15.10.4 and prior to the commissioning date, and under such subsequent conditions as defined by Power Purchase Agreements, Generator shall carry out the following tests:

i. Dependable Capacity
ii. Reliability Run
iii. Automatic Voltage Regulator (AVR) Droop
iv. Governor Operation
v. Reactive Capacity
vi. Short-term Load Capability
vii. Response of Unit to Step Load Changes
viii. Full Load Rejection
ix. Thermal Performance Tests

TC 15.10.6 Fully detailed requirements for Generator Testing are set out in Section 6 Testing and Monitoring of the Generation Code.

TC 15.11 Other operational tests

TC 15.11.1 Any Operational Test proposal accompanying a Test Request shall indicate whether Dispatch Instructions and operational switching instructions are required to facilitate the test.

TC 15.11.2 The System Operator shall, subject to any amendments it may require to be made, incorporate the Dispatch Instructions and operational switching instructions required to facilitate the test..

TC 15.11.3 The System Operator shall issue Dispatch Instructions for Operational Tests in accordance with the procedures set out in the Generation Code.

TC 15.11.4 In accordance with the Generation Code the Generator shall provide to the System Operator a timetable and list of all tests to be performed on the Generating Units, and such tests shall be subject to approval by the Grid Operator. The System Operator shall be given five (5) days notice of any testing and shall reserve the right to have a representative present during any such tests.

TC 15.11.5 The System Operator shall inform other Users of the scheduled time and nature of the test, if in the opinion of System Operator those Users will or may be affected by the test.

TC 15.11.6 The Operational Test shall proceed in accordance with normal operational practices but with particularly close communication between the system control engineer and the person responsible for the execution of the Test . Where the Operational Test is complex or time consuming, the System Operator shall provide additional support at the System Control Centre, if necessary.

TC 15.12 Site Investigation tests

TC 15.12.1 The System Operator may, if it reasonably considers that there may be an issue of non-compliance with an agreement by the User, carry out a Site Investigation to acquire or verify information relevant to Users Plant and/or

Apparatus design, Operation or Connection requirements under the Transmission Code, Connection Agreements and other agreements between Users and the System Operator.

TC 15.12.2 The System Operator may, having given reasonable notice, send a representative or agent to a User s site in order to investigate any equipment or operational procedure applicable to the User site insofar as the condition of that equipment or operational procedure is relevant to compliance with a the Transmission Code, a Connection Agreement, or other relevant agreements.

TC 15.13 Other tests

TC 15.13.1 The System Operator can, at any time, request a test. Where an Agreement exists (with appropriate test procedures) these shall form the basis of the test.

TC 15.13.2 Testing, including tests carried out under any relevant agreement may involve attendance by the System Operator or their representatives at User sites in order to carry out or observe such tests.

TC 15.13.3 Where required, a test shall be carried out in accordance with Dispatch

Instructions and operational switching instructions issued by the System Operator or by such alternative procedures as is required or permitted by the Transmission Code.

TC 15.13.4 Where a test is required at short notice, the System Operator shall use reasonable endeavours to accommodate the test in the requested timescale provided that in the System Operator s reasonable opinion the test would not compromise the security and stability of the Total System, or pose a risk to the safe and secure operation of Plant, or compromise the safety of related personnel and the general public.

APPENDIX A

FORM OF SIGNIFICANT INCIDENT REPORT

[1] Time and date of Significant Incident;
[2] Location;
[3] Pant or Apparatus directly involved (not merely affected by the Incident) including numbers and nomenclature;
[4] Description of Significant Incident including probable causes and any damage to Plant or Apparatus;
[5] Demand in MW and/or Generator output in MW interrupted and duration of interruption;
[6] Generator change in availability;
[7] Generator Frequency response (MW correction versus time achieved subsequent to the Significant Incident);
[8] Generator Mvar performance (change in output subsequent to the Significant Incident);
[9] Estimated or actual time and date of return to service and/or return to preIncident availability; and
[10] Any other relevant material.

TC 16 TRANSMISSION METERING

TC 16.1 Purpose

TC 16.1.1 This Chapter of the Transmission Code sets out the way in which power and energy flows shall be measured at an Operational Interface.

TC 16.1.2 The Metering Code is required to establish the requirements for metering the Active and Reactive Energy and Demand from its entry to the Transmission System to its exit to the Distribution System and Large Customers.

TC 16.1.3 The Code also sets out appropriate procedures for meter reading; and

TC 16.1.4 Ensures that procedures are in place to manage disputed readings.

TC 16.2 Scope

TC 16.2.1 This Chapter applies to:

a. The System Operator

a. Large Customers
b. Generators

TC 16.2.2 The requirements for the metering of Generators are set out in the Generation Code. An outline of the requirements is set out in TC 1

TC 16.2.3 For Large Customers the metering requirements follow those of a User connected to the Distribution System as set out in the Distribution Code. An outline of these requirements is set out in TC 19.

TC 17 METERING REQUIREMENTS - GENERATORS

TC 17.1 Adequate Metering Systems consistent with the technical specifications of this clause shall be installed by the Generator. The Metering System shall comprise a Primary and Backup Metering System and shall be designed, financed and installed by the Generator. The System Operator shall own and maintain the Primary Metering System while the Generator shall own and maintain the Backup Metering System

TC 17.2 Overall Accuracy

TC 17.2.1 The overall accuracy of Generator metering is to be designed to give a tolerance of +/- 0.5% on an ongoing basis.

TC 17.3 Relevant Metering Policies, Standards and Specifications

TC 17.3.1 Both Primary and Backup Metering Systems shall be installed to accumulate the outputs and/or inputs at the High Voltage side bushing of the Generating Unit step up transformer.

TC 17.3.2 The System Operator shall own and maintain the Primary Metering System while the Generator shall own and maintain the Backup Metering System.

TC 17.3.3 Each meter shall have its own Current Transformer (CT) and Voltage Transformer (VT) and necessary independent systems to function effectively.

TC 17.3.4 Instrument transformers shall conform to ANSI Standard C12.11 and C57.14 Class 03 and shall have sufficient capacity to handle the attached equipment. The ANSI standards refer to the physical characteristics of meters and the procedures and practices related to type and pattern approval. The detailed use of these standards in the testing of meters are set out in the OUR document Meter Testing Administrative Protocol which is attached at Appendix B.

TC 17.3.5 The Current Transformers secondary winding used for metering purposes shall supply only the metering equipment and associated systems. Notwithstanding the foregoing each Current Transformer may have other secondary windings that may be used for purposes other than metering.

TC 17.3.6 Potential transformers' secondary windings may be used for metering and other purposes provided that the total loading does not exceed one half burden of the rating of the transformer.

TC 17.4 Parameters for Meter Reading

TC 17.4.1 The Generator shall provide and install meters equal or equivalent to the specification provided by the System Operator and shall make a continuous recording on appropriate magnetic media or equivalent of the Net Energy Output of the Generating Unit(s).

TC 17.4.2 The parameters to be metered shall be subject to the Interconnection Agreement between the Generator and the System Operator, and may consist of but are not limited to any or all of the following parameters:

a. Active Energy (Wh) OUT;
b. Active Energy (Wh) IN;
c. Reactive Energy (VARh) First Quadrant;
d. Reactive Energy (VARh) Fourth Quadrant;
e. Active Power Demand (W) OUT;
f. Active Power Demand (W) IN;
g. Reactive Power Demand (VAR) First Quadrant; and
h. Reactive Power Demand (VAR) Fourth Quadrant.

All units shall be expressed at appropriate multiples determined by the maximum expected demand.

TC 17.5 Frequency of Reading

The Demand Interval shall be fifteen (15) minutes and shall be set to start at the beginning of the hour. Demand shall be calculated by averaging the respective parameters over the stated Demand Interval.

The System Operator shall read the appropriate meters To prevent clock drift, the clocks shall be checked and reset as agreed by the parties. If readings are obtained remotely, copies of the data produced by the computer which initiates the reading protocol can be made and provided to the Generator if requested.

TC 18 METERING REQUIREMENTS LARGE CUSTOMERS

TC 18.1 Overall Accuracy

TC 18.1.1 The overall accuracy of the metering for revenue purposes is to be designed to give a tolerance of +/- 1% when tested in the laboratory and +/- 2 when tested in the field.

TC 18.2 Relevant Metering Policies, Standards and Specifications

TC 18.2.1 The meters, and associated installations, used on the System Operator s Transmission System shall comply with the following documents which are identified as Transmission Code Technical Specifications in TC 10.6 or available from the OUR:

a. JPS Engineering Instruction 4.7
b. OUR Document ELE 2005/07 Electricity Meter Testing in Jamaica - Protocol on Administrative
c. Meter Facilities Policy as set out in JPS Engineering Bulletin TSD 007/3

TC 18.2.2 The meters shall be designed, constructed and operated to comply with the latest revision of the relevant ANSI standards or international equivalents in particular:

a. ANSI C12.1 2008 The Electric Meters code for Electricity Metering;
b. ANSI C12:10 2004 Physical aspects of watt-hour meters - safety standard; and
c. ANSI C12:20 2002 Electricity meters 0.2 and 0.5 accuracy Classes.

TC 18.3 Requirement for Metering

TC 18.3.1 All Connection Points to the Transmission System shall have appropriate metering in accordance with this Transmission Metering Code. The position of the metering shall be set out in the Connection Agreement between the System Operator and the Large Customer.

TC 18.4 Metering Responsibility

TC 18.4.1 The System Operator shall ensure that all Connection Points with Large Customers are metered in accordance with this Code.

TC 18.4.2 It is the responsibility of Large Customers and Generators to cooperate with the System Operator in the execution of its responsibilities under this Code and, where applicable, under the Generation Code.

TC 18.4.3 The costs for installation and replacement of meters shall be outlined in the

User s Connection Agreement or the Generator s Power Purchase Agreement or Standard Offer Contract

TC 19 METERING EQUIPMENT

TC 20.1 The metering equipment shall consist of :

a. Revenue Meters;
b. Current and Voltage Transformers where applicable;
c. All interconnecting cables, wires and associated devices, seals and protection; and
d. All equipment associated with Advanced Metering Infrastructure.

TC 20 REVENUE METERS

TC 20.1 The revenue meter shall have the appropriate rating for the connection requirements to be supplied and shall conform to the terms of the Interconnection Agreement between the System Operator and the Large Customer.

TC 20.2 Meters shall have an accuracy in accordance with ANSI class 0.5 or international equivalent.

TC 20.3 At the System Operator s discretion Advanced Metering Infrastructure may be installed at some Customers Sites. This metering infrastructure enables two way communication with the metering systems. These devices shall comply with the specifications in TC 19.2.2. The accuracy shall be equivalent to ANSI Class 0.5.

TC 20.4 The relevant metered parameters, as required by the System Operator for billing purposes, shall be stored cumulatively on the meter and shall be able to be accessed by the Large Customer.

TC 20.5 Where required these parameters may include any or all of the following depending on the connection and the tariff schedule:

a. KW Hours (delivered and received);
b. KVAr Hours (delivered and received);
c. KVA Hours (delivered and received);
d. Ampere Squared Hours;
e. Volt Squared Hours;
f. Maximum Demand (15 minute period);
g. Power Factor;

The above parameters shall be measurable over intervals from 1 minute to 60 minutes.

TC 21 VOLTAGE AND CURRENT TRANSFORMERS

TC 21.1 All Voltage and Current Transformers shall comply with IEC Standards or their equivalents and shall have an accuracy class of 0.5.

TC 21.2 The burden in each phase of Voltage and Current Transformers shall not exceed the specified burden of the said Transformers.

TC 22 METERING POINTS

TC 22.1 Whole Current Metering

TC 22.1.1 The Metering Point should be as close as possible to the Connection Point.

TC 23 CT METERING

TC 23.1 The Metering Point shall be at the position of the Current Transformers(CT) used for the metering system. This should be designed to be as close as possible to the Connection Point.

TC 23.2 Current Transformers should be installed in a separate chamber and must be before the main switch (on the line side). They shall be housed in suitable metal enclosures, and be able to be secured.

TC 23.3 Where the Connection Point is declared on the outgoing side of a high voltage circuit breaker the metering transformers may be accommodated in that circuit breaker unit.

TC 23.4 Where appropriate the Metering Point should be at the same voltage as the

Connection Point. Where the Metering Point is at a lower voltage than the Connection Point then appropriate loss factors should be calculated to ensure any additional loss is appropriately accounted for.

TC 24 METER READING AND COLLECTION SYSTEMS

TC 24.1 Meter Reading and Recording Responsibility

TC 24.1.1 It is the responsibility of the System Operator to ensure that meters are read in accordance with the requirements of overall Standard EOS7 in the System Operator s Licence.

TC 24.1.2 Meter reading and recording shall be undertaken by a suitable authorised representative of the System Operator.

TC 24.1.3 It is the responsibility of Generators and Large Customers to cooperate with the System Operator in the execution of its responsibilities under this Code.

TC 24.1.4 The Customer shall be provided with access to its billing and consumption records on request.

TC 24.2 Approval of meters

TC 24.2.1 Only meters that have received pattern approval from the Bureau of Standards, Jamaica (BSJ) in accordance with the OUR Document ELE 2005/07 Electricity Meter Testing in Jamaica - Protocol on Administrative and Testing Procedures, may be used on the System Operator s Transmission System.

TC 24.3 Calibration and sealing

TC 24.3.1 All meters (new meters and repaired meters) rated above 12kVA shall be calibrated and the tolerance adjusted to ensure that it measures as close to zero tolerance as possible prior to field installation.

TC 24.3.2 All meters rated above 12kVA shall be recalibrated every10 years unless they have a manufacturers guaranteed calibration period in which case this period shall be used.

TC 24.3.3 All laboratory calibration shall be undertaken in laboratories accredited by the Bureau of Standards, Jamaica (BSJ).

TC 24.4 Traceability

TC 24.4.1 The kilowatt hour standard used to calibrate electricity meters shall be traceable to the Systeme Internationale (SI) at the Bureau Internationale des Pois et Measures. This extends to the calibration of Equipment used to calibrate meters.

TC 24.5 Sealing

TC 24.5.1 All meters shall be constructed to enable the meter unit to be sealed to prevent unauthorised access or interference with the operation of the meter or the input terminals of the meter.

TC 24.5.2 Seals applied after calibration shall be marked with the date that recalibration is required.

TC 24.5.3 All seals shall include marks that identify the authorised person that sealed the meter.

TC 24.4 Metering Disputes

TC 24.4.1 If the metering system is found to be inaccurate more than the allowable error, and the System Operator and the User or Generator fail to agree upon an estimate for the correct reading within a reasonable time (as specified in the relevant PPA) of the Dispute being raised, then the matter may be referred for arbitration by either party in accordance with the relevant PPA.

TC 24.4.2 Meter Accuracy Check

TC 24.4.3 The User has a right to request a meter accuracy check when they consider that the meter may be reading incorrectly, in accordance with the meter testing protocol.

TC 24.4.4 Should a User request more than one accuracy check in a single calendar year and the accuracy is within +/-2% then the System Operator may charge for the additional checks.

TC 24.5 Inspection and testing

TC 24.5.1 Maintenance Policy

TC 24.5.2 The System Operator shall put in place and implement policy for the inspection and testing and recalibration of all metering Equipment. This policy shall be in accordance with the procedures set out in TC 19.2 above.

TC 24.6 Maintenance Records

TC 24.6.1 The System Operator shall keep all test results, maintenance programme records and sealing records.

TC 24.7 Generator Metering

TC 24.7.1 The Generator shall abide by the conditions of the Generation Code that details the maintenance procedures to be applied in the case of Generator meters. The Generation Code includes provisions on the use of Back-up meters when metering inaccuracies are suspected and on the resolution of metering disputes.