UTILITY REGULATORY AUTHORITY

Mauritius National Grid Code

Transmission Code

Version December 2022

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TRANSMISSION CODE

TC 1 OBJECTIVE AND SCOPE

The objective of this **Transmission Code** is to provide the guidelines controlling the development, maintenance and **Operation** of an efficient, coordinated and economic **Transmission System** in Mauritius.

This **Transmission Code** also sets out the procedures and principles governing the **System Operator**'s relationship with all **Users** of the **Transmission System**.

TC 1.1 Scope

The **Transmission Code** shall be complied with by the **System Operator** and any existing or potential **Generation Licensee** and **Users** connected to or seeking to **Interconnect** to the **Transmission System.**

The **Transmission System** is that part of the electric System that operates at 66 kV or higher consisting of the **Electrical Facilities** used for conveyance of electricity over **Electric Lines** between a **Generating Station** and **Substation**, or between **Generating Stations** or between **Substations,** and consists of **Electric Lines**, **Equipment** and meters owned and operated by the **Transmission Licensee** in connection with transmission of electricity.

a. The **Transmission System** includes the power transformers from the **HV** to the **MV Grids,** and the **MV Circuit Breakers.** The **Interconnection Boundary** of the **Transmission** and **Distribution Systems** shall be on the cable termination of the **MV** feeder panels of the **Distribution System** or **MV Customer,** as illustrated in Figure 1.

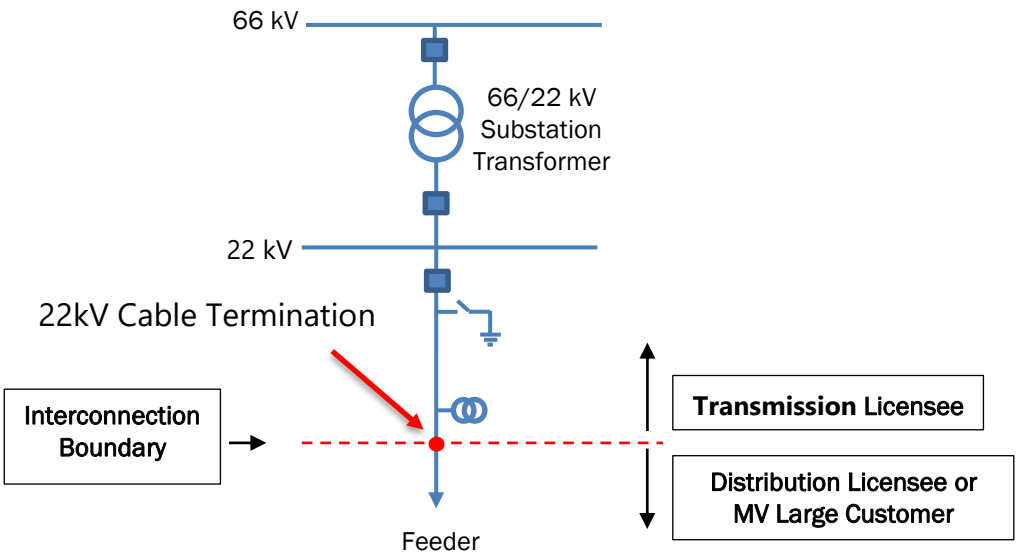

Figure 1. **Interconnection Boundary** between the **Transmission System** and the **Distribution System**.

b. The **Interconnection Boundary** of the **Transmission System** and **Generating Stations** is defined in the **Generation Code**.

TC 2 GENERAL REQUIREMENTS

This **Transmission Code** contains the procedures to provide an adequate, safe and

efficient service to all parts of Mauritius, taking into account a wide range of operational circumstances. It is however necessary to recognize 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 **License**;

e. compliance with the **Electricity Act** 2005 and its amendments;

f. compliance with the **Distribution Code**;

g. compliance with the **Generation Code**;

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

TC 3 TRANSMISSION PLANNING

TC 3.1 Purpose and Scope

The **Single Buyer** will be responsible for planning the development of the **System** in the medium and long term (**Integrated Resource Plan - IRP**)

The **Ministry** will provide the **Single Buyer** with policy guidelines for the development of the system such as policy objectives regarding the use of primary energy sources for generating electricity, future technologies, etc.

The **Single Buyer** will also develop procedures for development of an **Integrated Resource Plan**, engaging key electricity sector stakeholders in a collaborative process.

The objective of the long-term **Integrated Resource Planning (IRP)** is to define the development (upgrading and expansion) of the Transmission and Distribution Systems as well as the indicative incorporation of new generation resources based on policy guidelines provided by the **Ministry**, in order to guarantee the quality and reliability of electricity supply for the nation and the economic players.

The **Single Buyer** shall elaborate the long-term **IRP** according to the procedures and information requirements established in section SOC 1 of the **System Operations Code**.

The **System Operator** is responsible for the short-term planning (Operation Planning) as required by section SOC 2 of the **System Operations Code**.

The IRP horizon analysis shall be at least 10 years and the plan shall be updated yearly with the most recent updated information available such as policy guidelines, load forecasts, expected commercial operational date of key ongoing projects, fuel prices, new generation technologies and prices, etc.

In the elaboration of the **IRP** the **Single Buyer** shall specifically considers the location of renewable and other generation sources.

This section TC 3 specifies the following criteria, processes and information that will be used by the **Single Buyer** in the fulfilment of its planning duties:

a) Transmission System Planning Criteria
b) Planning Studies, and
c) Data Requirements

TC 3.2 Transmission System Planning Criteria

This section of the **Transmission Code** sets out the **Transmission System** planning criteria against which the **Single Buyer**, together with the **System Operator** shall plan the **Transmission System**.

TC 3.2.1 Transmission System Voltage

The **Single Buyer** and **System Operator** shall plan and design and the **System Operator** will operate the **Transmission System** so that under steady state the voltages at all 66 kV and 132 kV buses shall be in the following ranges:

a) **Normal Conditions**: -6 and +10% around the nominal value;

b) **Contingency Conditions**: from -10 and +12% around the nominal value

TC 3.2.2 Transmission System Frequency

The **System Operator** shall maintain the **System** frequency under **Normal Conditions** within the limit of 50 Hz ± 0.75 Hz.

In case of **Generation Outage**, the **System** may resort to automatic **Demand** shedding to control the **Frequency**, as outlined in TC 10.

TC 3.2.3 Load Power Factor

The **Transmission System** shall be planned for a normal load **Power Factor** of 0.90 lagging to 0.9 leading for voltages under **Normal** and **Contingency Conditions** within the ranges set forth in Section TC 3.2 for planning purposes.

TC 3.2.4 Thermal Loadings

(1) Under **Normal Conditions** all **Transmission System Electrical Facilities** shall operate within their continuous ratings.

(2) Under **Contingency Conditions**, **Electrical Lines** shall withstand a loading of up to 110% of continuous rating for at least 30 minutes before being disconnected either manually or automatically and **Transmission System** power transformers loadings shall not exceed their nominal rating.

TC 3.2.5 Fault Levels

The maximum short-circuit fault levels at the **Transmission System Substations** shall be limited to the rated capacity of the corresponding **Equipment** and calculated using the subtransient impedances of the synchronous **Generating Units**.

TC 3.2.6 System Stability

The 66kV **Transmission System** shall remain stable when subjected to a **Contingency**, such as the trip of a large **Generating Station**, or a short circuit on an **Electric Line**.

The **Fault Clearing Time,** as set in the main **Protection Equipment,** for a short circuit **Fault** shall be less than the **Critical Fault Clearing Time** calculated at the **Interconnection Boundary**.

TC 3.2.7 Reliability Criteria

The **Transmission System** shall be designed with built-in redundancy so as to ensure security of supply using the **N-1 Criterion**, which ensures continuity in supply in the event of failure of any one **Transmission** line and/or main power transformer.

The loss of **Demand** produced by the trip of **Generating Units** shall not be deemed to be a breach of the **Transmission System** planning criteria.

TC 3.3 Planning Studies

TC 3.3.1 General

(1) **Transmission System** planning studies shall be carried out in full compliance with the process established in TC 3.1 to ensure the safety, reliability, security, and stability of the **Transmission System** for the following purposes:

a. Preparation of a transmission least cost expansion plan for submission to the **Authority**;

b. Evaluation of **Transmission System** reinforcement projects; and

c. Evaluation of the individual and aggregated impact of the operation of existing and prospective **Users** of the **System**.

(2) The **Transmission System** planning studies shall be conducted to assess the impact on the **Transmission System** of the **Demand** growth, any proposed addition or change of **Electrical Facilities** to the **Transmission System** and to identify corrective measures to eliminate possible deficiencies in the **Transmission System**.

(3) The **Transmission System** planning studies shall be conducted periodically as required to assess:

a. the behaviour of the **Transmission System** under **Normal** and **Contingency Conditions**; and

b. the behaviour of the **Transmission System** during the electromechanical or electromagnetic transients induced by **Faults** or switching operations.

(4) The **Transmission System** planning studies shall comprise electrical power system studies conducted by the **Single Buyer** and / or **System Operator** or third party consultant pre-approved by the **Single Buyer**, according to the provisions of this Section TC 3.3, and using a power system software compatible with the one used by the **Single Buyer** and **System Operator**. The final results and the used **Models**, shall be handed over to the **Single Buyer** and **System Operator.**

(5) The **Generation Interconnection** studies shall be carried out by the **Single Buyer** or **System Operator** or third-party consultant pre-approved by the **Single Buyer** using power system simulation and calculation software compatible with the ones used by the **Single Buyer** and **System Operator**. The final results and the used **Models**, including the validated **Generating Station** user **Model** shall be handed over to the **Single Buyer** and **System Operator**. The **Generating Station Model** shall comprise all **Electrical Facilities** necessary for the generation of electrical power from the **Generating Unit(s)** to be integrated in the **System Model**.

TC 3.3.2 Load Flow Studies

(1) Load flow studies shall be performed to evaluate the behaviour of the **Transmission System** for the existing and planned **Transmission System Electrical Facilities** under forecasted maximum and minimum Load conditions over a planning horizon of up to 10 years. These studies shall determine the impact on the **Transmission System** of the **Interconnection** of new **Generating Stations**, **Customers**, or **Electric Lines**.

(2) Power flow simulations shall be conducted to verify the compliance with the **Transmission System** planning criteria in TC 3.2 under both **Normal** and **Contingency Conditions**. The results of the studies shall provide information regarding equipment loading (lines and transformers) and bus voltages together with any deficiencies in **Reactive Power** support, among others.

(3) Sensitivity analysis shall also be carried out to determine the impact that any proposed changes will have on the Operation of the Transmission System for the

most stringent Generation **Dispatch** scenarios, and if necessary, at other times than peak and minimum loads.

(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 the necessary remedial measures.

TC 3.3.3 Short Circuit Studies

Short circuit studies shall be performed to evaluate the effect on **Transmission System Electrical Facilities** associated with the Interconnection of new **Generating Stations**, **Transmission Electric Lines**, and other facilities that will result in increased fault duties for **Transmission System Equipment**. These studies shall identify the **Electrical Facilities**, such as switchyard **Equipment** and substation buses that could be permanently damaged when the current exceeds their design limit. The studies shall also identify the circuit breakers that may fail to interrupt the largest possible short circuit currents.

Short-circuit current calculations are also required to allow for the correct setting of **Protection** relays on which depends the stability of the **Transmission System** under **Fault** conditions. Nonetheless, the **Protection** system coordination may require calculations additional to the ones of the short circuit study.

Short-circuit studies shall be performed for all **Transmission System** busbars for the most stringent operating conditions corresponding to different feasible **System** generation, load and topology states or 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 in case the short-circuit withstand and breaking capability of existing **Equipment** is exceeded. Such changes in circuit configuration shall be subjected to load flow and stability analysis to ensure that the changes do not cause steady-state or transient unacceptable conditions.

The **Fault** types to consider, shall include at least the ones listed below:

a. three phase

b. phase to phase

c. phase to phase to ground and

d. single line to ground

The results shall be considered satisfactory when, at the planning stage, the short-circuit currents are within the value specified in TC 3.2.5 and the proposed **Transmission System** configurations are suitable for flexible and safe **Operation**.

TC 3.3.4 Transient and Frequency Stability Studies

Transient and frequency stability studies shall be performed to verify the impact of the **Interconnection** of new **Generating Stations**, **Electric Lines**, and **Substations** and changes in the **Transmission System** circuit configurations on the ability of the **Transmission System** to reach a stable operating point following a **Contingency**.

Transient and frequency stability studies shall comprise the time-domain simulation of **Contingencies** in critical **Transmission System Electrical Facilities** such as major transmission lines and transformers, or in **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 **Contingency** involving a **Fault** of a single **System** component for all possible operating conditions;
b. the **Transmission System** remains controllable by other means, such as

operator intervention and/or automatic tripping of demand or generation;; and

c. the **Transmission System** planning criteria set forth in Section TC 3.2 are met.

Transient and frequency stability studies shall be conducted for all new **Electric Lines** or substations and for the **Interconnection** of new **Generating Stations** with **Registered Capacity** larger than 10 MW connected to the **Transmission System**. In other cases, the **System Operator** shall determine the need to perform transient and frequency stability studies.

The transient and frequency stability studies shall define solutions, such as the installation of additional **Protection** and control **Equipment** or the adoption of safe **System** operating conditions, for the cases where a risk of unsatisfactory **System** performance is identified.

TC 3.3.5 Voltage Stability Analysis

Periodic studies shall be performed to determine if the **Transmission System** is vulnerable to voltage collapse under heavy loading conditions. A voltage collapse can develop very rapidly if the ability of **System**'s **Reactive Power** supply to support **Transmission System** voltages is exhausted. The voltage stability analysis shall:

a. identify the necessity to implement solutions such as the installation of dynamic or static **Reactive Power** compensation devices to avoid vulnerability to voltage collapse.
b. identify safe **Transmission System** operating conditions where vulnerability to voltage collapse can be avoided until solutions are implemented.

TC 3.3.6 Power Quality Studies

Power quality studies shall be performed, if deemed necessary by the **System Operator**, to verify the impact on the voltage and current waveforms of the **Interconnection** of new **Generating Stations**, **Electric Lines**, **Large Loads, Substations**, static or dynamic **Reactive Power** compensation **Equipment**, and changes in the **Transmission System** circuit configurations.

The results shall be considered satisfactory when, at the planning stage, the harmonic distortion, voltage fluctuations and phase unbalance are within the values specified in TC 6 for the most stringent conditions.

TC 3.4 Data Requirements

TC 3.4.1 General

A critical part of all the studies mentioned in Section TC 3.3 is the large volume of input data that is required by each study. This data set is necessary for the development of accurate **Models** that can reasonably mimic the **System's** actual response.

The following requirements apply to the information exchange for planning purposes:

a) The **Users** of the **Transmission System**, including **Customers** and **Generators**, shall submit to the **Single Buyer** and **System Operator** a hard copy of the **Transmission System** Data Registration Schedules in Section TC 18. All **Equipment** data shall also be submitted in the electronic format required by the power system simulation tools used by **Single Buyer** and **System Operator**. The **Single Buyer** or **System Operator** may request additional information reasonably required.
b) **Users** and **Generators** shall provide such information as the **Single Buyer**

and **System Operator** may reasonably request on a regular basis for the purposes of planning and developing the **Transmission System**. The information shall be submitted to the **Single Buyer** and **System Operator** without unreasonable delay. Such information may be required to plan and develop the **Transmission System**, monitor current and future power system adequacy and performance, and fulfill its statutory or regulatory obligations.

c) All **Users** shall notify without unreasonable delay the **Single Buyer** and **System Operator** of any changes that take place in the parameters of its **Electrical Facilities** at the **User**'s side of the **Interconnection Boundary**.

d) The **System Operator** shall provide **Users** or potential **Users**, upon any reasonable request, with any relevant information that they require to:
   a. properly plan and design their own **Electrical Facilities;**
   b. comply with the **National Grid Code.**
   c. enable such **Users** determine the effect of the **Transmission System** development on their **Electrical Facilities**.

   The information to be provided by the **System Operator** to the **Users** shall:
   i) be in the form of the schedules of TC 18 for the **Equipment** in the area of influence of the **User's Site;**
   ii) include network data at the **Interconnection Boundary,** including the maximum and minimum short circuit currents and X/R ratio; and
   iii) comply with the provisions of the Electricity Regulations 2016.

e) The **User** can approach the **Single Buyer** or **System Operator** for other specific data requirement not captured in the **National Grid Code**.

f) The **Single Buyer** and **System Operator** may estimate any system planning information not provided by a **User** under this TC 3.4. The **Single Buyer** and **System Operator** shall take all reasonable steps to reach agreement with the **User** on estimated data items. The **Single Buyer** or **System Operator** shall indicate to the **User** any data items that have been estimated. The obligation to ensure the correctness of data remains with the **User**.

TC 3.4.2 Demand

In order to carry out the load flow studies substation loads can be represented by their constant **Active** and **Reactive Power** consumptions. However, voltage and transient stability studies shall use more complex **Models** for substation loads catering for the voltage and frequency static and dynamic dependence.

Demand forecasts are required to enable the **Transmission System** to be developed in a coordinated and economic manner. The **Distribution Licensee** and the **Single Buyer** shall submit to the **System Operator** the forecast of **Demand** in **MV** feeders and the need to develop new **Distribution Substations**. The **System Operator** shall integrate the forecast of **Demand** at 66 kV and 132 kV **Substations** plus the **Demand** of **Large Customers** connected at 66 kV to produce the Demand forecast of the total **System**.

The overall process for development of the **Total System Demand** forecast shall be undertaken on an annual basis and shall be approved by the **Authority**. The forecasted **Demand** data shall then be used in the planning studies.

Any **Customer** connected directly to the **Transmission System** at 66 kV or higher applying for interconnection or modification of an existing Interconnection to the **Transmission System** shall also submit in writing to the **System Operator** each year their best estimate of power and energy **Demand** at its **Interconnection Boundary(s)** projected for five (5) succeeding years, unless otherwise instructed by the **System Operator**.

TC 3.4.3 Transmission System Data

The **System Operator** shall keep an updated technical database of the **Total System** which shall be shared with the **Single Buyer** for purposes of developing a **Model** and studying the behaviour of the **Total System**.

This network data is set out in Section TC 18, and shall include at least the following:

TC 3.4.3.1 Power Transformers

The primary input data for power transformers includes MVA rating, primary and secondary winding voltages, windings connection, sequence impedances, X/R ratio, tap ranges, tap settings, emergency ratings, inrush current,.copper and no-load losses, **Protection** relay settings, and **CTs** and **VTs** electrical characteristics.

TC 3.4.3.2 Transmission Lines and Cables

The primary input data required for transmission lines and cables among other things are line voltage, conductor type, type of construction, thermal ratings, emergency rating and sequence impedances.

TC 3.4.4 Generating Units

Generating Units shall be modelled by their real and reactive power capabilities for steady state analysis.

For dynamic analysis more detailed **Models** are required for **Generating Units** and their control systems. The **Generating Units** shall be represented following the modeling requirements set forth in the Generator Dataset section of the **Generation Code**.

TC 3.4.5 Other System Parameters

All **Users** of the **Transmission System**, including **Distribution Licensees**, **Large Customers** and **Generators** shall submit the following additional information:

a. In order to carry out transient stability studies:
   i. Settings of all **Protection** relays, including:
      a) **VTs** and **CTs** electrical parameters including the saturation curve
      b) Tested and validated **Protection** relay **Models**
   ii. **Circuit Breaker** and **Protection** relay operating time and operating sequences.
b. In order to develop a reliability data base: outage rates and durations for all major equipment are also necessary.
c. Any other information that may be required.

TC 4 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 **Authority**.

The **System Operator**, the **Transmission Licensee** and any **User** connected to the **Transmission System** shall comply with the requirements established in section SOC 12 of the **System Operations Code**.

TC 5 TRANSMISSION INTERCONNECTION CONDITIONS

TC 5.1 General

This section specifies the normal method of Interconnection 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 this section of the **Transmission Code**, **User** refers to **Generators, Distribution Licensees** and **Large Customers** connected to the **Transmission System**.

In addition, details specific to each **User**'s interconnection may be set out in a separate **IA, CA, PPA or ESPA**. The interconnection conditions set out in this section are complementary to these agreements.

All interconnection costs and responsibility shall normally be borne by the **User** connected to the **Transmission System**, unless otherwise specified by an **IA, CA, PPA or ESPA**, or policy, or as dictated by the **Authority**.

TC 5.2 Objective

The objective of Section TC 5 is to specify the minimum technical, design and operational criteria the basic rules for connection to the **Transmission System**.

The requirements in this section apply to the **System Operator** and to the following **Users**:

a. **Generators** connected to the **Transmission System**;
b. **Distribution Licensee** and **Large Customers** directly connected to the **MV section of the Transmission System** and
c. **Large Customers** directly connected to the 66 kV or above **Transmission System**.

TC 5.3 Method of Interconnection

TC 5.3.1 General

The method of **Interconnection** of a **Generating Station** to the **Transmission System** shall be as per Figure 2 and Figure 3 unless otherwise agreed with the **Transmission Licensee** and the **System Operator** on the grounds of **System** security, stability safety and compliance with the National Grid Code.

Provisions additional to the ones in the **Transmission Code** and related to the connection to the **Transmission System** shall be contained in each **IA, CA, PPA or ESPA** with a **User** and include requirements related to the compliance with the relevant **IA, CA, PPA or ESPA** for that **User**, detailed technical requirements, construction time schedule and approval to interconnect, among others.

TC 5.3.2 Information Requirements

Prior to the **Completion Date** under the **IA, CA, PPA or ESPA**, the following data are to be submitted by the **User** to the **System Operator**:

a) updated data requested under the provisions of Section TC 3 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 the **Project** drawings described in Section TC 8.4.1;
c) copies of all **Safety Rules** and **Local Safety Procedures** applicable at **User Site** which shall be used at the **System Operator**/**User** interface;
d) information to enable the **System Operator** prepare the **Site Responsibility Schedules** on the basis of the provisions set out in Section TC 19.1;
e) an **Operation Diagram** for all **HV Apparatus** on the **User** side of the **Interconnection Boundary**;
f) the proposed name of the **User Site** (which shall not be the same as, or confusingly similar to, the name of any **Licensee Site** or of any other **User**

Site);

g) a list of **Safety Coordinators** and **Operations Engineers;**
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 authorized to make binding decisions on behalf of the **User**;
i) a list of managers or nominated representatives who have been duly authorized to sign **Site Responsibility Schedules** on behalf of the **User**; and
j) information to enable **System Operator** to prepare **Site Common Drawings**.

TC 6 POWER QUALITY STANDARDS

TC 6.1 Power Quality

All Users connected to the **Transmission System** shall maintain the voltage waveform quality at the **Interconnection Boundary** measured at the **Point of Delivery** within the limits specified in this section.

.Permanent monitoring of the compliance with the power quality standards is not required under TC 6. However, if the **System Operator** reasonably considers that there may be an issue of non-compliance with TC 6 by the **User**, the **System Operator** may carry out a **Site Investigation Test** pursuant to TC 16.8.

TC 6.2 Harmonic Voltage and Current Distortion

Managing harmonics in the **System** is considered a joint responsibility involving both **Users** and the **System Operator.** Therefore, voltage and current harmonic distortion shall be controlled as follows:

a. The **System Operator** shall limit line-to-neutral voltage harmonics below the maximum values recommended in IEEE Std. 519 for the **Interconnection Boundaries,** measured at the **Point of Delivery,**of all **Users.**
b. **Users** connected to the **Transmission System** shall ensure that their harmonic current emissions at the **Interconnection Boundary,** measured at the **Point of Delivery,** do not exceed the limits recommended in IEEE Std. 519.

The necessary data will be exchanged between both **Parties** and the exchange of data shall not be unreasonably withheld. This data may consist of but is not limited to the dependence of the **System** impedance with the frequency at the **Interconnection Boundary** and the background distortion levels.

TC 6.3 Voltage Fluctuations

Users shall ensure that their connection to the **Transmission System** does not result in the level of fluctuation of the supply voltage on the **Transmission System** at the **Interconnection Boundary,** measured at the **Point of Delivery,** exceeding limits set out below. Any necessary data will be exchanged between both parties and the exchange of data shall not be unreasonably withheld.

TC 6.3.1 Voltage Flicker

Users shall take responsibility for limiting Voltage Flicker caused by their **Electrical Facilities** to remain within the maximum values at the **Interconnection Boundary,** measured at the **Point of Delivery,** specified in IEC TR 61000-3-7.

TC 6.3.2 Voltage Changes

Users shall ensure that the disturbance levels introduced by their **Electrical Facilities** do not promote rapid voltage changes at the **Interconnection Boundary,** measured at the **Point of Delivery,** above the limits specified in Table 1 with the stated

frequency of occurrence, where

$$\%\Delta V_{steadystate} = \left| 100 \times \frac{\Delta V_{steadystate}}{V_0} \right|$$

$$\%\Delta V_{max} = 100 \times \frac{\Delta V_{max}}{V_0}, \text{ and}$$

i) V_0 is the initial steady state **System** voltage;
ii) $V_{steadystate}$ is the **System** voltage reached when the rate of change of **System** voltage over time is less than or equal to 0.5% over 1 second and $\Delta V_{steadystate}$ is the absolute value of the difference between $V_{steadystate}$ and V_0;
iii) ΔV_{max} is the absolute value of the maximum change in the **System** voltage relative to the initial steady state **System** voltage of V_0;
iv) All voltages are the root mean square of the voltage measured over one cycle refreshed every half a cycle as per IEC 61000-4-30;
v) The voltage changes specified are the absolute maximum allowed, applied to phase to ground or phase to phase voltages whichever is the highest change;
vi) Voltage changes in category 3 only occur for infrequent or unplanned operational activities due to commissioning, maintenance and fault restoration, and in circumstances notified to the **System Operator**, such as for example commissioning in accordance with a commissioning programme, implementation of a planned outage; and
vii) For connections where voltage changes would constitute a risk to the **Transmission System** the **System Operator** may reasonably limit the number of voltage changes in category 2 or 3 to a lower number than specified in Table 1 to ensure that the total number of voltage changes at the **Interconnection Boundary** across multiple **Users** remains within the limits of Table 1.

Table 1. Limits for Rapid Voltage Changes

Category	Maximum number of occurrences	$\%\Delta V_{max}$ and $\%\Delta V_{steadystate}$
1	No limit	$\lvert \%\Delta V_{max} \rvert \leq 1\%$, and $\lvert \%\Delta V steadystate \rvert \leq 1\%$
2	Occurrences per hour with events evenly distributed according to Figure 1, where*: 180 for $\lvert \%\Delta V max \rvert = 1\%$ 18 for $\lvert \%\Delta V max \rvert = 2\%$ 5 for $\lvert \%\Delta V max \rvert = 3\%$	$1\% < \lvert \%\Delta V_{max} \rvert \leq 3\%$, and $\lvert \%\Delta V_{steadystate} \rvert \leq 3\%$
3	No more than 4 per day for Commissioning, Maintenance and Fault Restoration	$\%\Delta V_{max} \leq 12\%$ for up to 80ms. $\%\Delta V_{max} \leq 10\%$ for up to 2s. $\%\Delta V_{max} \leq 5\%$ for up to 0.5s. $\%\Delta V_{steadystate} \leq 3\%$.

(*) Occurrences for other voltage changes are obtained by linear interpolation

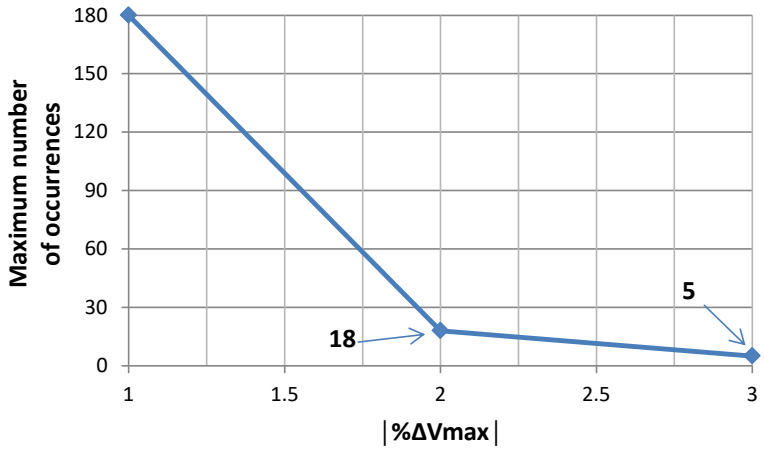

Figure 1. Maximum allowed occurrences per hour for voltage changes within Category 2 in Table 1.

TC 6.4 Phase Unbalance

The weekly 95 percentile of Phase (Voltage) Unbalance, calculated in accordance with IEC61000-4-30 and IEC61000-3-13, on the Transmission System for voltages equal to or greater than 66 kV shall be less than or equal to 1.3% unless abnormal conditions prevail.

The Phase Unbalance is calculated from the ratio of root mean square (rms) of negative phase sequence voltage to rms of positive phase sequence voltage, based on 10-minute average values, in accordance with IEC 61000-4-30.

TC 6.5 Exceptional Conditions (including cyclonic conditions)

In exceptional **Transmission System** conditions 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 outlined in TC 6. During these events, the **System Operator** and the **Users** shall be relieved of its obligation to comply with the **System** conditions referenced in the aforementioned sections, subject to informing the **Authority** when **Normal Conditions** are recovered.

TC 7 ELECTRICAL FACILITIES RELATED TO INTERCONNECTION SITES

TC 7.1 General Requirements

All **Electrical Facilities** relating to the **User** and **Transmission Licensee** at the **Interconnection Boundary**, shall comply with the conditions set forth in TC 7.

The design of connections between any **Generating Station** and the **Transmission System** shall be set out as per the **Interconnection** conditions of the **Generation Code**.

TC 7.2 Substation Electrical Facilities

All **User's Plant** and **Apparatus** associated with the connection to the **Transmission System** shall comply with the Mauritian laws, regulations and standards.

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/Licensee Interconnection Site** shall be designed, constructed, installed and tested in accordance with the standards prescribed in the appropriate specification of the Mauritius Standard Bureau, and relevant internationally accepted standards such as the SB, IEEE and IEC, or their equivalent.

Where the **System Operator**, acting reasonably, determines that in order to ensure safe and co-ordinated operation of a **User's Plant** and/or **Apparatus** with the **Transmission System**, there is a requirement for supplemental specifications and/or standards to apply to the design of a **User's Plant** and/or **Apparatus**, the **System Operator** shall notify the **User** and the **User** shall comply with the additional requirements. On request from the **User**, the **System Operator** shall provide reasonable evidence as necessary to demonstrate the need for the supplemental specifications and/or standards.

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

In the event that any standard or specification with which a **User's Plant** and/or **Apparatus** is required to comply under the **Transmission Code** is amended, the **System Operator** shall, having consulted with the affected **Users** and with the **Grid Code Review Panel**, make a recommendation to the **Authority** as to what action should be taken.

TC 7.3 Generator Interconnection Facilities

The requirements for the design of **Interconnection Facilities** between **Generating Stations** and the **Transmission System** are set out in the **Generation Code.**

TC 7.4 Interconnection Facilities of Distribution Systems or Large Customers

TC 7.4.1 Fault Disconnection Facilities

A **User** connected to the **Transmission System** shall have a **Circuit Breaker** at the **User** side of the **Interconnection Boundary** for **Fault** isolation and inter tripping.

Manual opening of the **Circuit Breaker** at the **User** side of the **Interconnection Boundary** shall not cause the tripping of the **Circuit Breaker** of the **Transmission System**, unless otherwise agreed with the **System Operator**.

TC 7.4.2 Automatic Switching Equipment

Where automatic re-closure of circuit breakers controlled or operated by the **System Operator** is required following **Faults** on the **User Electrical Facilities**, automatic switching equipment shall be provided as necessary.

TC 7.4.3 Neutral Earthing

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** required by the **Transmission Licensee** is met.

TC 7.4.4 Under Frequency Relays

As required under the **Transmission Code** and the **Distribution Code**, suitable arrangements shall be made to facilitate the implementation of **Under Frequency Relays** following the provisions of TC 3.2.2.

TC 7.4.5 Configuration of Substations

All **Substations** shall have the capability to disconnect or separate from the

Transmission System any **Transmission** or **Distribution** line, **Large Customer** and/or **Generating Unit** which is **Interconnected** to the **Substation**.

TC 7.5 User Protection Requirements

TC 7.5.1 General Requirements

Requirements in TC 7.5 shall apply to the **Transmission, Distribution Licensees**, **Generators**, and **Large Customers**.

a) The **Protection** relays to be applied to the **User's Equipment** at the **User** side of the **Interconnection Boundary** 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**.

b) The **Transmission Licensee** and the **User** shall be solely responsible for the **Protection** systems of **Electrical Facilities** at their respective sides of the **Interconnection Boundary**, and comply with applicable regulations.

c) . 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 **Transmission Licensee**'s **Equipment** is connected, shall not be longer than the one specified in TC 3.2.6.

d) Where the automatic reclosure of a **Circuit Breaker** is required following a **Fault** on the **User System**, automatic switching **Electrical Facilities** shall be provided in accordance with the requirements specified in the **IA, CA, PPA or ESPA**.

e) 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**.

f) The **System Operator** may require specific **Users** to provide other **Protection** schemes, designed and developed to maintain the overall system security, or to minimize the risk and/or impact of disturbances on the **Transmission System**.

g) The adequacy of protection equipment installed by the **User** for protecting the **User's Plant** and **Apparatus** against **Transmission System** disturbances is for the **User** to determine. It should also be noted that the **Transmission Licensee's** requirements are primarily intended to protect the **Transmission System** facilities, although they afford a level of protection to **Users,** they are not primarily designed to protect **User's Electrical Facilities**.

h) The minimum protection requirements for a **User** facility connecting to the **Transmission System** will vary according to type, size, **Earthing** and method of connection. **User Protection** required by the **Transmission Licensee** shall always be in service when associated plant is in service.

i) **Users** shall take precautions against disturbances on the **Transmission System** including without limitation protection against:

   (a) load unbalance (negative sequence) protection;

   (b) over/under-voltage;

   (c) over/under-frequency;

   (d) a combination of (b) and (c) that may result in overfluxing; and

j) **Users** may consult with the **Transmission Licensee** with respect to **Protection** adequacy. The **Protection** relay settings have to be calculated by the **User** based on the **Transmission Licensee** requirements for ensuring selectivity of protections and safety of the **Grid**.

k) In order to ensure secure operation of the **Transmission System** and correct co-ordination and discrimination between **Faults** on the **Transmission System** and the **Distribution System** and **User Systems**, settings for **User's Protection** systems that may have an **Operational Effect**, shall be notified to the **Transmission Licensee** and it will be necessary for the Transmission Licensee

to, and the **Transmission Licensee** may, prohibit the settings of some **User protection** systems within certain ranges. **Protection** systems where such limitations will apply include, but are not limited to:

(a) **Generation Unit** under-frequency, over-current, or distance **Protection**;

(b) transformer over-fluxing, over-current, or distance **Protection**;

(c) loss-of-mains **Protection**.

l) A mechanism for the notification, and where applicable approval and determination, of such settings will be set out in the **User's IA, CA, PPA or ESPA**.

m) The **Transmission Licensee** shall provide to the **User** the information and signals necessary for the interface co-ordination and operation of the User's **Protection**, in accordance with the relevant provisions of the **IA, CA, PPA or ESPA**.

n) At 66 kV and 132 kV **Substations Circuit Breaker** fail **Protection** shall be implemented by both the **User** and the **Transmission Licensee** on the **Circuit Breakers** at their respective sides of the **Interconnection Boundary**.

TC 7.5.2 Relay Settings

Protection relay settings shall be coordinated across the **Interconnection Boundary** to ensure effective disconnection of faulty **Equipment**. The coordination of the **Protection** relay settings shall be carried out by the **User** and approved by the **System Operator.** The **Protection** system coordination shall be reviewed every time a change in the **Grid** may affect the existing **Protection** system performance…

TC 7.5.3 Works on Protection Equipment

Where the **System Operator** owns the busbar at the **Interconnection Site**, no bus bar protection, AC or DC wiring (other than power supplies or DC tripping associated with the **Users' Electrical Facilities**) shall be worked upon or altered in the absence of a representative of the **System Operator**

TC 7.5.4 Generators

The requirements for the **Protection** systems to be applied to **Generating Units** are set out in the **Generation Code.**

TC 7.5.5 Distribution Systems and MV Large Customers

The requirements of **Error! Reference source not found.** apply to the **Distribution Licensee** and **Large Customers** directly connected to the **MV** part of the **Transmission System**.

The **Transmission Licensee** may require the **Distribution Licensee** or **MV Large Customer** to install additional **Protection** schemes, where the **Transmission Licensee** can reasonably show that it is prudent or necessary to do so, such schemes may include but are not limited to the following:

(i) direct intertripping between the **Circuit Breaker** on the **Transmission Licensee's** side of the **Interconnection Boundary** and a **Distribution System** or **MV Large Customer Circuit Breaker**;
(ii) loss of mains **Protection**;
(iii) under/over voltage **Protection**;
(iv) under/over frequency **Protection**;
(v) unit (differential) type **Protection** on **User's** lines or cables;

Earth Fault **Protection** and Over-Current **Protection,** directional or non-directional as the case may be**,** shall be provided by the **Transmission Licensee** on the **Circuit Breaker** at the **Transmission System** side of the **Interconnection Boundary**.

TC 7.5.6 HV Large Customers

The requirements of TC 7.4 Interconnection Facilities of Distribution Systems or Large Customers apply to **Large Customers** directly connected to the **HV Transmission System**.

Large Customers shall provide at least differential-protection, distance protection and directional overcurrent and earth fault protection.

The **Transmission Licensee** and/or the **System Operator** may require **Large Customers** to install additional **Protection** schemes, where the **Transmission Licensee** can reasonably show that it is prudent or necessary to do so, which may include the following:

a) neutral voltage displacement protection on HV side of Grid Connected Transformer(s);
b) loss of mains protection where the User System contains Embedded Generation;
c) under/over voltage protection where the User System contains Embedded Generation; and
d) under/over frequency protection where the User System contains Embedded Generation.

Distance **Protection**, Differential, over-current and earth fault **Protections** shall be provided by the **Transmission Licensee** on its side of the **Interconnection Boundary** .

TC 8 SITE RELATED CONDITIONS

TC 8.1 General

Responsibility for construction, commissioning, control, operation and maintenance responsibilities for the **Electrical Facilities** will be according to the ownership of each facility, unless an agreement between the **Parties** specifies differently.

TC 8.2 Responsibilities for Safety

Before **Interconnection** 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 **Electrical Facilities** at the **Interconnection Site** as specified in the Safety Coordination section SOC 15 of the **System Operations Code**.

TC 8.3 Site Responsibility Schedules

In order to inform site operational staff and the **System Control Engineers** of agreed responsibilities for **Electrical Facilities** at the **Interconnection Site**, a **Site Responsibility Schedule** shall be produced for **System Operator** and **Users** with whom they interface.

The format, principles and basic procedure to be used in the preparation of **Site Responsibility Schedules** are set down in Section TC 19.1.

TC 8.4 Diagrams and Drawings

TC 8.4.1 Project Drawings

With respect of **User**'s obligations relating to the drawings of a **Project**, the following shall apply:

a. The **User** shall submit to the **System Operator** and **the Single Buyer** for review and comments, its **Project** drawings detailing the **User Electrical Facilities, Protection** and control **Apparatus** and the **Transmission System Electrical Facilities** at the **Interconnection Site**, and the **System Operator** shall

undertake such review and provide its comments, if any, within 30 (thirty) days of the receipt of such drawings. The provisions of this Section TC 8.4.1 shall apply mutatis mutandis to the review and comments hereunder; and

b. Within 90 (ninety) days of the **Completion Date**, the **User** shall furnish to the **System Operator** and the **Single Buyer** a complete set of as-built drawings, in 2 (two) hard copies and in an electronic version in pdf format or in such other medium as may be acceptable to **System Operator** and the **Single Buyer**, reflecting the **User**'s **Plant** and **Apparatus** actually designed, engineered, constructed, tested and commissioned, including an as-built survey illustrating the layout of the **Plant** and setback lines, if any, of the buildings and structures forming part of the **Project Plant** and **Apparatus**.

TC 8.4.2 Operation Diagrams

TC 8.4.2.1 Introduction

An **Operation Diagram** shall be prepared by the **User** for its Interconnection Facilities and corresponding **Interconnection Site** in accordance with TC 19.3

The **Operation Diagram** shall include all **HV Apparatus** and the connections to all external circuits and incorporate numbering, nomenclature and labelling according to the system used from time to time by the **System Operator. Users** should also note that the provisions of. TC 15 apply in certain circumstances.

At those **Interconnection Sites** and **User Electrical Facilities** 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 to that used on the relevant **Interconnection Site** and circuit.

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 8.4.2.2 Validity of Operation Diagrams

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 **Interconnection Site** and **User Interconnection Facilities**. If a dispute arises as to the accuracy of the composite **Operation Diagram**, a meeting shall be held at the **Interconnection Site**, as soon as reasonably practicable, between **System Operator** and the **User**, to endeavour to resolve the matters in dispute.

The **Operation Diagrams** shall be updated whenever a relevant change is implemented at the **Interconnection Site** or **User Electrical Facilities.**

TC 8.4.3 Site Common Drawings

TC 8.4.3.1 Introduction

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

The **Large User** or the **Generator**, as the case may be, shall prepare and submit to the **Transmission Licensee Site Common Drawings** for its side of the **Interconnection Boundary**.

The **Transmission Licensee** shall then prepare, produce and distribute, using the information submitted by the **Large User or Generator**, as the case may be, **Site Common Drawings** for the complete **Interconnection Site.**

The **System Operator** shall receive a copy of the finalized **Site Common Drawings** for the **Interconnection Site**.

TC 8.4.3.2 Changes to Site Common Drawings

When the **Transmission Licensee**, **Large User** or **Generator**, as the case may be, becomes aware that it is necessary to change any aspect of the **Site Common Drawings** at an **Interconnection Site** it shall notify the other **Party** and amend the **Common Site Drawings** in accordance with the procedure set out in sub-section TC 8.4.3.

TC 8.4.3.3 Validity of Site Common Drawings

The **Site Common Drawings** for the complete **Interconnection Site** prepared by the **Transmission Licensee**, shall be the definitive **Site Common Drawings** for all operational and planning activities associated with the **Interconnection 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 **Transmission Licensee** and the **Large User** or **Generator**, as the case may be, to endeavour to resolve the matters in dispute.

TC 8.4.4 Transmission System drawings

The **Transmission Licensee** shall produce schematic drawings of the whole **Transmission System.** It shall be the responsibility of the **Transmission Licensee** to ensure that all its drawings and schematics are up to date

TC 8.5 Access

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 **IA, CA, PPA or ESPA**. Access to **System Operator** Sites by **Users**, and to **User** Sites by the **System Operator** shall be to the approval of the counterpart. The request for access shall be detailed and made 3 business days in advance for the **Parties** to make necessary arrangements.

TC 8.6 Maintenance Standards

All **Electrical Facilities** at the **Interconnection Boundary** 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 **Electrical Facilities** of the **System Operator** or the **User**.

The **User** shall maintain a log containing the test results and maintenance records relating to its **Electrical Facilities** on its side of the **Interconnection Boundary** and shall make this log available when requested by the **System Operator**.

The **System Operator** shall maintain a log containing the test results and maintenance records relating to its **Electrical Facilities** on its side of the **Interconnection Boundary** and shall make this log available when requested by the **Authority**.

TC 8.7 Site operational Procedures

The **System Operator** and the **Users** on their respective side of an **Interconnection Boundary** shall make available competent staff trained according to TC 4 to take necessary safety precautions and carry out operational duties as may be required to enable the necessary works and testing to be carried out and for the **Operation** of their respective **Electrical Facilities**.

High Voltage switching shall only be carried out with the permission of the **System Control Engineer** or its representative (s) except in case of **System Emergencies**. Persons required to carry out high voltage switching must be specifically certified

and authorized by the **System Operator** to carry out such switching.

The **System Operator** and **Users** shall follow the procedures set out in section SOC 7.2 of the **System Operations Code**.

TC 9 OPERATIONAL COMMUNICATIONS

TC 9.1 Introduction

The System Operators and Users shall exchange information in relation to **Operations** which have had (or may have had) or will have (or may have) an **Operational Effect**:

a) on the **Transmission System** in the case of an **Operation** on a **User System**, and
b) on a **User System** in the case of an **Operation** on the **Transmission System**.

For the purpose of this section, **Users** mean the **Distribution Licensee** and any user connected to the **Transmission System**.

The **System Operator** and **Users** shall comply with the requirements established in section SOC 10 of the **System Operations Code**.

TC 10 DEMAND CONTROL (TRANSMISSION SYSTEM)

TC 10.1 Introduction

The **System Operator** shall make provisions and procedures to be followed by the **System Operator** and **Users** to allow a reduction of **Demand** in the event that there is insufficient **Generation** available to meet the **Demand** in all or any part of the **Transmission System** and/or in the event of problems on the **Transmission System**, including, without limitation, in the event of both a steady state shortfall of generation and a transient shortfall of generation following a sudden loss of generation.

The **System Operator** and **Users** shall comply with the requirements established in section SOC 8 of the **System Operations Code**.

TC 11 SYSTEM CONTROL

The **System Operator** shall:

a) jointly agree with each **User** and outline in writing schedules specifying the responsibilities for control of **Equipment**,
b) maintain in coordination with the **Users** a suitable system of documentation which records all relevant operational events, and
c) specify suitable communication systems to be established between the **System Operator** and **Users** to ensure the **System Control** is carried out in a safe and secure manner.

The term **User** refers to any person using the **Transmission System**, or the **Distribution System**, including Generators, Transmission Licensee, Distribution Licensee and other users (Large Customers).

The **System Operator** and **Users** shall comply with the requirements established in section SOC 6 of the **System Operations Code**

TC 12 CONTINGENCY PLANNING

TC 12.1 Introduction

The **System Operator** shall develop a strategy to be implemented in **System Emergency** conditions of **Major System Failure**.

The **System Operator** and **Transmission Licensee, Distribution Licensee, Generators,** and **Users** connected to the **Transmission** or **Distribution Systems** shall comply with the requirements established in section SOC 13 of the **System Operations Code.**

TC 13 INCIDENT INFORMATION SUPPLY

TC 13.1 Introduction

The **System Operator, Users** or **Generators** shall issue notices of all **Incidents** on their respective **Systems** that have or may have implications for the **Transmission System**, **Distribution System** or a **User's System**.

The **System Operator** shall determine if an **Incident** should be classified as a **Major System Failure.**

The **System Operator, Users and Generators** shall comply with the requirements established in section SOC 14 of the **System Operations Code.**

TC 14 COMMUNICATIONS AND CONTROL

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

TC 14.1 Telephony

Control Telephony is the method by which a **User** Responsible Engineer/Operator and the **System Operator's Control Engineers** or Operators shall speak to one another for the purposes of control of the **Transmission System** in both **Normal** and **Contingency Conditions**.

There shall be a dedicated telephony system for communication directly with the **System Operator**.

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 according to the specification of the **System Operator**. Details of the required control telephony shall be set out in the **IA, CA, PPA or ESPA**.

TC 14.2 SCADA

The **System Operator** shall provide Supervisory Control and Data Acquisition (**SCADA**) outstation interface equipment on its side of an **Interconnection Boundary**. The **User** shall provide 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 National Grid Code, **IA, CA, PPA or ESPA** , and the **Generation Code** where applicable

TC 15 NUMBERING AND NOMENCLATURE OF HV APPARATUS AT CERTAIN SITES

TC 15.1 Introduction

This section sets out the requirements related to numbering and nomenclature that:

a. **Transmission Apparatus** on **Users' Sites**; and

b. **User Apparatus** on **Transmission Sites**

c. **User** and **Transmission HV Apparatus** in cases where the **User** is **Interconnected** to the **Transmission System** through an **Electric Line**;

shall have in accordance with the system used from time to time by the **System Operator**.

The numbering and nomenclature of each item of **Apparatus** shall be included in the **Operation Diagram** prepared for each **Interconnection Site** and **User Interconnection Facilities**. Further provisions on **Operation Diagrams** are contained in Section TC 19.3.

TC 15.2 Objective

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 15.3 Transmission Apparatus on Users' Sites

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

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** within a reasonable timeframe prior to the proposed installation.

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.

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**.

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**.

TC 15.4 User Apparatus on Transmission Sites

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

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.

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.

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 15.5 Changes

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**.

The provisions of this sub-section TC 15.5 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 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** 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.

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**.

When a **User** installs **Apparatus** in accordance with TC 15, 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 15 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.

When the **System Operator** installs **Apparatus** which is the subject of TC 15, 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 this section TC 15, 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 16 TESTING, MONITORING AND INVESTIGATION

TC 16.1 Introduction

This section sets out the required authorization and the procedures to be followed by the **System Operator**, and the **Users** wishing to conduct **Operational Tests** or **Site Investigation Tests** involving **Electrical Facilities** connected to the **Transmission System**.

System Operator authorization is required to conduct **Operational Tests** or **Site Investigation Tests**.

TC 16.2 Objective

The objectives of this section are to ensure that **Operational Tests** and **Site Investigation Tests**:

a) are authorized by the **System Operator** and are carried out in accordance with the appropriate procedures;
b) are carried out in a coordinated manner to avoid unnecessary risk or damage to **Electrical Facilities** and to minimize 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.

A further objective is to allow sufficient tests to be conducted to enable predictive **Fault** findings.

TC 16.3 Categories of Tests

This sub-section covers the following categories of test:

a. **Operational Tests** to commission or test the compliance of **Generating Units** with the requirements of an **IA, CA, PPA or ESPA** or for other purposes specified in the **Generation Code**.

b. **Site Investigation Tests** in relation to E**lectrical Facilities** 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 interconnection conditions in TC 5 are being complied with in respect of the **User's Electrical Facilities**.

TC 16.4 Authorization and Test Procedures

Prior authorization from the **System Operator** is required before conducting an **Operational Test**, **Site Investigation Test** or other tests.

Users seeking to conduct an **Operational Test** or **Site Investigation Test** shall submit a **Test Request** to the **System Operator** giving at least 8 weeks minimum notice before the date of the proposed test. The **System Operator** shall reserve the right to have a representative present during any such tests.

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 **License** 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.

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**.

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

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.

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**.

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 **Authority** for determination.

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 16.5 Test Commiittee

If a **Test Request** is approved, the **System Operator** shall decide if a **Test Committee** is required. If the **System Operator** decides that a **Test Committee** is required, the **System Operator** shall convene a **Test Committee**. The number of **Test Committee** members shall be kept to the minimum number of persons compatible with affected **User** representation.

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

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

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

The **System Operator** shall not disclose information provided to a **Test Committee** 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 16.6 Post Test Reporting Requirements

At the conclusion of an **Operational Test** or **Site Test 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** or **Site Test Investigation**. The report shall be copied to the **System Operator** and the **Authority**.

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.

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.

The **Test Committee** shall be disbanded after the final test report has been approved.

TC 16.7 Operational tests

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

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.

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

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 16.7.1 Operational Tests Required by the System Operator

The **System Operator** will in accordance with **Prudent Utility Practice**, need to carry out **Operational Tests** in order to maintain and develop operational procedures, to train staff, and to acquire information in respect of the **Transmission System** behaviour under abnormal system conditions.

The **System Operator** shall endeavour to limit the frequency of occurrence, scope, extent of effects and type of **Operational Tests** to those that are required by **Prudent Utility Practice**.

Operational Tests required by the **System Operator** from time to time shall include, but shall not be limited to the following:

(i) Tests involving the controlled application of **Frequency** and/or **Voltage** variations aimed at gathering information on **System** behaviour;

(ii) Tests of the **System Restoration Strategy**;

(iii) Testing of standing procedures for **System Emergency.**

(iv) Testing or monitoring of **Power Quality** under various **Transmission System** conditions and **Dispatch** configurations.

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 Electrical Facilities**, the **System Operator** shall give 8 weeks' notice and provide sufficient information to the potentially affected **Users** to enable them assess any risks to their **Electrical Facilities**.

The **System Operator** shall provide at least the following information:

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**.

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 16.7.2 Operational Tests Required by Users

Operation of **Users' Electrical Facilities** in accordance with **Prudent Utility Practice** requires testing to maintain and develop operational procedures, develop and measure **Equipment** performance, comply with statutory or other industry obligations and contracts, and to train staff.

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

Users shall submit a Test Request to the **System Operator** in accordance with the requirements of sub-section TC 16.4.

TC 16.7.3 Operational Tests of Generating Units

The procedure to be adopted to perform **Operational Tests** of **Generating Units** is set out in the **Generation Code**.

TC 16.7.4 Other Operational Tests

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

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.

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

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 **System Operator**.

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.

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 16.8 Site Investigation Tests

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 Test** to acquire or verify information relevant to **Users Plant and/or Apparatus** design, **Operation** or **Interconnection** requirements under the **Transmission Code**, **IA, CA, PPA or ESPA** and other agreements between **Users** and the **System Operator**.

The **System Operator** may, having given reasonable notice, send a representative or

agent to a **User 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 the **Transmission Code**, an **IA, CA, PPA or ESPA**, or other relevant agreements.

TC 16.9 Other Tests

The **System Operator** can, at any time, request a test. The tests specified in an **IA, CA, PPA or ESPA** shall form the basis of the test.

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.

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**.

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.

TC 17 TRANSMISSION METERING

TC 17.1 Purpose

This section of the **Transmission Code** sets out the way in which power and energy flows shall be measured at an operational Interface.

This section of the **Transmission Code**:

- Establishes the requirements for metering the **Active Energy, Reactive Energy and Demand** from its entry to and exit from the **Transmission System** to the **Distribution System** and **Large Customers,**
- Sets out appropriate procedures for meter reading, and
- Ensures that procedures are in place to manage disputed readings.

TC 17.2 Scope

This section applies to:

a. The **System Operator.**

b. **Large Customers.**

c. **Generators**.

The requirements for the metering of **Generators** are set out in the **Generation Code**. An outline of the requirements is set out in sub-sections TC 17.3, TC 17.4 and TC 17.5.

For **Large Customers** the metering requirements are set out in sub-sections TC 17.6, TC 17.7 and TC 17.8.

TC 17.3 Metering Requirements – Generators

TC 17.3.1 Overall Accuracy

For **Generators** connected to the **HV** sections of the **Transmission System**, both **Main and Back Up Metering System** will have an accuracy class of 0.2 and shall measure

the electrical energy delivered to **Transmission System** by the **Generator** as well as energy imported by the **Generator** from the **Transmission System**.

The overall accuracy of a **Generator** metering connected to the **HV** section of the **Transmission System**, is to be designed to give a tolerance of ±0.5% on an ongoing basis.

The metering requirements for **Generators** connected to the **MV** section of the **Transmission System** will be the same as the **MSDG-3** category as established in the **Distribution Code** (DC 17).

TC 17.3.2 Relevant Metering Policies, Standards and Specifications

Both **Main** and **Backup Metering Systems** shall be installed at the **Point of Delivery** on the **System Operator** side of the **Interconnection Boundary** to accumulate the outputs and/or inputs at **High Voltage**.

Each meter shall have its own **Current Transformer** (CT) or separate CT Core and **Voltage Transformer** (VT) or separate VT Core and necessary independent systems to function effectively.

Instrument transformers shall have an accuracy class of 0.2 and shall conform to the standard IEC 61869.

The **Transmission Licensee** and the **Single Buyer** shall inspect both **Main** and **Backup Metering Systems** upon installation and at least once every year thereafter, and shall also check the certification of these meters through an accuracy test at least once every 4 (four) years thereafter or at any time the readings of these meters and the **Generator Back-up Meter** (if applicable) differ by an amount greater than 0.5%.

The **Generator** shall inspect the **Generator Back-up Meter** (if applicable) both upon installation and at least once every year thereafter, and shall also check the certification of these meters through an accuracy test at least once every 4 (four) years thereafter or at any time the readings of this meter and both the **Main** and **Back Up Metering Systems** differ by an amount greater than 0.5%.

The **Generator Back-Up Meter** (if applicable) shall be installed on the **System Operator** side of the **Interconnection Boundary** and shall be connected to a dedicated CT Core and VT Core with necessary independent systems to function effectively.

The Generator may also install meters at the Generator terminals (LV side of the step-up transformer) to meter the energy generated from the power plant for recording purposes.

TC 17.4 Parameters for Meter Reading- Generators

The **Main and Backup Metering Systems** shall make a continuous recording on appropriate magnetic media or equivalent of both the exported and the imported **Net Energy Output** of the **Generating Unit(s)**

The parameters to be metered shall be subject to the **IA, CA, PPA or ESPA**, 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.

i. Apparent Power (Volt Amperes) OUT;

j. Apparent Power (Volt Amperes) IN;

k. Total Harmonic Distortion

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

TC 17.5 Frequency of Reading - Generators

The Demand Interval for integration shall be thirty (30) minutes or sliding demand (6 x 5minutes) 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 **Main and Backup Metering Systems** and the **Generator Back-up Meter** (if applicable) will be configured to measure output at 5 (five) minute intervals or lower

All **Metering Systems** internal clocks shall be synchronized with the GPS clock at least once every month or at any time the readings of the clock of each meter differ by an amount greater than 1 (one) minute with the GPS time.

TC 17.6 Metering Requirements - Large Customers

TC 17.6.1 Overall Accuracy

The overall accuracy of the metering for revenue purposes is to be designed to give a tolerance of ± 0.5% when tested in the laboratory and ± 1.0% when tested in the field.

TC 17.6.2 Relevant Metering Policies, Standards and Specifications

The meters, and associated installations, used on the **System Operator's Transmission System** shall comply with the **Transmission Licensee**'s specification for meters and switchgears.

TC 17.7 Requirement for Metering – Large Customer

All **Interconnection Boundaries** to the **Transmission System** shall have appropriate metering in accordance with this **Transmission Code**.

For a **Large Customer** the position of the metering shall be set out in the **Interconnection Agreement**.

TC 17.8 Metering Equipment – Large Customers

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** (if applicable pursuant to TC 17.8.1).

TC 17.8.1 Revenue Meters

The revenue meter shall have the appropriate rating for the **Interconnection** requirements to be supplied and shall conform to the terms of the **Interconnection Agreement**.

Meters for revenue prurposes shall have an accuracy class of 0.2 for **HV Large Customer** and an accuracy class of not greater than 0.5 for **MV Large Customer**, **Customer** and shall measure the electrical energy delivered to the **Large Customer** from the **Transmission System.**

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**.

The relevant metered parameters, as required by the **Single Buyer** for billing purposes, shall be stored cumulatively on the meter.

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

a. KW Hours (delivered and received);

b. KVAr Hours (delivered and received);

c. KVA Hours (delivered and received);

d. Maximum Demand (30-minute period); and

e. Power Factor.

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

TC 17.8.2 Voltage and Current Transformers

All **Voltage** and **Current Transformers** shall comply with IEC Standards or their equivalents and shall have an accuracy class of 0.2 for **HV Large Customer** and an accuracy class of not greater than 0.5 for **MV Large Customer** .

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

TC 17.9 Metering Responsibility

The **Transmission Licensee** and the **Single Buyer Licensee** shall ensure that all **Interconnection Boundaries** with Large Customers are metered in accordance with this Code.

It is the responsibility of **Large Customers** and **Generators** to cooperate with the **Transmission Licensee** and **the Single Buyer** in the execution of their responsibilities under this Code and, where applicable, under the **Generation Code**.

The costs for installation and replacement of **Main** and **Back Up Meters** shall be borne by the **Single Buyer**. For **Generators**, this responsibility should be reflected in the **Generator's ESPA**. or **PPA**, and in the case of **Large Users,** in the corresponding **User's Interconnection Agreement.**

TC 17.10 Delivery Points (metering points)

TC 17.10.1 Whole Current Metering

For whole current meters (meters where the electrical current passes through the meter itself), the **Point of Delivery** should be as close as possible to the **Interconnection Boundary**.

TC 17.10.2 CT Metering

The **Point of Delivery** 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 **Interconnection Boundary**.

Where the **Interconnection Boundary** is declared on the outgoing side of a high voltage circuit breaker the metering transformers may be accommodated in that circuit breaker unit.

Where appropriate the **Point of Delivery** should be at the same voltage as the **Interconnection Boundary**.

Where the **Point of Delivery** is at a lower voltage than the **Interconnection Boundary** then appropriate loss factors should be calculated to ensure any additional loss is appropriately accounted for.

TC 17.11 Meter Reading and Collection Systems

TC 17.11.1 Meter Reading and Recording Responsibility

It is the responsibility of the **Single Buyer** to ensure that meters are read in accordance with the requirements of the **Single Buyer License**. Meter reading and recording shall be undertaken by a suitable authorized representative of the **Single Buyer**.

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

The **Customer** shall be provided electronically its billing and consumption records on request as per the policy of the **Single Buyer**.

TC 17.12 Approval of Meters

Only meters that have received pattern approval from the Mauritius Bureau of Standards (MSB) in accordance with "Electricity Meter Testing in Mauritius - Protocol on Administrative and Testing Procedures", may be used on the **System Operator's Transmission System**, unless indicated otherwise by the Authority.

TC 17.13 Calibration and Sealing

TC 17.13.1 Calibration

All meters should be calibrated at the factory to ensure they comply with published accuracy specifications.

The **Meter Laboratory** will only perform calibration of electro-mechanical meters and accuracy test for electronic meters. Calibration of electronic meters (if required) will be done only at the factory.

Electronic meters should be certified by the manufacturer for a guaranteed calibration period over the operational life of the meter. However, in case that a meter experiences an accuracy drift over time due to environmental or other unknown factors, it shall be sent back to the factory for re-calibration and certification.

In case a meter has exceeded the guaranteed calibration period given by the manufacturer, it should be sent for accuracy test as soon as practical. In case the accuracy test is not within standard limits, the meter shall be sent for calibration.

All laboratory calibration shall be undertaken in laboratories accredited by the Mauritius Accreditation Service (MAURITAS), unless indicated otherwise by the Authority,

TC 17.13.2 Traceability

The kilowatt hour standard used to calibrate electricity meters shall be traceable to a recognized national or international standard.

TC 17.13.3 Sealing

All meters shall be constructed to enable the meter unit to be sealed to prevent unauthorized access or interference with the Operation of the meter or the input terminals of the meter.

Seals applied on a meter after calibration, shall be marked with the date of recalibration and serial number.

TC 17.14 Metering Disputes

TC 17.14.1 Meter Inaccuracy

If the **Metering System** is found to be inaccurate more than the allowable error (as indicated in TC 17.3.1 and TC 17.6.1, and the **Single Buyer** and the **User** or **Generator** fail to agree upon an estimate for the correct reading within a reasonable time of the **Dispute** being raised (as specified in the relevant **IA, CA, PPA or ESPA**), then the matter may be referred for arbitration by either party in accordance with the relevant **IA, CA, PPA or ESPA**.

TC 17.14.2 Meter Accuracy Check

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.

Should a **User** request more than one accuracy check in a single calendar year and the accuracy is within the allowable error, then the **Single Buyer** may charge for the additional checks.

TC 17.15 Inspection and Testing

TC 17.15.1 Maintenance Policy

The **Transmission Licensee** and the **Single Buyer** 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 sub-section TC 17.3.2 and TC 17.6.2 above.

TC 17.15.2 Maintenance Records

The **Transmission Licensee** shall keep all test results, maintenance program records and sealing records for a period of at least 5 years..

TC 17.16 Generator Metering

The **Generator** shall abide by the conditions of the **Generation Code** that details the maintenance procedures to be applied in the case of **Generator's** meters.

The **Generation Code** includes provisions on the use of **Main** and **Back Up Metering Systems** and Generator Back-up meter (if applicable) when metering inaccuracies are suspected and on the resolution of metering disputes.

TC 18 TRANSMISSION SYSTEM DATA REGISTRATION SCHEDULES

TC 18.1 User System Data Schedule

The data in this schedule is required from all **Users** connected directly to the **Transmission System**.

Data	Unit	Value
Operation Line Diagram		
Single Line Diagram showing all existing and proposed equipment and Apparatus and Interconnections together with equipment rating	Drawing	
Site Responsibility Schedules	Schedule	
Safety Coordinators	Text	
Reactive Compensation Equipment: For all reactive compensation equipment connected to the User System at 22kV and above, other than Power Factor correction equipment associated directly with a Customer Plant, the following details		
Type of equipment (e.g. fixed or variable)	Text	
Capacitive rating	MVAR	
Inductive rating	MVAR	
Operating range		
Details of any automatic control logic to enable operating characteristics to be determined	Test/Drawing	
Interconnection Boundary to the User System in terms of electrical location and System voltage	Text	
Switchgear: For all switchgear (i.e. circuit breakers, switch disconnectors and isolators) on all circuits directly connected to the **Interconnection Boundary**		
Rated short-circuit breaking current		
Single phase	kA	
Three phase	kA	
Rated load breaking current		
Single phase	kA	
Three phase	kA	
MV Motor Drives		
Rated Active Power	MW	
Full Load Current	kA	
Means of starting	Text	
Starting Current	kA	
Motor torque/speed characteristics	Chart	
Drive torque/speed characteristics	Chart	
Motor plus drive inertia constant	kg.m2	
User Protection Data: Following details relates only to protection equipment which can trip, inter-trip or close any Interconnection Boundary circuit breaker or any System Operator circuit breaker		
A full description including estimated settings, for all relays and Protection systems installed or to be installed on the User System	Text	

Data	Unit	Value
A full description of any auto-reclose facilities installed on the User System, including type and time delays	Text/Drawing	
The most probable fault clearing time for electrical faults on any part of the User System Directly Connected to the Transmission System	s	
Model of the **Protection** relays in the electronic format required by the power system simulation tools used by **System Operator**. The **Model** shall be validated with site test results		
Transient Over-Voltage Assessment Data: When requested by the System Operator, each User is required to submit data with respect to the Interconnection Site as follows (undertaking insulation co-ordination studies)		
Bus bar layout, including dimensions and geometry together with electrical parameters of any associated current transformers, voltage transformers, wall bushings, and support insulators	Drawing	
Physical and electrical parameters of lines, cables, transformers, reactors and shunt compensator equipment Connected at that bus bar or by lines or cables to the bus bar (for the purpose of calculating surge impedances)	Table	
Specification details of connected directly or by lines and cables to the bus bar including basic insulation levels	Text	
Characteristics of over-voltage protection at the bus bar and at the termination of lines and cables connected at the bus bar	Text/Tables	
Current and Voltage Transformers		
Current Transformer: (a) Number of CT provided (b) Type (c) Model/Make (d) Burden for protection (e) Burden for metering (f) Accuracy class for protection (g) Accuracy class for metering (h) Rated primary current (i) Rated secondary current (j) No. of primaries Voltage Transformer: (a) Number of units installed (b) Type (c) Model/Make (d) Burden (e) Rated primary voltage (f) Rated secondary voltage		

Data	Unit	Value
(g) Accuracy class (h) Transformation ratio (i) Rated thermal output **Model** of the **CTs** and **VTs** in the electronic format required by the power system simulation tools used by **System Operator**.		

TC 18.2 Transmission system connected transformer data

Parameter	Symbol	Units
Number of windings		
Vector group		
Rated current of each winding		A
Transformer rating		MVA_{Trans}
Transformer tertiary rating		MVA
Transformer nominal LV voltage		kV
Transformer nominal tertiary voltage		kV
Transformer nominal HV voltage		kV
Tapped winding		HV/MV/LV/None (Delete what is not applicable)
Transformer ratio at all transformer taps		
Transformer impedance (resistance R and reactance X) at all taps	R+jX	% on rating MVA_{Trans}
For three-winding transformers, where there are external connections to all three windings, the impedance (resistance R and reactance X) between each pair of windings is required, measured with the third set of terminals open-circuit	Z_{HVMV}	% on rating MVA_{Trans}
	Z_{HVLV}	% on rating MVA_{Trans}
	Z_{MVLV}	% on rating MVA_{Trans}
Transformer zero sequence impedances at nominal tap		
Zero phase sequence impedance measuredbetween the HV terminals (shorted) and the neutralterminal, with the LV terminals open-circuit	Z_{HT0}	Ohm
Zero phase sequence impedance measured between the HV terminals (shorted) and the neutral terminal, with the LV terminals short-circuited to the neutral	Z_{HL0}	Ohm

Parameter	Symbol	Units
Zero phase sequence impedance measured between the LV terminals (shorted) and the neutral terminal, with the HV terminals open-circuit	Z_{LT0}	Ohm
Zero phase sequence impedance measured between the LV terminals (shorted) and the neutral terminal, with the HV terminals short-circuited to the neutral	Z_{LH0}	Ohm
Zero phase sequence leakage impedance measured between the HV terminals (shorted) and the LV terminals (shorted), with the Delta winding closed	Z_{L0}	Ohm
Earthing arrangement, including LV neutral earthing resistance and reactance core construction (number of limbs, shell or core type)		
Open-circuit characteristic		Graph

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

TC 18.3 FACTS devices

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

Applications requiring rapid control capability include the following:

a) Voltage regulation following loss of a system component, generation, or large load
b) Arc furnace voltage flicker mitigation
c) Negative phase sequence voltage compensation
d) SSR (sub-synchronous resonance) damping
e) Machine transient stability enhancement
f) System load transfer capability enhancement
g) Load sharing control in interconnected, deregulated, networks

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

Because **FACTS** devices are purpose-designed for their specific applications, the data in the following table is required.

Name	Station, HV voltage, device number
Type	(SVC, STATCON, TCSC, etc.)
Configuration	provide a single line diagram showing all HV components and their MVA/Mvar and voltage ratings, with all controlled components identified as such

Control system	provide a dynamic **Model** of the **FACTS** and its control systems in the electronic format required by the power system simulation tools used by **System Operator**. The **Model** shall be validated with site test results
Primary control mode	Voltage control, arc furnace flicker mitigation, negative phase sequence voltage control, etc.

Users are required to perform harmonic studies to ensure that their **FACTS** devices do not excite harmonic resonance, and that harmonic distortion levels at the **Interconnection Boundary** with the **Transmission System** do not exceed the limits specified in this **Transmission Code**.

TC 18.4 Shunt capacitor or reactor data requirements

For each shunt capacitor or reactor or power factor correction equipment or harmonic filters with a rating in excess of 10 Mvar connected to or capable of being connected to a customer network, the **User** shall inform the **System Operator** and, if required, shall provide the **System Operator** with the specific shunt capacitor or reactor data as well as network details necessary to perform primarily harmonic resonance studies. The customer shall inform the **System Operator** of his intention to extend or modify this equipment.

If any **Party** finds that a capacitor bank of 10 Mvar or less is likely to cause harmonic resonance problems on the **Transmission System**, he shall inform the **System Operator**. The 10 Mvar minimum size limit shall thereafter be waived in respect of the affected network for information reporting purposes in respect of this code, and the **System Operator** shall inform the affected **Parties** of this fact and request the additional data. If the affected network is modified or reinforced to the extent that capacitor banks of 10 Mvar or less no longer cause harmonic resonance problems on the **Transmission System**, the **System Operator** shall inform the affected participants that information reporting requirements have returned to normal.

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

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

TC 18.5 Information on User's networks

Users shall provide detailed information on the lines and cables used for the connection to the **System**.

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

Overhead line data

Parameter	Units
Line description	Name ("from" busbar, "to" busbar, circuit number and, where applicable, line section number numbered from the "from" busbar end)
Line voltage (specify separately for dual voltage multi-circuit lines)	kV
Single/double/multiple circuit	
Standard suspension tower information (to confirm impedance): supply copy of tower drawing, or sketch drawing showing co-ordinates of shield wire and phase conductor bundle attachment points relative to tower centre line and ground level at nominal tower height	
Phase sub-conductor type (per circuit)	
Number of sub-conductors per phase conductor bundle	
Sub-conductor spacing, if applicable (supply sketch showing phase conductor bundle geometry and attachment point)	mm

Parameter	Units
Number of earth wires	
Earthwire description	
Line length	km
Conductor parameters (R, X, B, R0, X0, B0)	Ohmic values or p.u. on 100MVA base (specify)
Conductor normal and emergency ratings	Ampere or 3-phase MVA at nominal voltage

Cable data

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

TC 18.6 Fault Infeed Data Schedule

The following information is required from each **User** who is connected to the **Transmission System** via an **Interconnection Boundary** where the **User System** contains **Generating Unit**(s) and/or motor loads. The data is required for the three following years.

Data	Unit	Value
Name of **Interconnection Boundary**	Text	
Symmetrical three-phase short circuit current infeed:		
At instant of fault	(kA)	
After sub-transient fault current contribution has substantially decayed	(kA)	
Positive sequence X/R ratio at instant of fault	(p.u.)	
Zero sequence source impedance values as seen from the **Interconnection Boundary** consistent with the maximum infeed above:		
Resistance (R)	(ohm)	
Reactance (X)	(ohm)	

TC 19 Appendices

TC 19.1 APPENDIX A: Interconnection Boundaries

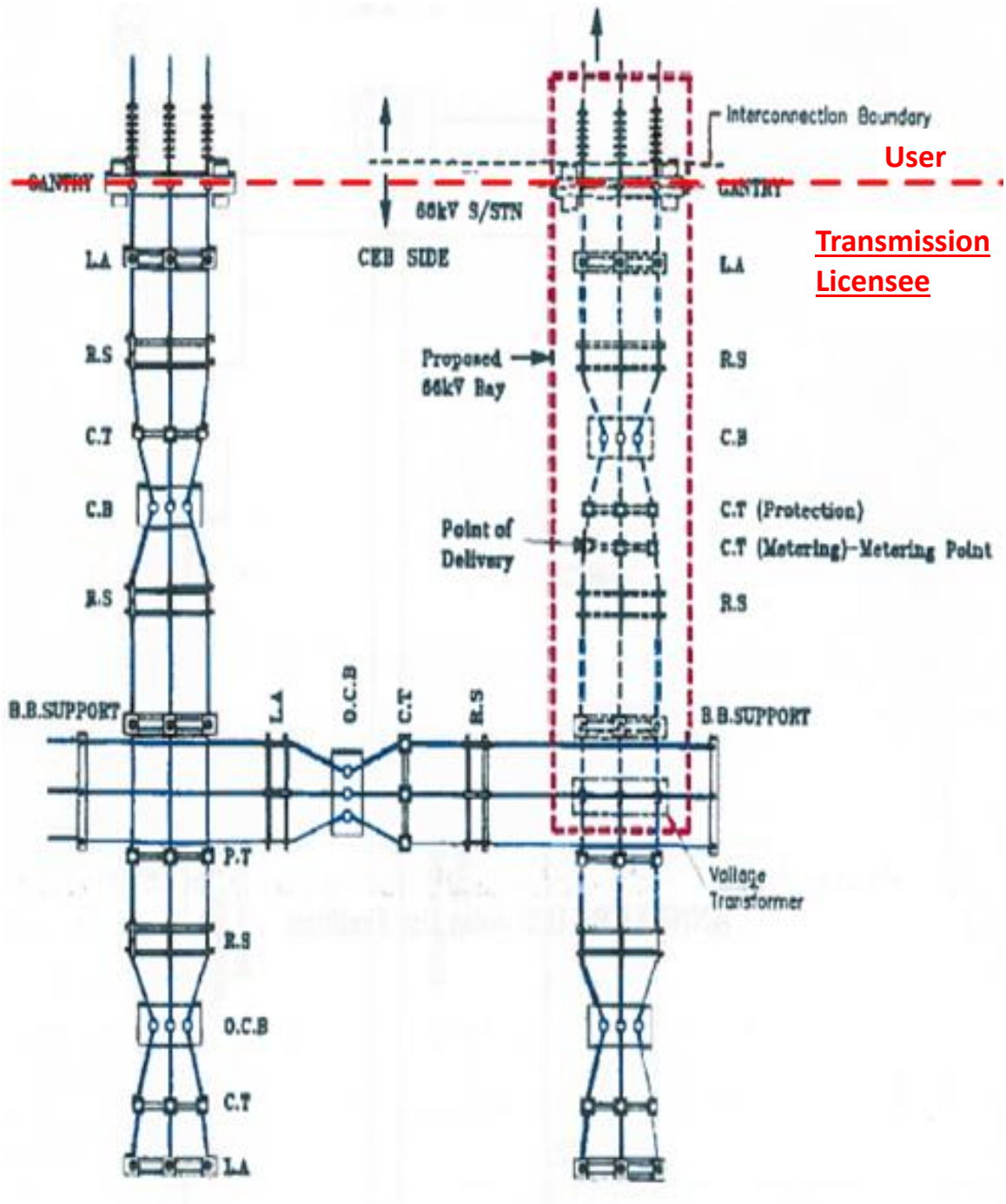

Figure 2: Interconnection Boundary in an AIS Substation.

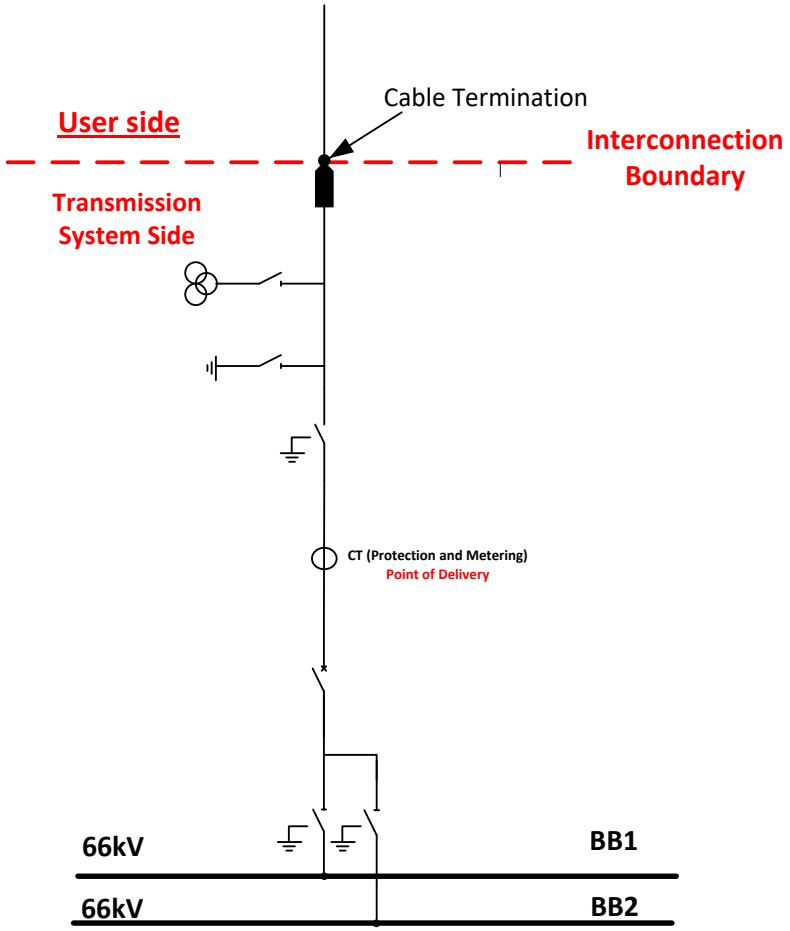

Figure 3: Interconnection Boundary in a GIS Substation.

TC 19.2 APPENDIX B: SITE RESPONSIBILITY SCHEDULES

At all **Interconnection Sites** the following **Site Responsibility Schedules** shall be drawn up using the pro-forma attached in TC 19.2.1 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 to produce the following schedules: 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 an **Interconnection Site** shall be prepared by the **System Operator** in consultation with other **Users** at least 2 weeks prior to the **Completion Date** under the **IA, CA, PPA or ESPA** for that **Interconnection Site**. Each **User** shall, in accordance with the timing requirements of the **IA, CA, PPA or ESPA**, provide information to the **System Operator** to enable it to prepare the **Site Responsibility Schedule**.

Each **Site Responsibility Schedule** shall provide the following information for each item of **Plant** and **Apparatus**;

1. Item of **Equipment** using the agreed numbering and nomenclature in accordance with Section TC 15.

2. Equipment Owner: identifies the party that owns the Equipment under common law;

3. **Safety Rules:** identifies whether the **System Operator**'s or **User**'s **Safety Rules** shall be applied to the **Equipment**.

4. Operational Procedures: 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 authorizing **Users** personnel from acting on its behalf and vice versa.

5. Control Responsibility: identifies whether the **Equipment** control used shall be **System Operators' System Control Engineer** or the **Users' Operations Engineer**.

6. Maintenance Responsibility: identifies whether the **System Operator** or the **User** is responsible for the inspection and maintenance of the **Equipment**.

7. Access and Security; 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 authorized in accordance with the prevailing **Safety Rules**.

The **HV Apparatus Site Responsibility Schedule** for each **Interconnection Site** must include lines and cables emanating from the **Interconnection** 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 involved **Users** for confirmation of its accuracy.

The **Site Responsibility Schedule** shall then be signed on behalf of **System Operator** by the manager or nominated representative responsible for the area in which the **Interconnection 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.

TC 19.2.1 ATTACHMENT TO APPENDIX B: PRO FORMA FOR SITE RESPONSIBILITY SCHEDULE

COMPANY:

INTERCONNECTION SITE:

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

Signed on behalf of the **System Operator** Date ...

Signed on behalf of the **User**.

TC 19.3 APPENDIX C: REQUIREMENTS RELATED TO OPERATION DIAGRAMS

TC 19.3.1 Basic Principles

Operational diagrams shall be produced according to the following principles:

a. Where practicable, all **HV Electrical Facilities** on any **Interconnection Site** and **User Electrical Facilities** 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 **Interconnection Site** and **User Interconnection Facilities**

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 Diagrams** must show accurately the current status of the **Apparatus**, e.g. whether commissioned or decommissioned. Where decommissioned, the associated switch bay 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 **Operation Diagrams**.

1. Bus bars
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. Power 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. Arc Suppression Coils
27. Current Transformers (where separate Plant items)
28. Wall Bushings
29. Any other **Equipment** as required by the **System Operator**

TC 19.3.2 Use of Approved Graphical Symbols

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