GRID CODE

MEDIUM SCALE DISTRIBUTED GENERATION (MSDG)

Greater than 200 kW and not exceeding 2 MW

Version 3.2

October 2019

CENTRAL ELECTRICITY BOARD

Corporate Office
P.O Box 134
Rue du Savoir, Cyber City, Ebène
Mauritius

Tel No.: (230) 404 2000
Fax No.: (230) 404 7630/(230) 454 7630

Foreword

The purpose of this document is to assist the public to better understand the procedure for application, the requirements of the Grid Code and other related issues regarding Medium Scale Distributed Generation (MSDG).

Any prospective applicant willing to take advantage of the Medium Scale Distributed Generation (MSDG) Scheme is informed that:

I. Compliance to this Grid Code shall be mandatory

II. The provisions of the Electricity Act 1939 and the Electricity Regulation 1939 shall be adhered to.

III. The provisions of the Environment Protection Act 2002, Local Government Act 2011 and Finance Act 2013.

IV. This Grid Code will be reviewed and updated when the need arises.

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DISCLAIMER

The Central Electricity Board's (CEB) "Grid Code for Medium Scale Distributed Generator (MSDG) – Greater than 200 kW and not exceeding 2 MW", including any periodic revisions, published on the CEB website, constitute the minimum technical requirements for the connection of an MSDG of size greater than 200 kW and not exceeding 2 MW to CEB's 22 kV distribution network. The owner of the MSDG may be required to meet additional requirements to ensure that the interconnection meets all local regulations and is safe for use. The requirements set in this Grid Code are based on system conditions that may be subject to change. As such, these requirements shall only be used as a guide, subject to in-depth evaluation. The use of this Grid Code and the information it contains is at the user's sole risk. Neither CEB, nor any of its personnel, makes any warranties or representations of any kind in connection with this Grid Code, including its correctness, accuracy, completeness or adequacy for any specific purpose. CEB will not be responsible or liable for any damage or loss that may arise due to the use of the Grid Code, reliance on the information it contains or any decisions made based on the Grid Code. CEB reserves the right to revise this Grid Code at any time. Any person wishing to make use of this Grid Code is invited to contact CEB before proceeding.

The CEB reserves the right to modify such technical specifications and requirements of the MSDG system and the MV switchgear before or during implementation of the MSDG connection process, in order to adhere to the latest operational and safety aspects of the network. The MSDG installation shall abide with the latest MSDG Grid Code and standards at the time of implementation of the project.

REVISIONS

Version	Date	Changes
Version 3.2	October 2019	Grid Code reviewed by CEB and updates performed in the following sections: Protection against relay malfunction (applicable on a case-to-case basis) and Inter-tripping protection.
Version 3.1	September 2019	Grid Code reviewed by CEB and updates performed in the following sections: MSDG High Voltage Switchgear, Protection and Communication Requirements, Metering, Guaranteed Operating Characteristics and Typical High Voltage Switchgear Panel layout.
Version 3.0	May 2016	Grid Code reviewed by Consultant and updates performed.
Version 2.1	December 2013	Added: Chapter 4: Guaranteed Operating Characteristic Added and Chapter 5: Testing and Commissioning.

1 CHAPTER 1: PURPOSE OF THE GRID CODE

This Grid Code describes the technical criteria and requirements for the connection of distributed generation plants of capacity greater than 200 kW but not exceeding 2MW to the CEB's 22 kV distribution network[1].

The proposed capacity shall be the AC power output from the RE installation. Capacity capping on inverters shall be applicable as appropriate.

For solar PV installations, the installed DC capacity of solar panels shall not exceed 2% of the proposed AC capacity.

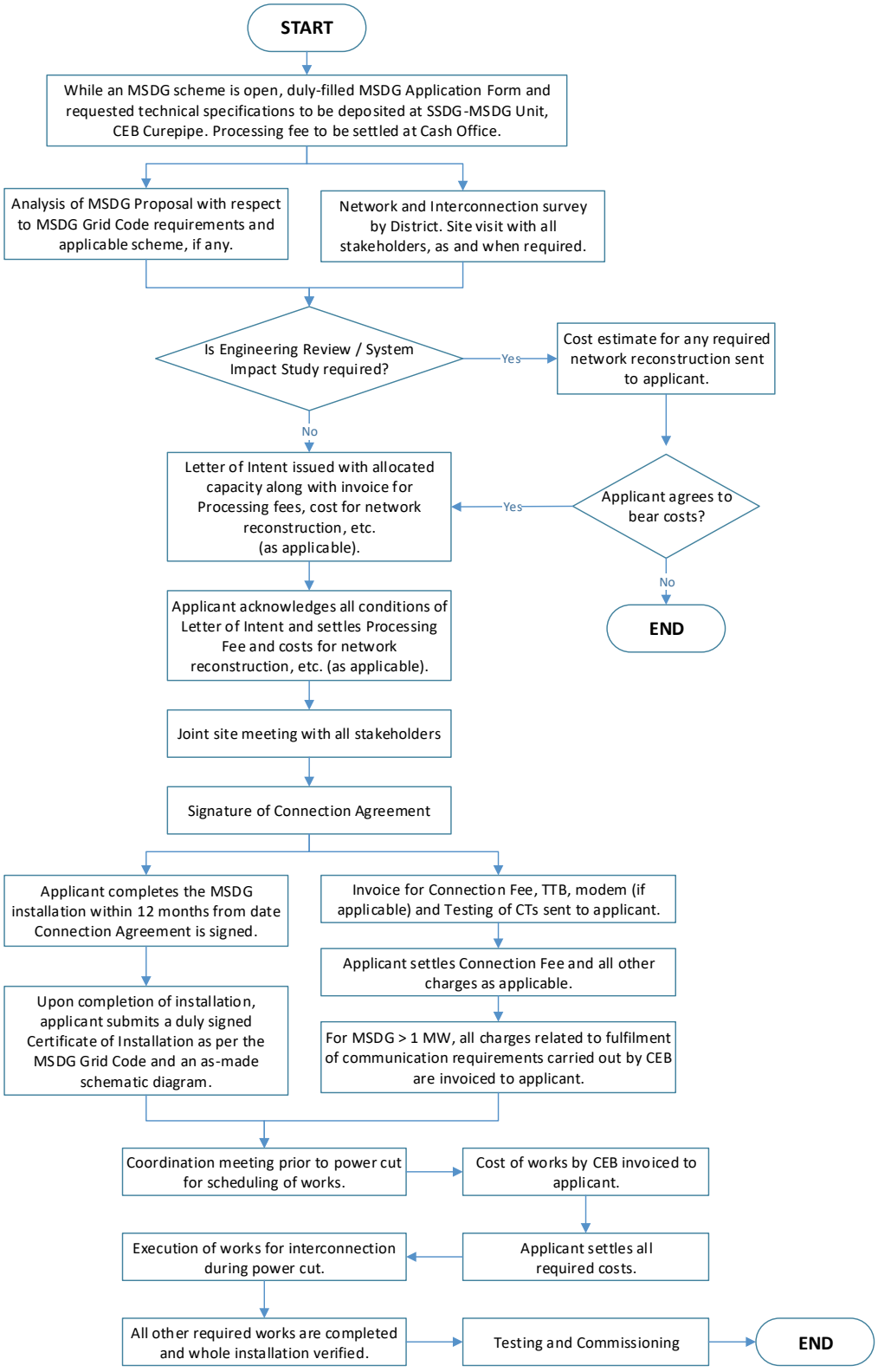
This Grid Code caters for the connection to the CEB distribution network and production of electricity by the following list of Renewable Energy Technologies (RETs):

1. Photovoltaic (PV)
2. Wind Turbine Generator (WTG)
3. Hydroelectric Generator
4. Biomass-based generator

[1] For the technical criteria and requirements for the connection of MSDG of capacity greater than 50 kW but not exceeding 200 kW, please consult the relevant grid code available on https://ceb.mu

2 CHAPTER 2: CONNECTING MEDIUM SCALE DISTRIBUTED GENERATION TO THE GRID

2.1 Connection Process



2.2 Connection Capacity

The maximum capacity of MSDG that can be connected to a Medium Voltage (MV) feeder is termed the connection capacity of that feeder. Different feeders have different connection capacities depending on the electrical characteristics of the conductor used, the magnitude and temporal variation of the feeder loading. Furthermore, the connection capacity also depends strongly on the proposed location of the connection of the MSDG to the MV feeder. In general, the connection capacity is larger near the CEB 66 kV-to-22 kV substation compared to the far-end of the feeder.

The feasibility to connect any MSDG to CEB 22 kV distribution network will need to be confirmed by an interconnection impact study which will be conducted by the CEB on a case-to-case basis. In addition, the possibility of interconnecting any MSDG facility with variable power output shall be subject to the maximum amount of variable renewable energy-based power generation that can be accommodated in the CEB's power system while maintaining the system's stability and security.

If any works in the power distribution network are necessary, the CEB will determine what network modifications (reinforcements or extensions) are required, if any, to connect the MSDG by conducting the necessary studies. The description of the required network modifications shall be communicated to the applicant for connection, detailing who will be the party (CEB or the applicant for connection) responsible for execution of each of the works and who will be the party (CEB or applicant for connection) responsible for payment of each of the works.

Capacity allocation in the feeders shall be done according to the following rules:

- Applications shall be processed strictly according to the date/time of the settlement of the application processing fees.
- Authorized applications shall be allocated to the feeder subject to a favorable interconnection impact study.
- Allocated capacity shall remain valid for the period of one (1) year, from the date the Connection Agreement is issued, where the applicant shall develop the project.
- Failing to finalize the MSDG installation and to submit the Certificate of Installation within the period of one year, from the date the Connection Agreement is issued, shall result in the automatic cancellation of the authorization and the capacity shall be freed for other applicants.

Note:

CEB shall process applications based on the principle of "first in first out". Requests will be processed in this priority order, and in each interconnection study all approved precedents requests will be considered as in service. Requests with positive interconnection study outcomes shall be considered.

The reference point will be when the "processing fee" has been settled.

3 CHAPTER 3: MSDG INTERCONNECTION REQUIREMENTS AND SAFETY ASPECTS

3.1 Interconnection Facility Characteristics

The interconnection facility required for the MSDG facility is described hereunder:

- The MSDG facility is connected to CEB's 22 kV network through a switchgear panel and a step-up interconnection transformer.
- The **"CEB Interconnection Facilities"** which shall be the facilities required to interconnect the Generation Facility to the CEB 22kV Distribution System located on the CEB side of the Point of Common Coupling(PCC) / Point of Delivery,(A), as shown in Annex 7 (see section 7.7 of this Grid Code).
- The **"MSDG Interconnection Facilities"** which shall be the facilities required to interconnect the Generation Facility to the CEB System located on the Generation Facility side of the Point of Common Coupling (PCC) / Point of Delivery (A) as shown in Annex 7 (see section 7.7 of this Grid Code).

3.2 22 kV System Parameters

The MSDG shall have the following design parameters. The MSDG has to function and protect itself within the following range of the voltages, currents and frequencies existing on the CEB grid.

Under normal system conditions:

Table 1 Design Parameters under Normal Conditions

Parameter	Values
Service Voltage	23.0 kV and 20.5kV (+4.5% and -7%)
System Earthing	Effectively earthed/Non-effectively earthed[2]
Frequency	50.75 Hz and 49.25 Hz (50 Hz ± 1.5%)
Fault Level	600 MVA

[2]The applicant should contact CEB to determine what type of system earthing is being used on the line to which his plant is proposed to be connected and adopt the system earthing type communicated by CEB.

CEB is responsible for maintaining those values inside the fixed limits using all normal means available to CEB.

After a single incident or under emergency conditions, frequency and voltage may go out of normal limits but still inside operational acceptable values. Generators must be able to operate within the following limits:

Table 2 Design Parameters under Incident and Emergency Conditions

Parameter	Values
Service Voltage	24 kV and 19.8 kV (+9% and – 10%)
System Earthing	Effectively earthed/Non-effectively earthed
Frequency	52.00 Hz and 47.00 Hz (+4% and -6%)
Fault Level	600 MVA

3.3 MSDG High Voltage Switchgear

The switchgears shall be arranged as illustrated in Annex 7 (see section 7.67 of this Grid Code), consisting of CEB interconnection facilities and MSDG interconnection facilities demarcated by a metallic barrier.

The applicant shall construct, install, test and commission the complete 22kV switchboard as per the default scheme shown in Annex 7 (section 7.7 of this Grid Code), i.e. the CEB as well as the Client side. CEB will take ownership of its side after the guarantee period. Alternative connection and switchgear schemes are possible if so approved by the CEB for every particular case. Switchgear with outgoing 22kV fuses on client side shall be replaced by outgoing 22kV Circuit Breakers by the Client. All other equipment (such as PT, CT, etc. as well as appropriate spares) which are not compliant with the current HT Metering Specifications as in Annex 7, shall be replaced by the Client to ensure compliance with the MSDG Grid Code and the HT Metering Specifications. The cost of all the above modifications in the 22 kV switchgear, be it on the CEB side or on the client side, shall be borne by the client.

The switchgear shall have the following characteristic:

Table 3 Switchgear Characteristics

Parameter	Values
Nominal system voltage	22 kV
Highest system voltage for equipment	24 kV
Rated voltage	24 kV
Impulse test voltage 1, 2/50 μs	125 kV peak
Rated short circuit capacity	16 kA rms 1 sec
Electro-dynamic withstand	40 kA peak
Busbar rating	630 A

The detailed technical characteristics and responsibilities of the 22kV switchgear should comply with the current HT Metering specifications, as given in Annex 7 (section 7.7 of this Grid Code). The 22kV switchgear shall be approved by the CEB prior to ordering.

For existing 22kV switchgear, all modifications required on CEB side of the interconnection facility for accommodating an MSDG installation, shall be performed by CEB at the expense of the MSDG owner.

3.4 MSDG Interconnection transformer

The MSDG interconnection transformer shall be of vector group Dyn11 (Delta on High Voltage Side and Star on MSDG Side). The delta winding on the CEB side ensures that:

(i). The performance and sensitivity of the earth fault protection scheme at CEB substation are not affected;
(ii). Triple harmonics from the MSDG do no reach CEB's network
(iii). The MSDG is provided some isolation from voltage sags due to single-line-to-ground faults, allowing it to better ride through voltage sags.

Alternative transformer vector groups may be used subject to CEB approval.

The detailed specifications of the interconnection transformer are given in Annex 7 (section 7.7 of this Grid Code, Schedule A5). The transformers shall be approved by the CEB prior to ordering.

3.5 Earthing Arrangement

The earthing arrangement of the generating plant must be designed to ensure compatibility with the earthing system of the CEB distribution network. The actual earthing arrangements will also be dependent on the number of generating units in use and the generators system configuration and method of operation. The system earth connection shall have adequate electrical and mechanical capability for the duty.

In the event that the Applicant is allowed to operate independently and isolated from the CEB's system, the Applicant shall ensure that the electrical and protection systems of the facility are designed to support such mode of operation. Safety of personnel and integrity of equipment shall be guaranteed at all times during both parallel and isolated modes of operation.

Earthing systems shall be designed, installed, tested and maintained according to BS 7354 (Code of Practice for Design of high voltage open terminal stations)[3] and BS 7430 (Code of Practice for Protective Earthing of electrical installations). Steps must be taken to prevent the appearance of hazardous step and touch potential when earth faults occur on the 22 kV network. The 22 kV earth electrodes and low voltage earth electrodes shall be adequately separated to prevent dangerous earth potentials being transferred to the low voltage network.

3.6 Protection Requirements

3.6.1 General requirements

The coordination and selectivity of the protection system must be safeguarded even with the entrance of new generation into the system. To satisfy this condition, the protections to be installed are listed in the following sections and the settings of those protections shall be proposed by the promoter and accepted by CEB.

In case of short circuits in the MSDG side, the MSDG shall adjust its protections in such a way that they will avoid unnecessary trips in the CEB's side of the interconnection facilities and at the same time avoid that the incident propagates to the general system.

In case of incidents of origin external to the MSDG system, such as short circuits in the distribution system, voltage or frequency excursions, MSDG shall give priority to the network protections to solve the incidence and act accordingly with the coordination and selectivity principles of the protections system.

[3] Corresponding updated version(s) at time of application

The protection system shall provide protection against fault occurring on both the CEB's network and the MSDG facility. The protection system is to provide protection against short circuit, earth faults and overloading conditions and also prevent islanding operation of the CEB distribution feeder whereby the MSDG is connected.

The protection system shall incorporate, where feasible, a watchdog function that monitors relay status. The protection system is detailed in the subsections 3.6.2 and 3.6.3 as interconnection protection scheme and anti-islanding protection scheme respectively. The protection guidelines for MSDG is illustrated in Annex 7, Schedule A2 (section 7.7 of this Grid Code).

In addition, the applicant must provide any additional protection functions necessary to adequately protect all equipment and personnel. The settings of the additional protection systems must be appropriately graded to prevent unnecessary trips during disturbances that affect voltage and frequency on the CEB system. Any modifications in the protection settings proposed to be carried out by the MSDG promoter shall be submitted to the CEB for approval before implementation.

The MSDG owner shall, at its expense, install, maintain, and operate system protection facilities on the Generation Facility side of the PCC, including such protective and regulating devices, or as otherwise necessary, to protect personnel and equipment and to minimize deleterious effects to CEB's electric service operation arising from the Generation Facility. Any such protective or regulating devices that may be required on CEB's facilities in connection with the operation of the Generation Facility shall be procured, tested and commissioned by the MSDG owner subject to the approval of CEB and in line with CEB Safety Rules and Regulations. The installation of same shall be performed by CEB at the expense of the MSDG owner. A duly signed test certificate shall be then submitted to CEB.

The MSDG owner shall maintain the protection system on his side according to the supplier/manufacturer's recommended maintenance frequency. The MSDG owner shall also keep in his custody spares of all relays used in the MV switchgear and provide same to CEB for replacement in case of any faulty relay in the future.

3.6.2 Interconnection protection scheme

The Interconnection Protection Scheme must provide protection against short circuit, earth fault and overloading conditions. This scheme shall consist of the following protection functions:

(i) Multi steps instantaneous/time delayed and IDMT overcurrent (50/51)
(ii) Multi steps instantaneous/time delayed and IDMT earth fault (50N/51N)
(iii) Neutral Voltage Displacement (59N).

The protection relay for CB1 (see Annex 7) must comprise of multi-stages for both overcurrent and earth fault:

- The I>/Io> (low set for overcurrent and earth fault) elements must provide a selection of inverse definite minimum time (IDMT) curves, or be settable to a fixed (definite) time delay.
- The I>>/Io>> (high set for overcurrent and earth fault) elements must provide both time delayed and instantaneous functions.

The characteristics for these protection functions are detailed in Annex 7 (section 7.7 of this Grid Code). The protections 50/51 and 50N/51N shall act on the interconnection circuit breaker of the CEB Interconnection facilities (CEB MSDG Circuit Breaker (CB1)) and the protection 59N shall act on all client's outgoing circuit breakers of the Interconnection facilities.

The settings for the protection functions 50/51 and 50N/51N shall be determined by the applicant, through a proper protection study, and submitted to CEB for information.
The setting for the neutral voltage displacement is to be calculated as follows:

Table 4 NVD trip settings

Parameter	Symbol	Trip setting	Clearance
Neutral Voltage Displacement (59N)	NVD	Subject to clearance time, trip signal to be issued when the neutral point voltage displacement on the 22 kV side exceeds 10% of $\frac{22kV}{\sqrt{3}}$ (1,270 V).	5.5 s

CEB reserves the right to set updated settings for the NVD relay based on network parameters.

Under normal setup, the NVD relay shall be driven from PTs on the client side of the MV switchgear.

Exceptionally, where it is practically not possible to install PTs on the client side, the NVD relay (client side) may be driven by the PT protection core (CEB side), via a set of Test Terminal Block (TTB) on the CEB side of the switchgear.

Protection settings shall be adjusted so that the protections closer to the fault act first and the second level protections only act if the short circuit condition persists. Thus, the time settings shall be adjusted in coordination with and to the satisfaction of CEB.

Note: The protection requirement for the step-up transformer shall be determined by the applicant.

Under certain circumstances, if in case discrimination of setting is not achieved and for MSDG installations having synchronous and/or induction machines, CEB reserves the right to request the client to install directional protection relays which shall act on CB1.

Directional Over-Current and Earth-fault Relay

The relay shall be numerical type with appropriate current and voltage inputs to achieve directional protection.

The relay shall provide at least three independent stages for overcurrent (I>, I>>, I>>>) and earth fault (Io>, Io>>, Io>>>).

The time/current characteristics associated with the low stage elements (I> and Io>) must provide a selection of inverse definite time (IDMT) curves and definite time delay (DT). The high set elements (I>>, I>>>, Io>> and Io>>>) must be settable to definite time and instantaneous.

Directional Control shall be determined by Voltage Polarization Principle for both Over-Current and Earth Fault and should be settable for both forward and reverse direction of the fault.

3.6.3 Anti-islanding protection

The MSDG shall not supply power to the CEB's network during any outages of the system. The MSDG shall cease to energise the CEB's network within 0.5 seconds of the formation of an island. The following protection functions and settings are required.

- Over and under frequency (functions 81O and 81U)
- Three-phase under-voltage and overvoltage (functions 27 and 59)
- Loss of mains protection: Rate of Change Of Frequency (ROCOF) and/or Voltage vector shift (VVS).

Table 5 Anti-islanding protection trip settings

Parameter	Symbol	Trip setting*	Clearance
Overvoltage (27)	U>>	$V_{\varphi-\varphi}$ + 9%	0.2 s
Overvoltage (27)	U>	$V_{\varphi-\varphi}$ + 6.0%	1.5 s
Undervoltage (59)	U<	$V_{\varphi-\varphi}$ – 10%	3.0 s
Overfrequency (81O)	f>	52 Hz	0.5 s
Underfrequency (81U)	f<	47 Hz	3 s
Loss of mains	LoM	2.5 Hz/s (ROCOF) 10 degrees (Vector Shift)	0.5 s 0.5 s

NB: $V_{\varphi-\varphi}$ is the nominal line-to-line voltage at generator terminals

***** *The above trip settings are indicative and may be subject to change upon request of the CEB for safe interconnection to the network.*

The anti-islanding protection shall act on CB4 (MSDG circuit breaker) as shown in the typical switchgear and protection arrangement in Annex 8(section 7.8 of this Grid Code). In case inverters are used, the anti-islanding protection of the inverters may be acceptable if the inverters satisfy the standards required by CEB and set forth in the Grid Code.

For MSDG facilities of capacity equal to or greater than **1 MW**, inter-tripping facility using fiber optic cables or wireless communication will be required. This is detailed further in section 3.6.5.

3.6.4 Inter-tripping protection

An intertripping and interlocking system shall be provided to ensure that tripping of the CEB 22kV Circuit Breaker (on fault, open locally or remotely) shall inter-trip ALL the Client outgoing 22 kV Circuit Breakers instantaneously.

Closing of the CEB 22kV Circuit Breaker is ONLY allowed if ALL the Client 22 kV Circuit Breakers are in the open position.

The intertripping and interlocking system shall be supplied from a secured AC auxiliary source of supply; refer to section 3.9 (Uninterruptible Power Supply) for the requirements of the secured AC auxiliary source of supply.

3.6.5 Inter-tripping protection for MSDG of capacity equal to or greater than 1 MW

The inter-tripping scheme shall be designed and pre-wired such that tripping of the interconnecting feeder circuit breaker in the CEB 22 kV substation results in the tripping of CB1 (see Annex 8, in section 7.8 of this Grid Code). The tripping of CEB's 22 kV circuit breaker shall be a tripping due to protective relay action at CEB 22 kV substation level. Manual opening and tripping due to protective relay of CB1 shall not cause tripping of corresponding circuit breaker at CEB 22 kV substation. However, the above scheme shall be wired but disabled initially.

So as to harmonise MSDG installations with existing solar PV farms, the following indicative tripping scheme shall be implemented for MSDG installations employing solar PV systems:

(1) **During the day**, upon tripping of the 22 kV circuit breaker at the respective CEB substation on fault**,** CEB System Control operator shall open CB1 remotely.

CB1 intertrips CB2 (refer to typical schematic diagram in Annex 8).

Upon supply restoration, CEB System Control operator shall reclose CB1 remotely and liaise with the contact person at the MSDG site to reclose CB2 locally.

(2) **During the night**, upon tripping of the 22 kV circuit breaker at the respective CEB substation on fault**,** CEB System Control operator shall **not** open CB1 as there is no PV generation at night, and hence no fault contribution due to the PV installation.

(3) In case of abnormal setup (MSDG shifted to another feeder), CEB System Control shall adopt the same philosophy as above.

For MSDG using RE technologies other than solar PV systems, generation occurs throughout the day and night. Hence, upon tripping of the 22 kV circuit breaker at the respective CEB substation on fault**,** CEB System Control operator shall open CB1 remotely, irrespective of the time of occurrence of the fault.

CEB reserves the right to amend the above indicative procedure depending on operational constraints and RE technologies employed.

Reliable communication is required between CEB System Control Centre and the MSDG site.

Communication scheme shall be set as per section 3.11.

3.6.6 Protection against relay malfunction

The watchdog function of the protection relay must issue an alarm and trip the circuit breaker on which the protection relay normally acts in case there is a malfunction. This requirement will be applicable on a case-to-case basis.

For MSDG of capacity equal to or greater than 200 kW, this alarm signal, if required by CEB, shall be transmitted to the interconnecting CEB substation via the fiber optic channel or wireless communication.

3.6.7 Protection Settings: Grading and Discrimination

For MSDG of capacity above 200 kW, the Applicant shall submit to CEB appropriate settings for grading and discrimination of the interconnecting protection (22 kV circuit breaker, CEB side) with the upstream CEB substation protection.

The applicant shall also submit to CEB the fault contribution (both single phase to earth and three phase) on 22 kV side from the generating plant.

3.7 Additional Protection and Safety requirements

The protection requirements set forth in the previous sections are mandatory on all MSDG irrespective of the generation technology used. In addition to mandatory safety interlocks as per IEC 62271-200, for metal-enclosed MV switchgear, appropriate interlocking mechanism shall be incorporated between the circuit breakers on the CEB and Client side as a measure of protection against an incorrect sequence of manoeuvres by operating personnel. This interlocking mechanism shall prevent the option of mechanically closing CB1 onto a live busbar on Client Side via a mechanical interlocking system between CB1 and CB2. However CEB may request additional interlocking and protection systems for safety reasons.

The MSDG Owner shall be required to demonstrate the incorporation of the above safety interlocking mechanism both at design and implementation/commissioning stages

In case the MSDG contains synchronous and/or induction machines, additional measures listed below are required:

- A dead-bus/live-line check synchronism relay shall be provided to prevent remote/electrical closure of CB1 as long as the MSDG-side 22 kV busbar is energised.
- Check Synchronizing shall be provided on all generator circuit breakers and any other circuit breakers (including low voltage circuit breakers), unless interlocked, that are capable of connecting the MSDG plant to the CEB's network.

3.8 Re-connection

Following a protection initiated disconnection, the MSDG is to remain disconnected from the network until the voltage and frequency at the supply terminals has remained within the nominal limits for at least 3 minutes. Automatic reconnection is only allowed when disconnection was due to operating parameters being outside the normal operating range stated in Table 1, not if disconnection was caused by malfunctioning of any devices within the MSDG installation.

3.9 Uninterruptible Power Supply

a. The operation of the equipment under Central Electricity Board's responsibility shall require secured AC auxiliary source of supply also protected by surge and lightning devices. An online uninterruptible power supply (UPS) is required and it shall have adequate capacity to ensure that the protection, measurement, control and communication systems operate without interruption for a minimum duration of at least 3 hours after loss of CEB power supply. The Client shall submit the calculations in the determination of the sizing of the UPS. In the event of loss of the secured auxiliary supply, all the Client's 22kV circuit breakers shall be tripped until remedial actions are taken. The UPS system shall be installed on the Client side and be maintained accordingly by the Client. The UPS shall be equipped with a bypass switch/system that will allow continuous operation during maintenance on the UPS.

b. For MSDG installations equal to or greater than 1 MW, all equipment used for the transmission of signals and commands (PLC, modem, router, etc.) between the MSDG site and CEB System Control shall be supplied from a separate uninterruptible power supply (UPS) than the one stated in section 3.9 (a) above. All associated requirements shall also be applicable to this separate UPS.

3.10 Indication, Alarms and Instrumentation

The alarm and trip facilities shall have local indication and, for MSDG equal to or greater than 1 MW, an additional set of potential-free contacts for onward transmission of the alarm/trip signals to the CEB Substation.

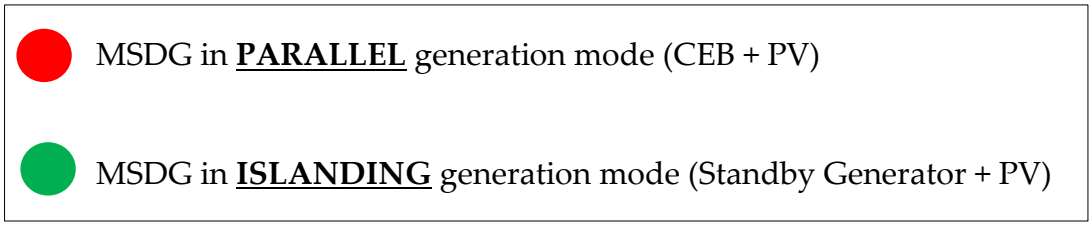
For MSDG equal to or greater than 1 MW, a local **SCADA (System Control and Data Acquisition) system** shall be installed to allow monitoring and control of the MSDG installation.

The following panel instrumentation and other fittings are required in addition to other standard equipment required or implied for the type of panel and scheme functionality:

b. Transducer fed voltmeter, ammeter, MW, MVAr, indicating import and export, and appropriate test blocks for current and voltage circuits.

c. Suitable test facilities shall be provided for the secondary injection of current/relay testing and for any other tests as reasonably required by CEB.

External indicator lamps, for MSDG greater than 200kW, shall be installed to indicate parallel operation of the MSDG facility with CEB distribution network. A lighted red lamp shall indicate parallel operation while a lighted green lamp shall indicate isolated operation.



All required equipment for the above shall be procured, installed, tested, commissioned and maintained by the MSDG owner.

3.11 Communication Requirements

Until the DMS project is implemented by the CEB, the communication requirement for MSDG Facilities shall be as described hereunder. However, once the DMS project is implemented by the CEB the following two conditions shall apply:

1. The communication requirements for all new MSDG Facilities shall be as per Annex 7, Schedule A3.
2. All existing MSDG Facilities shall modify their communication setup to be in line with Annex 7, Schedule A3.

The MSDG owner shall install communication equipment for secured transfer of operating data and protection and control signals via:

- Fiber optics cable as per Annex 9 (section 7.9 of this Grid Code) for MSDG of capacity equal to or greater than 1 MW.

In those cases where the installation of fiber optic cable is not feasible or advisable because of high risk of damaging cane fire below the cable and there is no alternative routing for the fiber optic cable at a reasonable cost, the communication can be based on wireless technologies, subject to approval by the CEB for each particular case.

Applicant shall bear the cost for the installation of communication system from the MSDG plant to the corresponding substation and shall install, test, commission and maintain the system (this includes equipment found in the CEB side of the interconnection facility and in the corresponding CEB 66 kV-to-22 kV substation).

An LV supply (230 V ± 6%) shall be provided by the CEB in the 66 kV-to-22 kV substation. However, given that this LV supply may be subject to unavoidable voltage disturbances and variations, the MSDG Owner shall ensure that all appropriate measures have been catered on his side for the protection of his communication system which may be sensitive to such power quality issues. In addition, the MSDG Owner shall be responsible for the maintenance of the communication equipment at the CEB substation. The CEB's liability shall lie up to the LV supply and shall not bear any liability for damage in the MSDG owner's communication equipment.

Relevant information for the operation of the electrical system will be transmitted in real time to the System Control Centre through the RTU (remote terminal unit) available at the CEB Substation.

i. One-Way communication from the CEB Substation to the Generation Facility of:

   - 22kV Circuit breaker status at the CEB substation(open/close);

ii. One – Way communication from the Generation Facility to the CEB Substation of:

   - Load Break Switch status OPEN for each incomer (if available)
   - Load Break Switch status CLOSED for each incomer (if available)
   - Circuit Breaker CEB (CB1) Status (open/close)
   - Outgoing Circuit Breaker (client side) (CB2) Status (open/close)
   - Outgoing Circuit Breaker (client side) (CB4) Status (open/close) (if required)
   - Alarms (list of warnings/alarms will be determined at discussion stage with CEB):
     - Protection Operated
     - Protection relay not healthy
     - SF6 Alarm (if available)
     - UPS Alarms
     - Door Alarm (Switchgear room door on CEB side)
     - Inter-tripping signal
     - Remote/Local signal (Circuit Breaker CEB (CB1))
     - Other Alarms (grouped)
   - MW, MVAr (at the import/export interface) (calculated value using 3-phase voltages and current on phases 1 and 3 (Red and Blue))

- Voltage level of the Generation Facility 22kV Busbar (Line-to-line voltage between phases 1 and 2 (Red and Yellow))
- Current (at the import/export interface) (Phase 2 (Yellow))

iii. Remote control facilities shall be provided only for MSDG facility greater than 1MW:

- Load Break Switch OPEN CTRL command for each incomer (if available).
- Load Break Switch CLOSE CTRL command for each incomer (if available).
- Circuit breaker CEB (CB1) open.
- Circuit breaker CEB (CB1) close.

iv. Optical Fiber

The Optical fiber shall connect the generation facility and the 22kV feeder's Substation on which the MSDG is interconnected. The applicant shall bear the cost of the procurement, installation and commissioning of the fiber optic link.

v. Wireless Communications

Where wireless communications are used, either as backup communication channel or as replacement of the fiber optic channel wherever authorized, it shall comply with any requirements approved by CEB and in particular with the following minimum characteristics:

- Use the latest 3G/4G/LTE or newer communication technologies for the bands of frequency used in the Republic of Mauritius;
- Use Microwave link as main channel and the latest 3G/4G/LTE as backup channel. Should any of the channel fail, switching to the other channel shall be seamless. In addition, SLA of 4 hours (Service Level Agreement) shall be applicable on the communication equipment to cater for their failure and link loss.
- Alternatively, communication equipment/modem having dual SIM slot capability and using latest 3G/4G/LTE can be used. This shall allow to remove carrier dependency and swapping network operators seamlessly if the primary run into trouble.
- Furthermore, all channels using 3G/4G/LTE technology shall deployed and configured in VPN tunnel mode (virtual private network) for increased security.
- Be equipped with at least two routers, each capable of accommodating two SIM cards from different network operators and automatic switching between operators in case of unsuccessful transmission. The two routers

shall be set up as one main and one hot standby router. This setup shall ensure equipment and network redundancy.

- Be capable of transmitting data at a rate of at least 85 kbps downloading and 42 kpbs uploading.
- Have a configuration interface protected by password;
- Be capable of using VPN tunnels using, at least, technology Open VPN; and
- Be equipped with support autorecovery mechanism.

3.12 Metering

The CEB meter, current transformers (CTs) and voltage transformers (VTs) will have, at least, an accuracy class according to the table below. The CEB meter shall have separate registers for import and export of energy to measure the electrical energy delivered to CEB by the MSDG and the import energy imported by the client's load from the CEB System. All CEB meters installed shall be certified by the meter lab of CEB.

Table 6 Metering Accuracy

Installed Capacity	Meters (Active)	Meters (Reactive)	CTs	VTs
>200 kW	0.5	1	0.5 *	0.5

Note: For Greenfield projects the metering accuracy class shall be 0.2

The CEB metering circuits shall be totally separate from the MSDG metering circuits. This is to be achieved through cabling directly from the metering current transformers (CTs) and voltage transformers (VTs). CEB shall be fully responsible for the commissioning of the metering circuits associated with CEB Meters, i.e. all pre-commissioning and final commissioning involving cabling and other circuit verification, CT and VT checks and certification, functional testing, as well as meter testing, secondary injection and final documentation.

As regard to the CTs and VTs, the MSDG promoter shall first seek CEB's approval prior to ordering and send same to CEB's Meter Lab Section for tests prior to installation.

Toroidal CTs WILL NOT BE ACCEPTED for HT metering purposes.

A second meter, namely the production meter, shall be installed by CEB inside the MSDG installation to measure the energy production of the MSDG generation facility. The power cable should fit in the inner diameter of the CT for the production meter and the CT shall be according to IEC 61869-2. The CTs must have sealing facilities.

In cases where it is not possible to locate the production meter next to the import/export meter, the production meter shall be equipped with a separate modem and SIM card and shall be installed at a convenient location and be easily accessible to CEB officers. The cost of this additional modem and the monthly communication charge shall be charged to the applicant, as well as any faulty metering equipment in the future.

In cases where additional production meters are required due to site specificities, all production meters, including the associated modems, SIM cards and communication charge, shall be charged to the applicant, as well as any faulty metering equipment in the future.

The MSDG promoter shall send the specifications and burden calculations of the proposed CTs and the Test Terminal Block (TTB) to the CEB for approval before procurement. Alternatively, the TTB can also be purchased from CEB. Before installation, the CTs shall be sent to the CEB for testing, which will be chargeable to the applicant.

*: For MSDG installations requiring summation CTs, both the CTs and summation CTs shall have an accuracy class of 0.2.

All meters and related equipment (such as CT, TTB, etc.) shall be housed in a secured cabin, as per CEB's requirements.

A metering cabin shall be erected to house the production meter, TTB, CTs and an isolator, as per CEB's requirements.

All metering cabins shall be fitted with a 13A power socket, protected by a 2A circuit breaker and fed from a secured source of supply.

In addition the panel shall also provide space for the accommodation of a digital 3-phase power recorder/monitor with the remote communication capabilities, if required, for power quality analysis, energy management, data transfer and supervisory control needs.

The applicant may install at his own cost a backup meter (Refer to Drawings in Annex 8) capable of recording both the export of electrical energy from Facility to the CEB Interconnection Facilities and the import of electrical energy by the Facility from the CEB Interconnection Facilities.

3.13 Preventive and corrective maintenance

3.13.1 Generation Schedule

There is no need for promoters to facilitate forecast of their generation for MSDG of capacity lower than 1 MW.

MSDG of capacity equal to or greater than 1 MW shall facilitate a generation forecast to CEB. This forecast shall be with the schedule (day ahead, before certain limit hour) and

granularity (by default, hourly values) required by CEB for its security studies and generation schedule. This requirement can be withdrawn/redefined if so agreed between the CEB and the MSDG owner in each particular case.

3.13.2 Generator Maintenance

MSDGs with capacities equal to or greater than 1 MW shall submit their preventive maintenance plans to CEB for its approval every year for the following year, in the dates required by CEB and any modification thereof, if needed, on a monthly basis.

CEB shall approve or require modifications to the annual preventive maintenance plan, which could be modified, if needed, at least with 15 days advance notice.

If a corrective maintenance action is to be performed, CEB shall be informed of the unavailability, its causes and its expected duration no later than 3 hours after the initiation of the incident. The information shall be kept permanently updated, communicating any relevant change to CEB or at any moment at CEB's request. Information will be by mail or any other agreed channel.

MSDGs with capacity lower than 1 MW will not need to communicate preventive and corrective maintenance plans or actions.

3.13.3 Network maintenance

Maintenance works or any faults occurring on the feeder to which the MSDG is connected may prevent the generator from exporting. No compensation will apply for any loss of generation due to preventive and corrective maintenance in CEB's network.

CEB shall communicate its maintenance plans to MSDGs of capacity equal to or greater than 200 kW and lower than 1 MW on the same terms that apply to general clients.

CEB shall communicate its maintenance plans by mail, or any other agreed channel, to MSDGs of capacity equal to or greater than 1 MW before the planned maintenance action takes place.

3.14 Safety, Isolation and Switching

3.14.1 Safety Procedures regarding the operation of High Voltage Switchgear

CEB personnel working on the network shall strictly abide by the procedures set out in the "CEB T&D Safety Rules".

The "CEB T&D Safety Rules" are in compliance with the Occupational Safety and Health Act 2005 or any subsequent amendment(s) in connection with this present Act.

In order to ensure the safety of personnel while operating or working on High Voltage Switchgear installed for the purpose of supplying electricity to the customer's premises, the following requirements and procedures shall be adhered to:

(a) To comply with Section 7(2) of the Occupational Safety and Health Act of 2005 which states "Where the total power used or generated by the machinery installed at any place of work exceeds 750 kilowatts, the employer shall employ a Registered Professional Engineer to be in general charge of all such machinery and shall notify the Director, Occupational Safety and Health of any such employment".

(b) The Applicant shall appoint and train competent person/s who shall be responsible for the operation of the High Voltage Switchgear. He/they shall be fully conversant with the electrical set-up, including that of the Switchgear belonging to CEB. The list of such competent person/s shall be communicated to the CEB and shall be updated by the MSDG owner as warranted. The experience of each competent person in operating the electrical installation (from the MSDG side of the Interconnection Facility to the generator) shall be submitted with the list.

(c) An up-to-date schematic diagram of the switchgear set-up shall be displayed in the switchgear room (See Annex 8).

(d) All switchgear panels shall be clearly numbered and labelled.

(e) Before any work can be performed on either side of the switchgear panel appropriate switching operations shall be carried out by the respective competent person in the presence of his respective counterpart. The competent person performing the operations shall certify the operations carried out on the approved form ("Certificat de Consignation"- Annex 2) and shall remit the original to his counterpart, who may then proceed with the work in accordance with the procedures applicable.

Note:

The person receiving the above information shall ensure that the switchgear involved shall not be inadvertently operated by securing them by means of personal padlocks and by affixing proper warning signs.

(f) CEB may request for additional safety requirements.

(g) In case of private generation, the client shall ensure that his system is completely isolated from CEB system.

3.14.2 Safety Concerns

For any work or activity in the connection point between distributed generation and the CEB network, all agents involved will follow the "CEB T&D Safety Rules".

The "CEB T&D Safety Rules" are based on the Occupational Safety and Health Act 2005. In addition to the requirements stipulated in the "CEB T&D Safety Rules", the MSDG owner shall observe the following safety concerns which include:

(a) Persons must be warned that the installation includes an MSDG so that precautions can be taken to avoid the risk of electric shock/electrocution. Both the mains supply and the electric generator must be securely isolated before electrical work is performed on any part of the installation. Adequate labelling must be placed to warn that the installation is connected to another source of energy.

(b) Photovoltaic (PV) cells will produce an output whenever they are exposed to light, and wind turbines are likely to produce an output whenever they are turning. Additional precautions shall be taken to prevent the generator from generating electric energy or even generating voltage, such as covering the PV cells or restraining the turbine from turning will be necessary when working on those parts of the circuit close to the source of energy and upstream of the means of isolation.

To guarantee this isolation, the generation operator shall follow the supplier instructions.

(c) The manufacturer or supplier of the MSDG is required to certify compliance with the Electrical Equipment Safety Regulations and the Electromagnetic Compatibility Regulations. The MSDG will be CE marked or tested by equivalent accredited testing agencies to confirm this. This should ensure that the MSDG is satisfactory in a domestic installation in terms of the power factor, generation of harmonics and voltage disturbances arising from starting current and synchronisation.

(d) The maintenance works at the MSDG installation shall be carried out in such a way that all safety procedures recommended by the manufacturer or supplier are followed.

(e) CEB personnel must be warned of the safety procedures pertaining to switching operation applicable to the MSDG. These procedures must clearly be displayed and visible at the MSDG site.

3.14.3 Electromagnetic emission/Immunity

The MSDG shall comply with the requirements of the EMC Directive and in particular the product family emission standards.

3.14.4 Labels

Figure 1 MSDG warning sign

To indicate the presence of the MSDG within the premises, a label as per Figure.1 will be fixed by the CEB at:

(a) The nearest 22 kV pole on which the switch fuses are installed (or the Ring Main Unit in case of underground networks)

(b) Switchgear Room

(c) the transformer cabin door and fence

(d) the metering cabin and box

(e) the CEB incoming feeder cubicle

(f) the voltage transformer cubicle

(g) the interconnection circuit breaker cubicle

(h) any other locations found necessary.

The installation operating instructions must contain the manufacturer's contact details e.g. name, telephone number and web address.

3.15 Documentation

Up-to-date information must be displayed at the MSDG as follows:

(a) A circuit diagram showing the relationship between the MSDG and the CEB's incoming feeder as shown in Annex 6 (section 7.6 of this Grid Code). This diagram is also required to show by whom the generator is owned and maintained.

(b) All relevant information related to fault contribution to all different types of faults from the MSDG. A copy of the protection test results obtained during commissioning must be delivered to CEB

(c) A summary of the interconnection and anti-islanding protection settings. The Annex 8 (section 7.8 of this Grid Code) is an example of the type of circuit diagram that needs to be displayed.

(d) Switching operation at the MSDG facility.

(e) In addition the maintenance requirements and maintenance services available shall be documented.

(f) The MSDG Owner shall keep a certificate signed by the maintenance contractor containing at least the following:

- A statement confirming that the solar PV system/wind turbine/hydro, switchgear, UPS and interconnection transformer meets the requirements of this grid code.
- Client's name and address.
- Site address (if different).
- Contractors name, address etc.
- List of key components installed.
- Estimation of system performance
- Maintenance schedule

3.16 Information plate

The following information shall appear on the information plate:

(a) manufacturer's name or trade mark;

(b) type designation or identification number, or any other means of identification making it possible to obtain relevant information from the manufacturer;

(c) rated power;

(d) nominal voltage;

(e) nominal frequency,

(f) phases;

(g) power factor.

3.17 Electrical contractor / Installer

The MSDG shall be installed in accordance with the instructions issued by the manufacturer.

In designing a connection for any MSDG, the electrical contractor /installer must consider all the issues that would need to be covered for a conventional final circuit, including:

- the maximum demand (and the generator output);
- the type of earthing arrangement;
- the nature of the supply;
- external influences;
- compatibility, maintainability and accessibility;
- protection against electric shock;
- protection against thermal effects;
- protection against overcurrent;
- isolation and switching;
- selection and installation issues.

The installer must affix a label clearly indicating the next scheduled maintenance of the installations and inform the CEB, who will add the information to the MSDG-register.

The installer must be skilled in the field of MSDG installations and possesses an MQA-approved qualification or equivalent in electrical installation and renewable energy installations (as applicable to the MSDG installation) which is acceptable to the CEB.

3.18 Standards and Regulations

All electrical apparatus, materials and wiring supplied shall comply with the Electricity Act, the Central Electricity Board Act, Electricity Regulations, this code and the following standards:

PV Modules	
IEC TS 62804-1	Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline Silicon
IEC TS 62804-2	Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Thin-film
EN 50380	Datasheet and nameplate information of photovoltaic module.
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61701	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61853-1	Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating
PV INVERTERS	
EN 50524	Data sheet and name plate for photovoltaic inverters
IEC 61683	Photovoltaic Systems – Power conditioners – Procedure for measuring efficiency
IEC 62109	Safety of power converters for use in photovoltaic power systems
IEC 62116	Test Procedure for islanding prevention measures for Utility connected photovoltaic inverters
GRID-CONNECTED PV SYSTEM	
EN 50438	Requirements for the connection of micro-generating plants in parallel with public low voltage distribution networks
ER G59/3	Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed Distribution Network Operators
ER G83/2	Recommendations for the connection of type tested small-scale embedded generators (up to 16 A per phase) in parallel with low-voltage distribution systems
EN 50521	Connectors for photovoltaic systems – Safety requirements and tests
IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface
IEC 61836	Solar photovoltaic energy systems - Terms, definitions and symbols

IEC 62093	Balance-of-system components for photovoltaic systems – Design qualification natural environments
IEC 62446-1	Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance – Part 1: Grid-connected systems – Documentation, commissioning tests and inspection
IEC: 60904-1	Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics
IEEE P1547	Series of Standards for Interconnection, May, 2003, NREL/CP-560-34003
Wind Turbine Generators	
IEC 61400 -21	Wind Turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines.
GENERAL ENGINEERING STANDARDS	
BS 7354	Code of Practice for Design of high voltage open terminal stations
BS 7430	Code of Practice for Protective Earthing of electrical installations
IEC 60068-2	Environmental testing of specimen to withstand specific severities of repetitive and non- repetitive nature
IEC 60076	Power transformers - ALL PARTS
IEC 60228	Conductors of Insulated Cables
IEC 60364-1	Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions
IEC 60364-5-54	Low-voltage electrical installations - Part 5: Selection and erection of electrical equipment. Chapter 54: Earthing arrangements and protective conductors
IEC 60364-5-55	Electrical installations of buildings – Part 5: Selection and erection of electrical equipment. Chapter 55: Other equipment
IEC 60502-1	Power Cables with extruded insulation and their accessories for rated voltages from 1 kV (Um – 1.2 kV) up to 30 kV (Um = 36 kV) Part 1 - Cables for rated voltages for 1 kV (Um=1.2 kV) and 3 kV (Um = 3,6 kV)
IEC 60664-1	Insulation coordination for equipment within low-voltage systems –Part 1: Principles, requirements and tests
IEC TR 60909-1	Short circuit currents in three-phase ac systems – Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0
IEC 62208	General requirements for empty enclosures for low voltage switchgear and control gear assemblies

IEC 62305-3	Protection against lightning - Part 3: Physical damage and life hazard in structures
IEEE C37.90	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
Power Quality	
IEC 61000-3-2	Electromagnetic compatibility (EMC) - Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
IEC 61000-3-3	Electromagnetic compatibility (EMC) - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
IEC TR 61000-3-7	Electromagnetic compatibility (EMC) - Assessment of emission limits for the connection of the connection of fluctuating installations to MV, HV and EHV power systems.
IEC 61000-6-1	Electromagnetic compatibility (EMC) - Generic standards – Immunity for Residential, Commercial and Light-industrial environments
IEC 61000-6-3	Electromagnetic compatibility (EMC) - Generic standards – Emission standard for Residential, Commercial and Light-industrial environments
IEEE 519	IEEE Recommended practice and requirements for harmonic control of electric power systems

The applicant may be required to produce certificates conforming to the above standards for their MSDG installation upon CEB's request.

Note: All specifications shall be according to the latest edition of the standards mentioned above.

In addition the MSDG owner shall ensure that his proposed installations comply with all prevailing regulations pertaining to environment, health and safety, etc.

4 CHAPTER 4: GUARANTEED OPERATING CHARACTERISTIC

Installers are required to ensure that all equipment proposed have the capabilities to implement all the requirements of the MSDG Grid Codes, especially requirements stipulated in this chapter.

4.1 Fault Ride through Requirements

The MSDG shall remain connected to the distribution system for system voltage dips on any or all phases, where the distribution system voltage measured at the point of common coupling to the CEB network remains above the blue line in the voltage duration profile of the figure below.

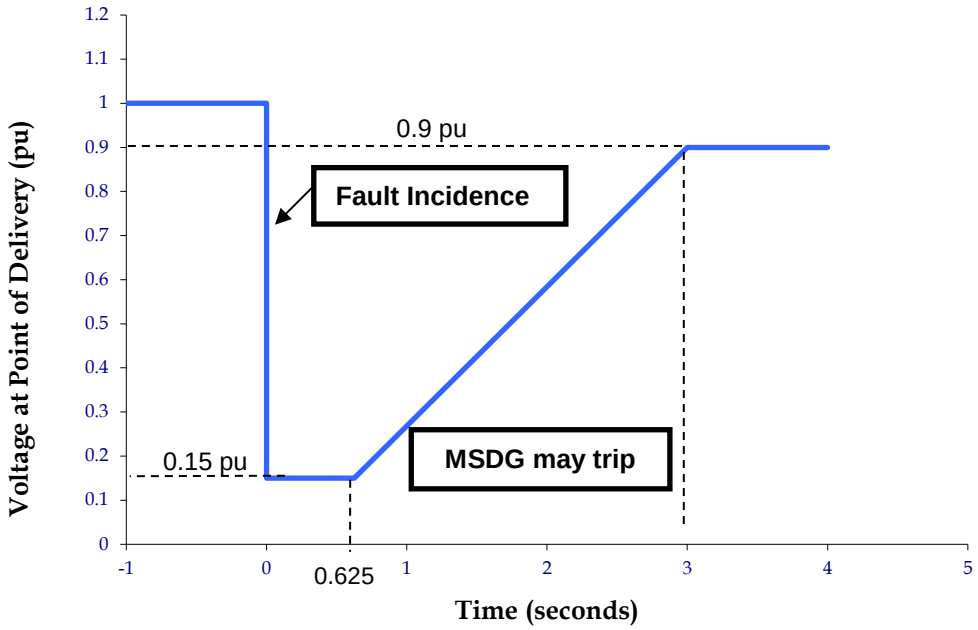


Figure 2 – Fault Ride Through requirement

In addition to remaining connected to the distribution System, the MSDG shall have the technical capability to provide the following:

- During the distribution system voltage dip, the MSDG shall provide active power in proportion to retained voltage and maximise reactive current to the distribution system, within the technological and design limitations of the MSDG facility and without exceeding its design limits. The maximisation of reactive current shall continue for at least 3 seconds or until the distribution System Voltage recovers to within the normal operational range of the distribution System whichever is the sooner.

- Due to the dynamic nature of the distribution network, higher or lower fault clearance time and the LVRT voltage curve for the MSDG may be required, which shall then be discussed with the CEB.

- The above LVRT curve shall be coordinated with the under-voltage protection settings (refer to Table 5) to ensure grid support during fault conditions

4.2 Frequency Response

In case of frequency deviations in the CEB network, the MSDG shall be designed to be capable to provide power-frequency response in order to contribute to the stabilisation of the grid frequency.

MSDG of capacity equal to or greater than 1 MW shall be able to provide frequency response as displayed in Figure 3 below. Under normal system frequency ranges, the MSDG should operate with an active power output as set in Figure 3 below

The MSDG shall have to reduce the power output above a system frequency of 50.5 Hz. The power has to be reduced with a gradient of 40% per Hz of the instantaneously available power as per Figure 3 below. The output power is only allowed to increase again as soon as the frequency is only 50.05 Hz as per the same ramp rate during start-up (Refer to Section 4.5). Above 52 Hz and below 47 Hz the plant has to disconnect from the grid.

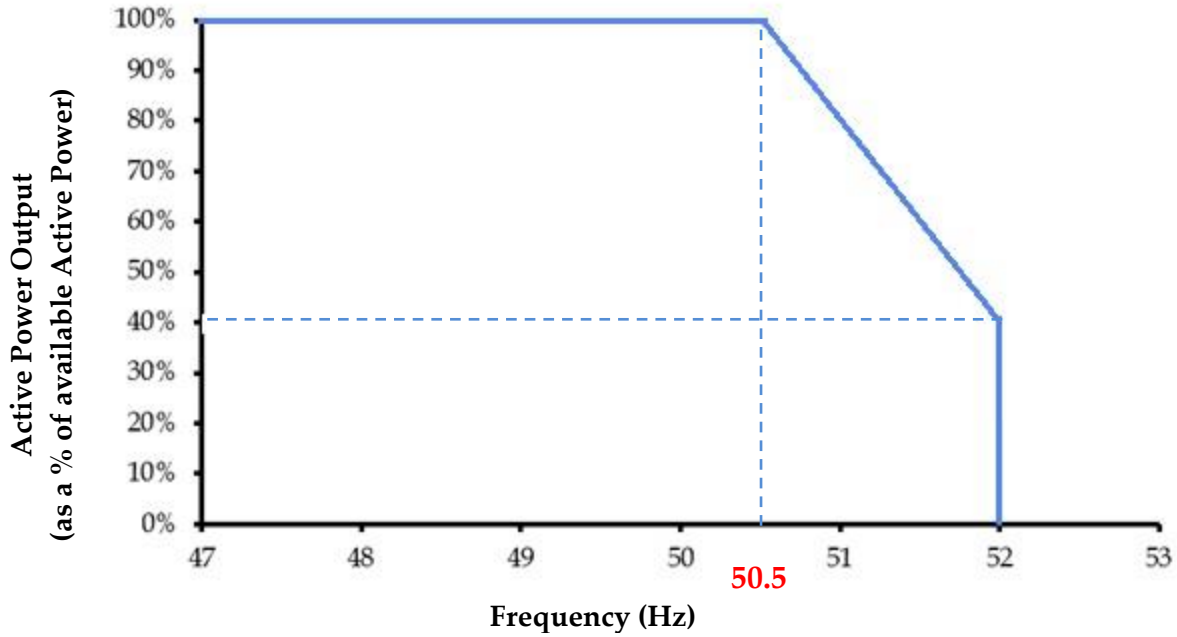


Figure 3: Frequency response requirements

The MSDG output power is only allowed to increase again as soon as the frequency is back at 50.5 Hz or below.

All MSDGs shall disconnect within 0.5 seconds from the network in case the system's frequency is above 52 Hz.

All MSDGs are allowed to disconnect from the network in case the system's frequency is below 47 Hz for longer than 0.5 seconds.

4.3 Reactive Power Capability

MSDGs of capacity equal to or greater than 1 MW shall be equipped with reactive power control functions capable of controlling the reactive power supplied by the MSDG at the point of common coupling with CEB's network. The reactive power control functions shall be mutually exclusive, which means that only one of the two functions mentioned below can be activated at a time:

a) Power Factor Control
b) Reactive Power Control

If previously agreed with the CEB on a case by case basis, a Voltage Control mode may also be required.

The actual operating modes, as listed above, as well as the operating point shall be determined by the CEB. The functional mode and set-point of the MSDG shall not be changed unless instructed by CEB.

MSDGs of capacity equal to or greater than 200 kW shall be designed with the capability to supply rated power (MW) for power factors ranging between 0.95 lagging and 0.95 leading, available from 20% of rated power measured.

4.4 Power Quality

The MSDG facilities and equipment shall not cause excessive voltage excursions nor cause the voltage to drop below or rise above the range maintained by CEB. The MSDG facility and equipment shall not introduce excessive distortion to the sinusoidal voltage or current waves.

4.4.1 Limitation of voltage flicker induced by the MSDG

The MSDG installation shall not cause abnormal flicker beyond the limits defined in IEEE 519.

4.4.2 Harmonics

The total harmonic distortion will depend on the injected harmonic current and the system impedance seen from the PCC.

The MSDG system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. The MSDG system electrical output at the PCC should comply with IEEE 519 (Recommended Practice and Requirements for Harmonic Control in Electric Power Systems) which will be used to define the acceptable distortion levels for MSDG installations connected to the utility. The IEEE 519 recommendation is to be applied at the PCC, not to downstream equipment. The key requirements of this recommendation are summarized as follows:

Recommended Harmonic Voltage Limits: At the PCC, system owners or operators should limit line-to-neutral voltage harmonics as follows. All values should be in percent of the rated power frequency voltage at the PCC. The table below (Table 7) applies to voltage harmonics whose frequencies are integer multiples of the power frequency.

Table 7: Recommended Harmonic Voltage Limits

Bus voltage V at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV $< V \leq 69$ kV	3.0	5.0

At the PCC, users should limit their harmonic currents as follows:

The table below (Table 8) applies to harmonic currents whose frequencies are integer multiples of the power frequency.

Table 8: Maximum Harmonic Current Distortion

Maximum harmonic current distortion in percent of I_L						
Individual harmonic order (odd harmonics)[a, b]						
I_{SC}/I_L	$3 \leq h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h \leq 50$	TDD
< 20[c]	4.0	2.0	1.5	0.6	0.3	5.0
$20 < 50$	7.0	3.5	2.5	1.0	0.5	8.0
$50 < 100$	10.0	4.5	4.0	1.5	0.7	12.0
$100 < 1000$	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

[a]Even harmonics are limited to 25% of the odd harmonic limits above.

[b]Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c]All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.

where

I_{sc} = maximum short-circuit current at PCC

I_L = maximum demand load current (fundamental frequency component) at the PCC under normal load operating conditions

4.4.3 Voltage Step Change

The process of starting a medium scale distributed generation (MSDG) can sometimes cause step changes in voltage levels in the distribution network. These step changes are caused by inrush currents, which may occur when transformers or induction generators are energised from the network. Step voltage changes will also occur whenever a loaded generator is suddenly disconnected from the network due to faults or other occurrences.

Step voltage changes caused by the connection and disconnection of generating plants at the distribution level should not exceed +/- 3% for infrequent planned switching events or outages and +/-6% of the nominal voltage of 22kV for unplanned outages such as faults.

4.4.4 Surge Withstand Capability

The interconnection system shall have a surge withstand capability, both oscillatory and fast transient, in accordance with IEC 62305-3. The design of control systems shall meet or exceed the surge withstand capability requirements of IEEE C37.90.

4.4.5 Voltage Unbalance

The contribution to the level of unbalance of the voltage at the point of common coupling of any installation with generation should be less than or equal to 1.3%.

4.5 Ramp Rate Limits

MSDG of capacity equal to or greater than 1 MW shall have ramp up/down in normal conditions, positive ramp rate only during start-up and negative ramp rate during shut down of the MSDG facility, as follows:

- **1 minute maximum ramp rate: MSDG's installed capacity (MW) divided by 5.**

The ramp rate settings shall be approved by CEB prior to testing and commissioning of the system on the network. For any subsequent change, a minimum of two weeks' notice shall be given. Implementation by the Promoter shall be done within two weeks of formal request.

5 CHAPTER 5: TESTING AND COMMISSIONING

5.1 Introduction

The Applicant shall perform the testing and pre-commissioning phases of the MSDG as per relevant standards norms. The Applicant shall keep written records of test results and protection settings. The Applicant shall regularly maintain the protection systems in accordance with good electrical industry practice.

The interconnection protection of the MSDG shall be regularly tested and maintained by the owner. In addition, it may be necessary to perform tests on ad-hoc basis for purposes such as ascertaining level of harmonic emissions, voltage rise, protection operation in the context of system changes, fault investigation and protection changes etc.

5.2 Testing and Pre-Commissioning

For Greenfield projects, the Applicant shall submit appropriate testing and pre-commissioning procedures and plans as per applicable standard for the MSDG Facility to CEB for approval at least 3 (three) months prior to the Scheduled Commercial Operation of the MSDG Facility.

5.2.1 Testing Phase for PV and WTG MSDG Facility

A number of typical tests among others for PV and WTG MSDG Facility have been identified by the CEB in this Grid Code. However it is the responsibility of the MSDG owner to ensure that all required tests are performed to ensure compliance with this grid code. The tests identified are as follows:

a) Photovoltaic facility

- Earthing continuity of array frame to earth and connection to main earthing terminal
- Polarity of each module string
- PV string Open-Circuit Voltage (Voc) Test;
- PV Short Circuit current (Isc) Test;
- PV array insulation Test;
- Operational Test PV string current;
- Functional Test;
- Insulation resistance Testing; and
- Performance verifications;

b) Wind TG Facility

- 6 hour test run with the generator connected to the grid
- Demonstration of WTG vibration level below acceptable level.
- Test of trip function when WTG is generation and grid loss occurs
- Test of over speed trip of each WTG

- Test of yaw drives
- Functional test
- Performance verification

5.2.2 Pre-Commissioning Phase

The Pre-Commissioning tests shall be performed in the presence of the CEB. CEB reserve the right to request the applicant to perform additional tests which CEB may find necessary to ensure integrity of its network.

The pre-commissioning of the electrical system shall include at least the following:

a) Demonstration of satisfactory operation of power measurement equipment
b) Functional tests of the relay protection and verification of settings
c) Demonstration of satisfactory operation of internal reticulation
d) Pressure tests on 22kV switchgear
e) Reactive Power Capability.
f) Power Quality Test as per IEC 61400-21
g) Anti-islanding
h) Test of the facility to withstand step load change

5.3 Power Quality

After satisfactory testing and pre-commissioning of the MSDG installation and submission of the Certificate of Installation, CEB will then perform tests to ensure that the facility is compliant with Section 4.4 of this Grid Code.

5.4 Commissioning Engineer

Given the size and complexity of the MSDG installation as per the requirements of this Grid Code, testing and Pre-Commissioning of the facility shall be performed by a Registered Professional Engineer. It is desired that the Registered Professional Engineer possess past experience in the commissioning of similar projects.

Prior to testing phase by the CEB (refer to Section 5.3 above), the Registered Professional Engineer shall inspect and test the installation for compliance with existing requirements and standards and report the results to CEB. The MSDG Owner shall then submit a Certificate of Installation duly filled and signed by the Registered Professional Engineer.

In case of compliance of the MSDG Interconnection Facility to the requirements of this Grid Code after testing procedures in respect to per Section 5.3, the CEB shall then prepare a Certificate of Compliance for internal purposes confirming that the installation:

- complies with the requirements of this Grid Code,
- has been found to be fit for connection to the Grid, and
- is being commissioned after the signature of the Connection Agreement.

6 COMPLIANCE WITH THE CODE

In case of non-compliance with any of the technical provisions in this Grid Code, CEB shall inform the owner in writing of the discrepancies. The MSDG owner shall have 90 days to rectify the discrepancies.

Failing to do that, CEB shall be entitled to disconnect the MSDG installation.

CEB shall be entitled to disconnect the MSDG facility without prior notification if the installation conditions are harmful or creates unavoidable risks for the safety.

CEB shall not be responsible for any damage if such disconnection requires the disconnection of other loads associated or connected to the same connection as the MSDG.

Reconnection of the MSDG shall require that CEB certifies that the installation complies with this Grid Code. Fees applicable shall be the same as for reconnection fees.

7 ANNEXES

7.1 Annex 1: Abbreviations and Definitions

- "AC" or "a.c." means Alternating Current;
- "Applicant" means a producer of electricity through an MSDG installation;
- "CEB" means the Central Electricity Board;
- "Circuit breaker" means a switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal conditions such as those of short circuit;
- "DC" means Direct Current;
- "DG" means Distributed Generation
- "Distributed generation" means electric generation facilities connected to the Utility network at the PCC;
- "Flicker" means a variation of input voltage sufficient in duration to allow visual observation of a change in electric light source intensity;
- "Fault" means a physical condition that causes a device, a component, or an element to fail to perform in a required manner, for example a short-circuit, a broken wire, an intermittent connection;
- "Frequency" means the number of complete cycles of sinusoidal variations per unit time;
- "Greenfield project" means an MSDG installation of MSDG at a location without existing connection point;
- "Grid" means CEB's network that brings electricity from power stations to consumers;
- "GPRS/VPN" means Virtual Private Network set up over a General Packet Radio Service (GPRS);
- "Harmonic distortion" means continuous distortion of the normal sine wave; typically caused by nonlinear loads or by inverters, measured in Total Harmonic Distortion (THD);
- "HT" means High Tension (refers to systems normally operating at a voltage exceeding 1000 volts A.C. or 1500 volt D.C.);
- "HV" means High Voltage (see "HT");

- "Registered Professional Engineer" means a person registered as a Professional Engineer (Electrical or an alternative equivalent acceptable to the CEB) under the Registered Professional Engineers Council Act (Mauritius);
- "Installer" means a person who is skilled in the field of MSDG installations and possesses an MQA-approved qualification or equivalent in electrical installation and renewable energy installations (as applicable to the MSDG installation) and which is acceptable to the CEB. ;
- "Islanding" means a condition in which a portion of the CEB's network is energised by one or more MSDGs through their PCC(s) while electrically separated from the rest of the system;
- "Isolated Generation" means a condition where the electrical path at the PCC is open and the MSDG continues to energise local loads;
- "kV" means kilovolt;
- "kVA" means Kilovolt Ampere
- "kW" means Kilo Watt (1,000 W = 1,000 J/s);
- "kWh" means Kilowatt hour (1,000 watt hours);
- "LV" means Low Voltage (refers to systems normally operating at a voltage not exceeding 1000 volts A.C. or 1500 volt D.C.);
- "MSDG" means Medium Scale Distributed Generation greater than 200 kW up to 2000 kW
- "MW" means megawatt (1,000,000 W = 1,000,000 J/s);
- "Parallel operation" means a condition where the MSDG is operating while connected to CEB's network;
- "PCC" means point of common coupling;
- "Point of Common Coupling (PCC)" means the point at which an MSDG is connected to the CEB's network
- "Power factor" means ratio of real to total apparent power (kW/kVA) expressed as a decimal or percentage;
- "Producer" means a producer of electricity through any MSDG installation or the owner thereof;
- "PV" means photovoltaic;
- "RE" means renewable energy;
- "SWC" means Surge Withstand Capability, the immunity of this equipment to fast and repetitive electrical transients;
- "THD" means Total Harmonic Distortion

7.2 Annex 2: Specimen of "Certificat de Consignation"

Vocab. No. 1100015

CENTRAL ELECTRICITY BOARD / ....

CC No:

"Certificat de Consignation" at CEB / Private Party (PP) Interface

Being an authorization to perform, execute work(s) at the CEB/PP interface or in proximity of existing HT System(s) which has/have been made safe for work by proper OPENING, ISOLATION, TESTING and EARTHING prior to any intervention. To be filled in by an **AUTHORISED PERSON** of the CEB and issued **ON SITE** to an **AUTHORISED PERSON** from the PP side **AND/OR** vice-versa. (*To be filled in Duplicate*)

PART A

a) **Request made by: CEB** or **PP** (*Delete as appropriate*)

b) **Description of work(s),** Voltage and location of Apparatus / lines on which work(s) is/are to be carried out:....................
....
....

c) **Planned Period of Interruption:** Date and Time:

From ....../......./.......... ....:........hrs To ....../...../....... ....:........hrs

d) **Planned Operations:**

CEB side	PP side
Switches to be opened:.. Links to be opened:.. Apparatus / line on which work (s) is/are to be performed:...........	Switches to be opened:.. Links to be opened:.. Apparatus / line on which work (s) is/are to be performed:........ ....

e) **Switching Operations Performed:**

CEB side	PP side
Points at which apparatus / lines have been **Isolated** and **Locked** wherever practicable. State location, name(s), number(s) of switch(es) and link(s), etc:................................... .... as per Operational Message Form No.................................	Points at which apparatus / lines have been **Isolated** and **Locked** wherever practicable. State location, name(s), number(s) of switch(es) and link(s), etc:............................... .... as per Operational Message Form No..................................

f) **Authorised Person responsible** for switching operation(s) / giving information at (d) & (e) above.

CEB side	PP side
Name: .... Date:......./......./........... Time:.........:..........hrs Signature:...	Name: .... Date:......./......./........... Time:.........:..........hrs Signature:...

PART B - Certificate

(*Original to be handed over to the Authorised Person of the Requesting Party, directly and continuously supervising the work*)

a) I hereby certify that the switching operations, as described in **Part A** above, have been performed and that the source of supply from **CEB** side / **Private** side (*delete as appropriate*) has been effectively isolated.

b) Appropriate **warning notices** have been affixed to the switch(es) and link(s) mentioned in **Part A** above.

c) The following apparatus/line(s) are in proximity to the apparatus/line covered by this Certificate and care must be taken to keep clear therefrom. (If not existing, state "**none**"). ....

d) I hereby declare that none of the switches / links detailed under **Part A (e)** above will be closed or opened until **Clearance** for this Certificate is given by the requesting party.

Name.. Date.................... Time.................. Signature.........................
The Authorised Person (CEB or PP)

e) ***This Certificate, bearing CC No.......... is hereby linked with the HT-PW No. .... which is to be issued prior to the start of any work as described at Part A above.***

PART C - ***Clearance & Cancellation of "Certificat de Consignation".***

I hereby declare that the HT-PW No. ...., mentioned at **Part B (e)** above, has been cancelled and that the apparatus/line(s) may be energized and put back into service.

Name.. Date.................... Time.................. Signature.......................................
The Authorised Person (CEB or PP)

THIS *"CERTIFICAT DE CONSIGNATION"* IS HEREBY CANCELLED

CEB side	PP side
Name: .... Date:......./......./........... Time:.........:..........hrs Signature:...	Name: .... Date:......./......./........... Time:.........:..........hrs Signature:...

7.3 Annex 3: CEB Fees

Interconnection facility and cost

The MSDG will be connected to CEB 22kV network through a High Voltage switchgear and metered on the high-voltage side.

In addition, the applicant shall bear fees for processing applications and preparation of cost estimate for network construction or modification. The value of each of the listed fees will be set by the CEB in specific bylaws and published on the CEB website.

Some of the fees that may be applicable are as follows:

- **Processing fee**
- **Connection Fee**
- **Engineering Review / Distribution Study:** Preparation of estimate for network modification by the relevant CEB District section.
- **Revision of Estimate**

Applicants are advised to consult the CEB website for the latest fees.

Network construction / modification

The cost for network construction or modification will be determined after carrying out the engineering review.

7.4 Annex 4: Certificate of Installation

Applicant/installer to submit duly signed certificate (as shown below), with the Company's header and seal, to the CEB. The MSDG installation shall be certified by a Registered Professional Engineer (CRPE Mauritius).

CERTIFICATE OF INSTALLATION

I hereby certify that the installation of the SSDG of Capacity [……..] kW, situated at address [……] for [……] has been done as per the requirements of the SSDG Grid Code and as per attached detailed schematic diagram.

MSDG S.No.: MSDG/_____

1. The details of the equipment installed are as follows:

Equipment		Make/Model	Rating (W)	Quantity
Photovoltaic Modules				
Inverter	Rated Output Power (AC)			
	Serial No			

2. The inverter has been set as per the following settings:

Protection Parameters Settings	Trip Setting	Clearance Time	Trip Indication Provided
Over Voltage (a) (230 V + 10 %)			
Over Voltage (230 V + 6 %)			
Under Voltage (230 V – 6 %)			
Over Frequency (b) (50 Hz + 2 %)			
Under Frequency (50 Hz - 6 %)			
Loss of Mains(df/dt - Vector shift)			
Reconnection Time			
Active Power Limit Set (W) - (if applicable)			
Line impedance (ohm)			

7.5 Annex 5: Certificate of Compliance

Certificate of Compliance

This is to certify that on **[date]** the MSDG installation with an installed capacity of …….kW, situated at **[address]** in the name of **[Applicant name]**bearing Serial No. **[MSDGX/XX/XXX]** has been found compliant with the requirements of the MSDG Grid Code by the Representatives of the CEB Sections found hereunder and it has been found to be fit for the connection to the Grid. The installation is being commissioned after the signature of the Connection Agreement.

Representative of Distribution Network

Name (Block Letters): …….. Signature: ……..

Representative of Meter Installation

Name (Block Letters):: …….. Signature: ……..

Representative of MSDG-SSDG Unit

Name (Block Letters):: …….. Signature: ……..

Representative of Safety and Health Section

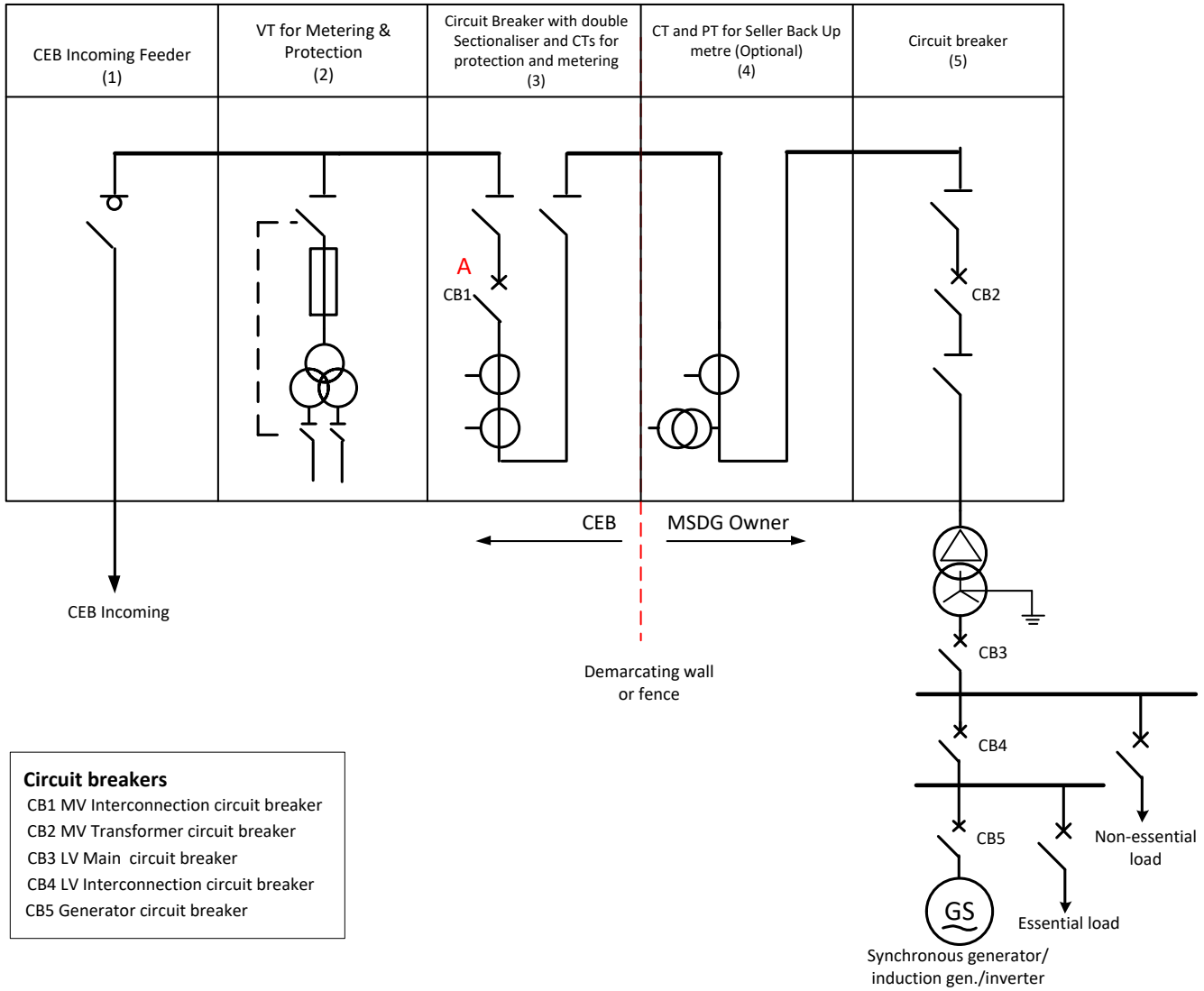
Name(Block Letters):: …….. Signature: ……..

Representative of C&M Section

Name (Block Letters): …….. Signature: ……..

Date: ……..

7.6 Annex 6: 22KV Switchgear Arrangement



7.7 Annex 7: Interconnection Facility Description

A.1 Responsibility and Cost of Installation of Interconnection Facilities:

(1) CEB shall be responsible for the construction, installation and commissioning of the 22kV interconnection line forming part of the CEB Interconnection Facilities. CEB shall own and be responsible for the operation, maintenance and repair of the CEB Interconnection Facilities.

(2) The Applicant shall be responsible for the acquisition of the right of way for CEB with regard to the interconnection 22kV line with CEB 22 kV existing network.

(3) The Applicant shall be responsible for the construction, installation, testing and commissioning of the complete 22kV switchboard as per Annex 6 (section 7.6 of this Grid Code), i.e. the CEB as well as the MSDG side. CEB will take ownership of its side after the guarantee period.

(4) The Applicant shall bear the cost of the procurement, installation, testing and commissioning of both CEB and MSDG's Interconnection Facilities.

(5) The Applicant shall be responsible for all civil works inclusive of cable trench, draw-pits, laying of PVC pipes and construction of switchgear room as per CEB specifications . All Civil Works shall be approved by the CEB prior to implementation.

(6) The Applicant shall own and be responsible for the operation, maintenance and repair of MSDG's Interconnection Facilities.

A.2 CEB Interconnection Facilities

A2.1 Scope of CEB Interconnection Facilities

The CEB Interconnection Facilities shall be as per the current Technical Specifications for HT Metering, as reproduced hereunder.

However, the latest version of the Technical Specifications for HT Metering shall be applicable to the MSDG at the time of implementation.

TECHNICAL SPECIFICATIONS FOR HT METERING

TECHNICAL SPECIFICATIONS FOR HT SWITCHGEAR (PART I) AND DISTRIBUTION TRANSFORMERS (PART II)

The HT Switchgear shall be supplied as per technical specifications provided in Schedules A1, A2, A3 and A4 below and the Client shall supply all relevant data where applicable by filling in the Schedules B1, B2, B3 and B4 of the Guaranteed Particulars.

The Distribution Transformer shall be supplied as per technical specifications provided in Schedules A5 and A6 below and the Client shall supply all relevant data where applicable by filling in the Schedules B5 and B6 of the Guaranteed Particulars.

PART I: HT SWITCHGEAR

Schedule A1

General

The cubicles shall have the following electrical characteristics:-

1. Network

Service Voltage	:	22 kV
System Earthing	:	Effectively earthed
Frequency	:	50 Hz
Fault Level	:	600 MVA

2. Cubicles

Insulation rated voltage	:	24 kV
Impulse test voltage 1, 2/50 µs	:	125 kV peak
Rated short circuit capacity	:	minimum 16 kA rms 1 sec
Electrodynamic withstand	:	40 kA peak
Busbar rating	:	630A

Arrangement of Cubicles under CEB's responsibility

The cubicles under Central Electricity Board's responsibility and those under client's responsibility shall form one single switchboard. However, Central Electricity Board's liability shall stop at the point of supply found at the outgoing terminals of the circuit breaker in Cubicle No. 4.

The cubicles' arrangement shall be from left to right as follows:-

Cubicle No. 1 (Incoming No. 1)

22 kV load break switches for the control of first incoming feeder (see item 1).

Cubicle No. 2 (Incoming No. 2)

22 kV load break switches for the control of second incoming feeder (see item 1).

Cubicle No. 3

Voltage Transformer (V.T) Cubicle (see item 2).

Cubicle No. 4

CEB Circuit Breaker cubicle with double isolation (see item 3).

Degree of Protection

IP 3X.

Safety equipment for switching operations

The client should provide the following safety equipment which shall be always readily available in the switchgear room:

On Client side:-
(i) 22 kV insulating mat.
(ii) One pair of 22 kV insulating gloves.
(iii) Appropriate Line tester with both visual and audible features.
(iv) Rescue rod

- The client to ensure that the above items are maintained on a regular basis.

ON CEB side,

(i) 22kV insulating mat is required.

The Client shall ensure that all the fire extinguishers shall be in good working condition. For fire extinguisher on CEB side, the Client shall inform CEB with one week notice for maintenance/inspection of fire extinguisher.

Spares

The client shall provide the following spares for the cubicles under Central Electricity Board's responsibility:-

(i) 1 set Voltage Transformer as specified in item 2.

(ii) 1 set Current Transformer as specified in item 3.

(iii) 1 set HRC fuses as specified in item 2.

(iv) 1 charging motor for item 1

(v) 1 charging motor for item 3.

Standards

The switchboard shall conform to the following standards or the relevant parts thereof:-

(i)	IEC 62271-102	-	AC Disconnectors (Isolators) and Earthing Switches
(ii)	IEC 62271-103	-	HV Switches
(iii)	IEC 62271-200	-	HV Metal-Enclosed Switchgear and Control Gear.
		-	Internal Arc Classification (A-FLR)
(iv)	IEC 60282	-	High Voltage Fuses
(v)	IEC 62271-105	-	HV AC Fuse Switch combination and Fuse Circuit Breaker combinations
(vi)	IEC 61869	-	Instrument transformers.

Note: All specifications shall be according to the latest edition of the standards mentioned above.

Protection Relays

Appropriate numerical protection relays having technical specifications detailed in Schedule A2 shall be provided on the CEB circuit breaker cubicle.

Communication Systems

In line with the implementation of Distribution Management System (DMS), the 22kV switchgear shall make provision for transfer of real-time operating data and protection and control signals via a communication system to the CEB SCADA. The communication system comprising of the Remote Terminal Unit (RTU), Relay Panel/ Transducers and the communication channel shall be installed and tested by the CEB.

However, the Client shall provide the connection link of the signals from the switchgear panels to a dedicated terminal block fitted in a wall-mounted control cubicle with hinged door placed inside the CEB side of the room. The required signals together with a simplified block diagram of the communication system are provided in schedule A3.

It is to be noted that the maximum load required for the communication equipment is around 500W.

Safety Procedures

Safety Procedures regarding the operation of HT Switchgear are described in Schedule A4.

General Notes:

(i) The bus riser cubicle and transformer protection cubicles shall be specified by client.

(ii) The current and voltage transformers (including the spares) have to be sent to CEB Meter Laboratory for necessary tests before commissioning.

(iii) The client should also provide a 2-pole circuit breaker on the secured AC auxiliary supply for the spring charging mechanism inside the LV upper compartment of the CEB circuit breaker module.

(iv) The operation of the equipment under Central Electricity Board's responsibility shall require secured AC auxiliary source of supply also protected by surge and lightning devices. An online uninterruptible power supply (UPS) is required and it shall have adequate capacity to ensure that the protection, measurement, control and communication systems operate without interruption for a minimum duration of at least 3 hours after loss of CEB power supply. The Client shall submit the calculations in the determination of the sizing of the UPS. In the event of loss of the secured auxiliary supply, all the Client's 22kV circuit breakers shall be tripped until remedial actions are taken. The UPS system shall be installed on the Client side and be maintained accordingly by the Client. The UPS shall be equipped with a bypass switch/system that will allow continuous operation during maintenance on the UPS.

(v) **For clients with standby generator, an electrical & mechanical interlock (break before make) be provided in such a way that the generator supply does not feed at any time the CEB's network.**

Guaranteed Particulars

The Client shall also supply all relevant data where applicable by filling in the Schedule of Guaranteed Particulars - Schedule B1.

Item 1 - Incoming Feeder Cubicle

The 22 kV Incoming Feeder Cubicle shall comprise the following basic equipment:-

1	-	Three-phase 630 A busbar
1	-	Motorised load break switch disconnector of rating 630A and housed in SF_6/ Vacuum filled enclosure having padlocking facilities.
1	-	Motor operated spring charged operating mechanism for quick closing and opening independent of the operator. Manual spring charged operating mechanism should also be provided in case of failure of motor.
1	-	Earthing switch located in such a position to allow its contacts to be seen easily through the cubicle window
1	-	Mechanical interlocking system between disconnector and earthing

switch

1 - Neon lamp for live cable indication

1 - Cable compartment with cable terminations for the reception of 3-core aluminium 240 mm² or copper 300 mm² XLPE cable to IEC 60502-2.

The cable entry is to be at the front of the panel

1 - Bottom plate with cable gland

1 - Built-in padlocking device of the cubicle door

The front facia should be equipped with appropriate padlocking facilities that will allow the operator to lock the disconnector switch and earth switch in close/open position independently.

The incoming 3-Core power cable shall be centered below the Panel Base / Bottom Plate and cable terminations (Indoor) shall be mounted inside the MV compartment of the incomer switchgear panel (refer to drawing 6640-18). Rubber Bushings shall be provided for sleeve protection for cable of size ranging from 65mm to 100mm.

The load break switch disconnector shall have both local and remote modes of operation via a key selector switch which should be mounted on the front facia. The key should be released in local mode only.

Guaranteed Particulars

The Client shall also supply all relevant data where applicable by filling in the Schedule of Guaranteed Particulars - Schedule B2.

Item 2 - Voltage Transformer Cubicle

The 22 kV Voltage Transformer Cubicle shall comprise the following basic equipment:-

1 - Three-phase 630 A busbar

1 - Triple pole isolator

1 - Manual operating mechanism

3 - HRC fuses to DIN specifications rated to suit VT's rating

Note: Access to the fuses shall only be possible with the switch in the "Earth" position in such a way that both sides of the fuse are effectively earthed.

1 - Auxiliary switch connected to the VT secondaries and opening with the 22 kV isolator to prevent feedback from the LV side.

3 - Single phase voltage transformers

2 - Secondary windings. Each PT shall be equipped with 2 windings: one winding to be used for metering and the second winding for open delta protection.

Metering core

Ratio : $\frac{22\,000}{\sqrt{3}}$ V : $\frac{110}{\sqrt{3}}$ V

Rated burden : minimum of 10 VA

Accuracy Class : CL 0.5

Protection core

Ratio : $\frac{22\,000}{\sqrt{3}}$ V : $\frac{110}{\sqrt{3}}$ V or $\frac{110}{3}$V

Rated burden : minimum 15VA

Accuracy Class : 3P

1 - LV fuse box containing 3 LV fuses of appropriate rating + 3 neutral links

1 - Built-in padlocking facility on the cubicle door

The system shall be designed and implemented to prevent or damp any ferroresonance effect in the PTs.

As mentioned above, the burden for the PTs (metering) shall be minimum 10VA. However, the Client's Electrical Engineer shall provide the burden calculation for the instrumentation transformers so as to ensure that the proposed PTs are rated correctly and they are operating within the optimum range (i.e. between 0% and 100% of the rated burden). It can be assumed that the maximum burden for the meter is 3VA per phase and secondly, the supervisory cable used is 1.5 mm^2 Copper cable.

The front facia should be equipped with appropriate padlocking facilities that will allow the operator to lock the disconnector switch and earth switch in close/open position independently.

Guaranteed Particulars

The Client shall also supply all relevant data where applicable by filling in the Schedule of Guaranteed Particulars - Schedule B3.

Item 3 - CEB Circuit Breaker Cubicle

The 22 kV Circuit Breaker Cubicle shall be of double isolation and comprise the following basic equipment:-

1	-	Three-phase 630 A busbar
2	-	Triple pole isolator
1	-	SF_6 Gas/ Vacuum Circuit Breaker
1	-	Motor operated spring charged operating mechanism for quick closing and opening both locally by push button and remotely.
1	-	Tripping coil 230 V ac for emergency tripping
1	-	Trip release device to work in conjunction with the relay mentioned below in Schedule A2.
3	-	Current transformers with dual primaries e.g. 100/200 or 200/400 rated amp with secondaries of 5A, Class 5P20, 10VA burden for protection and 5A Class 0.5, minimum of 10 VA burden for metering. The minimum primary current shall be 100A to prevent any saturation of the CT during a fault condition.
1	-	Voltage test terminal block
1	-	Current test terminal block
2	-	Tripping test terminal block
1	-	Mechanical interlocking between earthing switch and triple pole isolator
1	-	Earthing switch located in a position to allow its contacts or position to be seen easily through the cubicle window
1	-	Bottom plate with cable gland
1	-	Neon lamp for live cable indication
1	-	Built-in padlocking device for the cubicle door

As mentioned above, the burden for the CTs (metering) shall be minimum 10VA. However, the Client's Electrical Engineer, shall provide the burden calculation for the instrumentation transformers so as to ensure that the proposed CTs are rated correctly and these are operating within the optimum range (i.e. between 25% and 100% of the rated burden). It can be assumed that the burden for the meter is 0.1VA per phase and the supervisory cable used is 2.5 mm^2 Copper cable.

The Circuit Breaker shall have both local and remote modes of operation via a key selector switch which should be mounted on the front facia. The key should be released in local mode only.

The front facia should be equipped with appropriate padlocking facilities that will allow the operator to lock the disconnector switch and earth switch in close/open position independently.

Note:

1. ***Toroidal CTs WILL NOT BE ACCEPTED for metering purposes.***

2. ***CT ratio will depend on installed load and will have to be specified at the time of order.***

3. The metering CT shall be mounted so that P1 is located on CEB side direction and P2 on client side direction.

4. In addition, an interlocking system shall be provided to ensure that closing of the CEB 22kV Circuit Breaker is ONLY allowed if ALL the Client 22 kV Circuit Breakers are in the open position. The opening of the CEB 22kV Circuit Breaker shall inter trip ALL the Client 22 kV Circuit Breakers. <u>However, this interlocking/ inter-tripping feature shall be enabled only for MSDG, IPPs installations etc..</u>

<u>Guaranteed Particulars</u>

The Client shall also supply all relevant data where applicable by filling in the Schedule of Guaranteed Particulars - Schedule B4.

<u>Item 4- Outgoing Feeder Cubicle/s (Client's Side)</u>

22 kV circuit breaker(s) shall be required on the outgoing feeder panel(s) on Client's Side.

Schedule A2

MULTIFUNCTIONAL PROGRAMMABLE NUMERICAL PROTECTION RELAYS

The Programmable Protection Relays shall include at least Overcurrent, Earth Fault and Neutral Voltage Displacement (NVD) protections and shall operate with the **secured** auxiliary supply, with independent time settings for each type of protection as detailed hereunder:-

The numerical relay shall comprise of two or more low set stages and one high set stage for both overcurrent and earth fault protection.

Low set overcurrent and earth fault elements must consist of both Inverse Definite Minimum Time (IDMT) and Definite Time Stages. Relay must also provide both delayed and instantaneous overcurrent and earth fault high set elements.

(a) The primary range of overcurrent protection should be as follows:

1. Low Set (I>):
   At Inverse time: 15 Amp to 400 Amp with time multiplier range: 0.05 to 1.5

2. High set (I>>):
   At definite time or instantaneous stage: 200Amp to 2000 Amp with time range of 0s to 20s DT.

(b) The primary ranges for the earth fault elements should be as follows:

1. Low Set (I>):
   At Inverse time: 10 Amp to 100 Amp with time multiplier range: 0.05 to 1.5

2. High set (I>>):
   At definite time: 50 Amp to 1500 Amp with time range of 0s to 20s.

The typical range of overcurrent is based on an installation capacity of 500kVA to 10MVA. In case, the capacity is outside the above range the overcurrent setting might be inappropriate. It is also assumed that the minimum primary setting of the CT is set on 100A to prevent saturation of the CT during a fault.

The supplier shall select the appropriate protective relay based on the above primary ranges.

(c) Neutral Voltage Displacement

At Definite time : 1…. 20% x (22kV/√3)

Operating time at Definite time: 0.05 ….. 20s

Prior to relay testing, the client's settings proposal for 'CEB side relay' must be verified and approved by CEB. The client is to take responsibility that the 'client's side protection relay' settings grades properly with 'CEB's side relay'. Relay test certificates must be provided.

Any relay settings' changes (if required) is to be carried out by the client and tested accordingly by the client. However, these settings must be vetted by the CEB. The Client shall provide CEB with a PC-to-relay communication cable and the updated relay software.

Note:

(i) The circuit breaker's main function is for protecting Central Electricity Board's system from client's system against faults on client's side and not for transformer protection. Client shall therefore provide for a transformer protection panel for each transformer.

(ii) The Client shall make provision for the training of CEB personnel on the configuration and operation of the relays.

(iii) All protection relays shall have test blocks for current, voltage and tripping. Client to provide CEB with pre-wired plugs for each test block.

(iv) The Neutral Voltage Displacement protection shall be enabled only for MSDG and IPPs clients.

(v) Alarms should be communicated to CEB SCADA to signal any loss of supply to and from the UPS.

(vi) Client shall be responsible for providing the CEB with a study report complete with curves illustrating co-ordination between new and existing systems along with all calculations to determine relay settings.

(vii) The Client shall submit a hard copy as well as a soft copy of the relay configuration, settings and manuals (if required by the CEB) before commissioning.

(viii) Multi-function protection shall have the functions indicated on the electrical schematic/specification drawings.

Schedule A3

Communication Requirements

With regards to the communication link between the 22kV switchgear Panels (Upper LV control compartment) and the CEB SCADA facilities, the required signals to be provided with proper labelling in a dedicated electrical panel located in the CEB side of the switchgear room are:

1. **Status and Alarms (dry contacts)**

   (i) Load Break Switch status OPEN for each incomer (item 1).
   (ii) Load Break Switch status CLOSED for each incomer (item 1)
   (iii) Circuit Breaker CEB status OPEN
   (iv) Circuit Breaker CEB status CLOSED
   (v) Outgoing Circuit Breaker(s) (client side) status OPEN - applicable for MSDG & IPPs
   (vi) Outgoing Circuit Breaker(s) (client side) status CLOSED – applicable for MSDG & IPPs
   (vii) Protection Operated
   (viii) Protection relay not healthy
   (ix) SF6 Alarm (if available)
   (x) UPS Alarms
   (xi) Door Alarm (Switchgear room door on CEB side)
   (xii) Other Alarms (grouped)

2. **Control Signals (through potential free contacts)**
   (i) Load Break Switch OPEN CTRL command for each incomer (item 1)
   (ii) Load Break Switch CLOSED CTRL command for each incomer (item 1)
   (iii) Circuit Breaker CEB OPEN CTRL command (item 3)
   (iv) Circuit Breaker CEB CLOSED CTRL command (item 3)

Note:

(i) The information given above in 1(i), 1(ii), 2(i) and 2(ii) is applicable for the load break switches in ALL the CEB 22kV incoming cubicles as described in item 1.

(ii) The Circuit Breaker here refers only to the CEB Circuit Breaker as described in item 3.

(iii) A simplified diagram showing the communication system is given below.

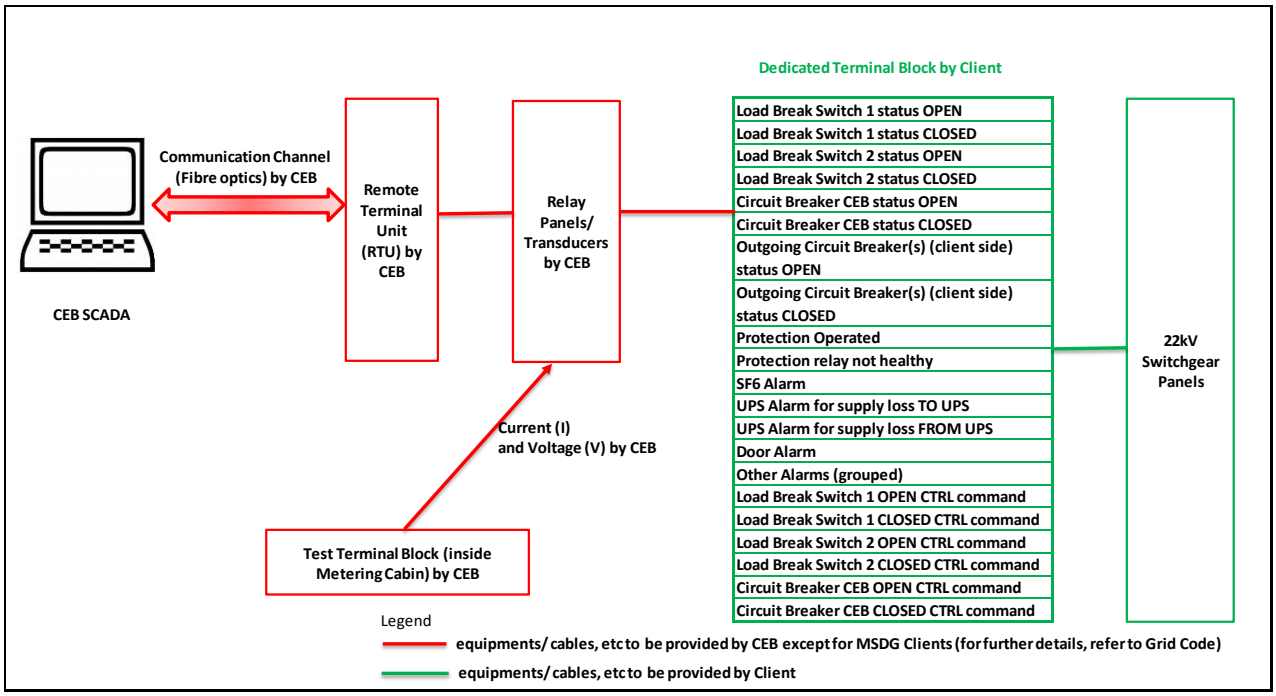


Figure 1: Simplified block diagram showing the communication system

Note: For MSDG implementation, layout of the communication system shall be as per Annex 9.

Schedule A4

Safety Procedures regarding the operation of High Voltage Switchgear

In order to ensure the safety of personnel while operating or working on High Voltage Switchgear installed for the purpose of supplying electricity to the Client's premises, the following requirements and procedures shall be adhered to:-

1. To comply with Section 7(2) of the Occupational Safety & Health Act 2005 (OSHA 2005) which states "Where the total power used or generated by machinery installed at any place of work exceeds 750 kilowatts, the employer shall employ a Registered Professional Engineer to be in general charge of all such machinery".

2. The Client shall appoint and train competent person/s who shall be responsible for the operation of the High Voltage Switchgear. He/they shall be fully conversant with the electrical set-up, including that of the Switchgear belonging to CEB. The contact details of the competent person(s) shall be affixed within the CEB side of the switchgear room. The CEB shall be immediately notified of any change in the contact details.

3. An up-to-date schematic diagram of the switchgear set-up shall be displayed in the switchgear room.

4. All switchgear panels shall be clearly numbered and labelled.

5. Before any work can be performed on either the CEB side or Client side of the switchgear panel appropriate switching operations shall be carried out by the respective competent person in the presence of his respective counterpart. The competent person performing the operations shall certify the operations carried out on the approved Certificat de Consignation form and shall remit the original to his counterpart, who may then proceed with the work in accordance with the Safety Rules.

   Note:

   The person receiving the above information shall ensure that the switchgear involved shall not be inadvertently operated by securing them by means of personal padlocks and by affixing proper warning signs.

6. In case of private generation, the client shall ensure that his system is completely isolated from CEB system.

7. For MSDG, the provision of the MSDG Grid Code shall be followed.

PART II: OUTDOOR DISTRIBUTION TRANSFORMERS

Schedule A5

Outdoor Distribution Transformers (with Plug-in Bushings)

The Distribution Transformer shall preferably be of the outdoor type*, ground-mounted and cover the following capacities:-

Item 1 - 500 kVA
Item 2 - 1000 kVA

Characteristics of the Distribution Transformer

No. of phases	-	3
Voltage ratio	-	22 000/415 volts
Frequency	-	50 Hz
Type	-	Oil immersed, hermetically sealed, non-gas cushion *
Cooling	-	Natural
Construction	-	Core type double wound or shell type
Vector Group	-	Dyn 11
Winding	-	Enamelled Copper Wire
Standard	-	IEC 60076

* Customers wishing to purchase cast resin transformers (for indoor use), should submit all detailed characteristics of the proposed units including Type Test Report from an independent and recognised institution.

Other Requirements

The transformer shall be:-

1. Supplied with oil as per specifications contained in Schedule A6 – ***Mineral Insulating Oil for Transformers*.**
2. Fitted with:-
   (a) Oil level indicator
   (b) Oil filling hole with plug
   (c) Lifting lugs
   (d) Earthing terminal for tank
   (e) Drain plug with sampler cock
   (f) Diagram and rating plate
   (g) Terminal marking plate
   (h) Off-circuit tap changer with ± 2 ½% and ± 5% taps (as per the above-mentioned standard)
3. Supplied with detachable top yoke to allow removal of windings for repairs.
4. Externally hot dip galvanised to BS EN ISO 1461.

5. Designed for ground mounting with rollers.

6. Designed with a bolted cover.

7. Designed with the following terminations:-

   (a) HT side - 3 plug-in type bushings rated 200A, 24 kV suitable for the reception of elbow plug-in connector

   (b) LT side - 4 bushings and associated copper cable terminals having the following characteristics:-

   (i) be of vertical type.

   (ii) bottom part to be threaded onto the bushing rod and tightened by two side bolts.

   (iii) have a top palm, undrilled, and of dimensions (width x height):-
   60 mm x 70 mm for 500 kVA

   60 mm x 130 mm for 1000 kVA

Standards

The transformer shall conform to the following standards:-

(i)	IEC 60076	-	Power Transformers
(ii)	BS EN ISO 1461	-	Hot dip galvanised coatings on fabricated iron and steel articles (specifications and test methods)

Note: All specifications shall be according to the latest edition of the standards mentioned above.

Guaranteed Particulars

All relevant data shall be supplied where applicable by filling in the Schedule of Guaranteed Particulars – Schedule B5, and dimensional drawings of the transformer shall also be submitted.

Schedule A6

TECHNICAL SPECIFICATIONS

MINERAL INSULATING OIL FOR TRANSFORMERS

The insulating oil shall be for use in transformers and switchgear and shall comply to IEC 60296 and 60156 or equivalent.

The oil shall be free of PCB and be of such quality that it shall not require any user precautionary labelling as defined by the EEC Dangerous Substances Directive 67/548/EEC.

The CEB prefers that the oil be of Uninhibited Type.

The polycyclic aromatic content by IP 346 shall be maintained below 3%.

Guaranteed Particulars

All relevant data shall be supplied where applicable by filling in the Schedule of Guaranteed Particulars – Schedule B6.

Schedule B1

GUARANTEED PARTICULARS

COMPLETE SWITCHBOARD

Serial No.	Description	Units	
1.	Rated Voltage	kV	
2.	Impulse test voltage 1,2/50µs	kV	
3.	Rated short time current - I_{SC}	kA 1 sec	
4.	Electrodynamic withstand	kA peak	
5.	Type of busbars (copper/aluminium)		
6.	Are busbars insulated?	Yes/No	
7.	Busbar Rating	A	
8.	Degree of Protection	IP	
9.	Colour of switchboard		
10.	Dimensions of assembled switchboard:- (i) Length (ii) Depth (iii) Height	 mm mm mm	
11.	Reference of IEC standards to which switchboard complies with		

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

Signature of authorised signatory: _____

Name of authorised signatory: _____

Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

Schedule B2

GUARANTEED PARTICULARS
INCOMING FEEDER PANEL

Serial No.	Description	Units	
1.	Rated Voltage	kV	
2.	Rated Current	A	
3.	Rated short time current	I_{SC} [kA(rms)]	
4.	Making Capacity	kA peak	
5.	Arc quenching medium e.g. SF_6/ Vacuum	To specify	
6.	Is double or single break?	To specify	
7.	Type of operating mechanism (motorised spring charged)	Yes/No	
8.	Minimum clearance: (a) Between phases (b) Live part to earth	 mm mm	
9.	Type of design contacts: (a) Movable contacts (b) Fixed contacts	To specify	
10.	Type of metal used for contacts: (a) Movable contacts (b) Fixed contacts	To specify	
11.	Padlocking facility to allow locking of disconnector and earth switch in close/open positions independently	Yes/No	
12.	Are all signals required as per schedule A3 being provided?	Yes/No	
13.	Does load break switch disconnector have both local and remote mode of operations?	Yes/ No	

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

Signature of authorised signatory: _____

Name of authorised signatory: _____

Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

Schedule B3

GUARANTEED PARTICULARS

VOLTAGE TRANSFORMER PANEL

Serial No.	Description	Units		
1.	Rated Voltage	kV		
2.	Rated Current	A		
3.	Type of Disconnector	To specify		
4.	Type of operating mechanism of Disconnector	To specify		
5.	Standard of HRC fuse links	To specify		
6.	Voltage Transformer:- (a) Number of units installed (b) Type (c) Model/Make			
			Metering core	Protection core
	(d) Burden (e) Rated primary voltage (f) Rated secondary voltage (g) Accuracy class (h) Transformation ratio (i) Rated thermal output	VA kV V VA		
7.	Padlocking facility to allow locking of disconnector and earth switch in close/open positions independently	Yes/No		

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

Signature of authorised signatory: _____

Name of authorised signatory: _____

Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

Schedule B4

GUARANTEED PARTICULARS

CIRCUIT BREAKER PANEL

S. No.	Description	Units	
1.	Rated Voltage	kV	
2.	Rated Current	A	
3.	Rated short time current	I_{SC} [kA(rms)]	
4.	Making Capacity	kA peak	
5.	Arc quenching medium e.g. SF_6/ Vacuum	To specify	
6.	Is double or single break?	To specify	
7.	Type of operating mechanism (manual spring charged; manual)	To specify	
8.	Minimum clearance:- (a) Between phases (b) Live part to earth	 mm mm	
9.	Type of design contacts:- (a) Movable contacts (b) Fixed contacts		
10.	Type of metal used for contacts:- (a) Movable contacts (b) Fixed contacts	To specify	
11.	Padlocking facility to allow locking of disconnector and earth switch in close/open positions independently	Yes/No	
12.	Current Transformer:- (a) No. 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	 VA VA A A	
13.	Does CEB Circuit Breaker have both local and remote mode of operations?	Yes/ No	
14.	Are all signals required as per schedule A3 being provided?	Yes/No	
15.	Has interlocking/ inter-tripping feature been provided between CEB Circuit Breaker and all Client Circuit Breakers	Yes/ No	

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

Signature of authorised signatory: _____

Name of authorised signatory: _____

Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

Schedule B5

GUARANTEED PARTICULARS

OUTDOOR DISTRIBUTION TRANSFORMERS

S. No.	Description	Units	Proposed Item(s)
1.	Continuous maximum rating (CMR) at rated voltage with ONAN cooling	kVA	
2.	Is transformer totally oil-filled with no gas cushion?	Yes/No	
3.	Current rating – Amps H.V L.V	 A A	
4.	Winding connection Vector Group Symbol		
5.	Impedance Voltage	%	
6.	Normal ratio of transformation at no load		
7.	Total range of variation of transformation ratio	±%	
8.	Size of steps	%	
9.	Tappings on H.V. winding	Yes/No	
10.	Regulation at 75°C and at full load as percentage of normal voltage (a) At unity p.f. (b) At 0.8 p.f. lagging	 % %	
11.	Fixed losses at normal ratio and 75°C	kW	
12.	Load losses at normal ratio and 75°C at full rated power	kW	
13.	Ratio on Inrush Current to Primary Current at 0.3 sec after energising transformer		
14.	Efficiency at normal ratio and 75°C at: (a) Rated power at unity power factor (b) Rated power at 0.8 power factor (c) Natural circulation rating	 % % %	
15.	Winding temperature:- Hottest spot temperature at full rated power (assuming an air temperature at 32°C approx.)	°C	

S. No.	Description	Units	Proposed Item(s)
16.	Maximum observable top oil temperature at:- (a) Full rated power (assuming an air temperature at 32°C) approx. (b) Natural circulation rating (assuming an air temperature 32°C) approx.	 ºC ºC	
17.	Calculated ONAN thermal time constant	Hrs	
18.	Type of transformer – shell or core		
19.	Type of core joint - butt or mitred		
20.	Type of core sheet - cold rolled or hot rolled		
21.	Maximum current density in windings:- H.V. L.V.	 kA/sq.m kA/sq.m	
22.	Whether special surge protection is provided in conjunction with modified end-turn reinforcement	 Yes/No	
23.	Type of axial coil supports:- (a) H.V. winding (b) L.V. winding		
24.	Type of radial coil supports:- (a) H.V. winding (b) L.V. winding		
25.	Can winding be removed for repairs?		
26.	Total quantity of oil required to fill complete transformer		
27.	Standard specifications of oil used for filling transformer		
28.	Is transformer externally hot dip galvanised?	 Yes/No	
29.	Required for each transformer:- (a) Weight of copper (W) (b) Weight of core sheets (c) Weight of all other ferrous parts	 kg kg kg	
30.	Approximate weight of core and winding assembly	 kg	

S. No.	Description	Units	Proposed Item(s)
31.	Total weight of transformer complete as in service	kg	
32.	Approximate dimensions of transformer incl. all fittings:- (a) Length (b) Breadth (c) Height	 mm mm mm	
33.	Windings:- (a) Type of winding - H.V. L.V (b) Wire size - H.V. L.V. (c) Type of wire insulation (d) Number of coils per winding (e) Number of turns per coil (f) Number of layers per coil (g) Number of turns per layer (h) Type of insulation between layers (i) Thickness of insulation between layers (j) Turn numbers in tapping coils (k) Total length of winding (l) Winding & clearances from yokes (m) Interphase winding clearance (n) Total weight of copper per phase (o) Limb diameter Limb length Limb centre distance (p) Top yoke clearance from tank cover (q) Whether tapping connection are of the crimped type?	 mm mm mm kg mm mm mm mm Yes/No	

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

Signature of authorised signatory: _____

Name of authorised signatory: _____

Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

Schedule B6

GUARANTEED PARTICULARS

MINERAL INSULATING OIL FOR TRANSFORMERS

S. No.	Description	Units	Proposed Item(s)
1.	Sludge Value (max.)	%	
2.	Acidity after oxidisation (max.)	mg KOH/g	
3.	Flash point (closed) – min.	ºC	
4.	Viscosity:- (a) at 15ºC (max.) (b) at 20ºC (max.)	 mm^2/s mm^2/s	
5.	Pour point (max.)	ºC	
6.	Electric strength (breakdown) min. for oil received in Mauritius in drums	kV/mm	
7.	Acidity (neutralisation value) – max.	mg KOH/g	
8.	Corrosive sulphur		
9.	Water content (max.) for oil received in Mauritius in drums	p.p.m.	
10.	Density at 20ºC (max.)	g/ml	
11.	Loss tangent at 90ºC (max.)		
12.	Resistivity		
13.	Polycyclic aromatic content (IP 346)	%	
14.	Polychlorinated Biphenyls	(mg/kg)	
15.	Reference of standard specifications		
16.	Are any precautions to be taken in compliance with the EEC Dangerous Substance Directive 67/548/EEC?	Yes/No	

8

Name of Client/ Supplier: _____

Contact Person: _____ Phone No: _____

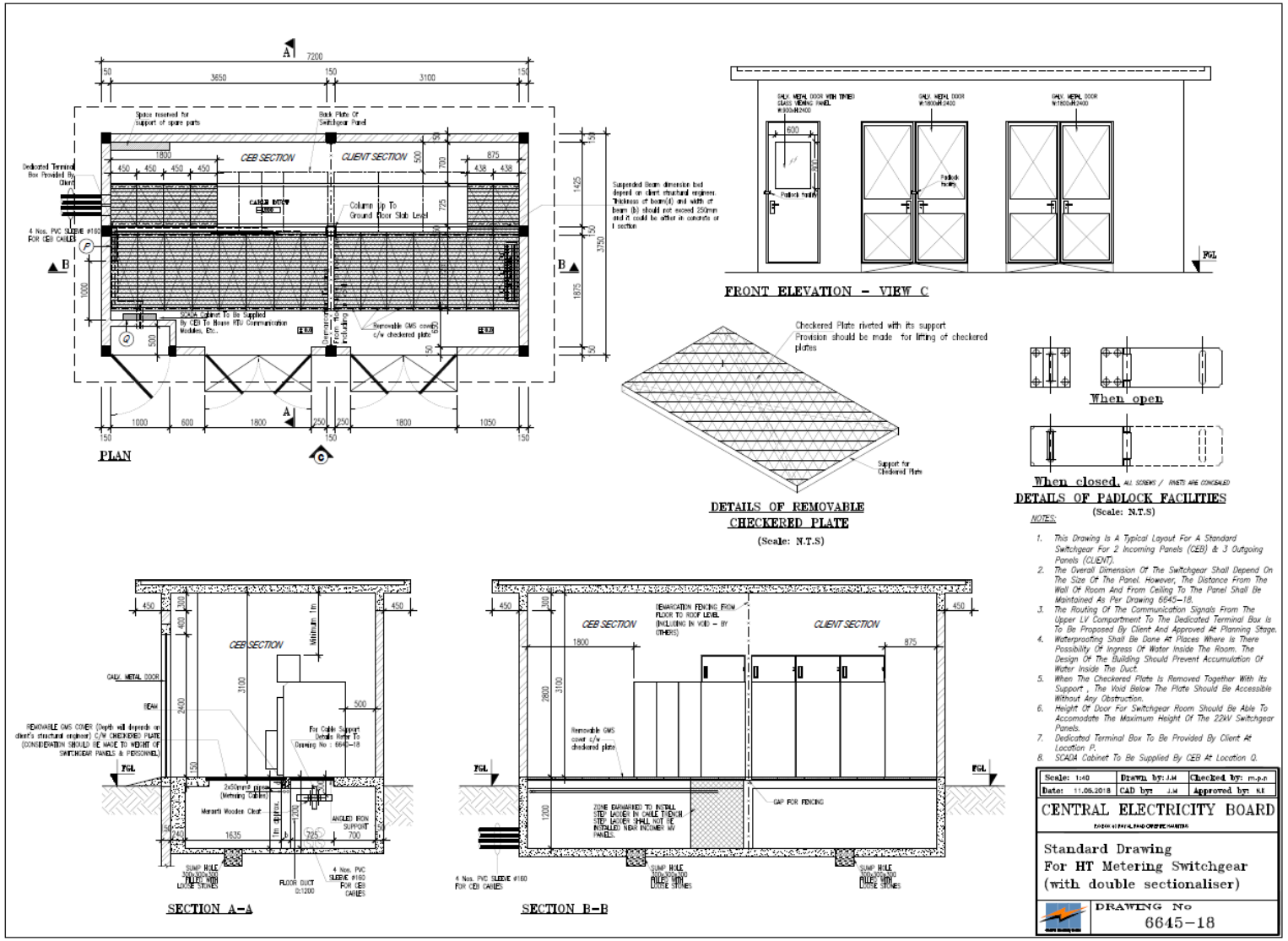
Signature of authorised signatory: _____

Name of authorised signatory: _____

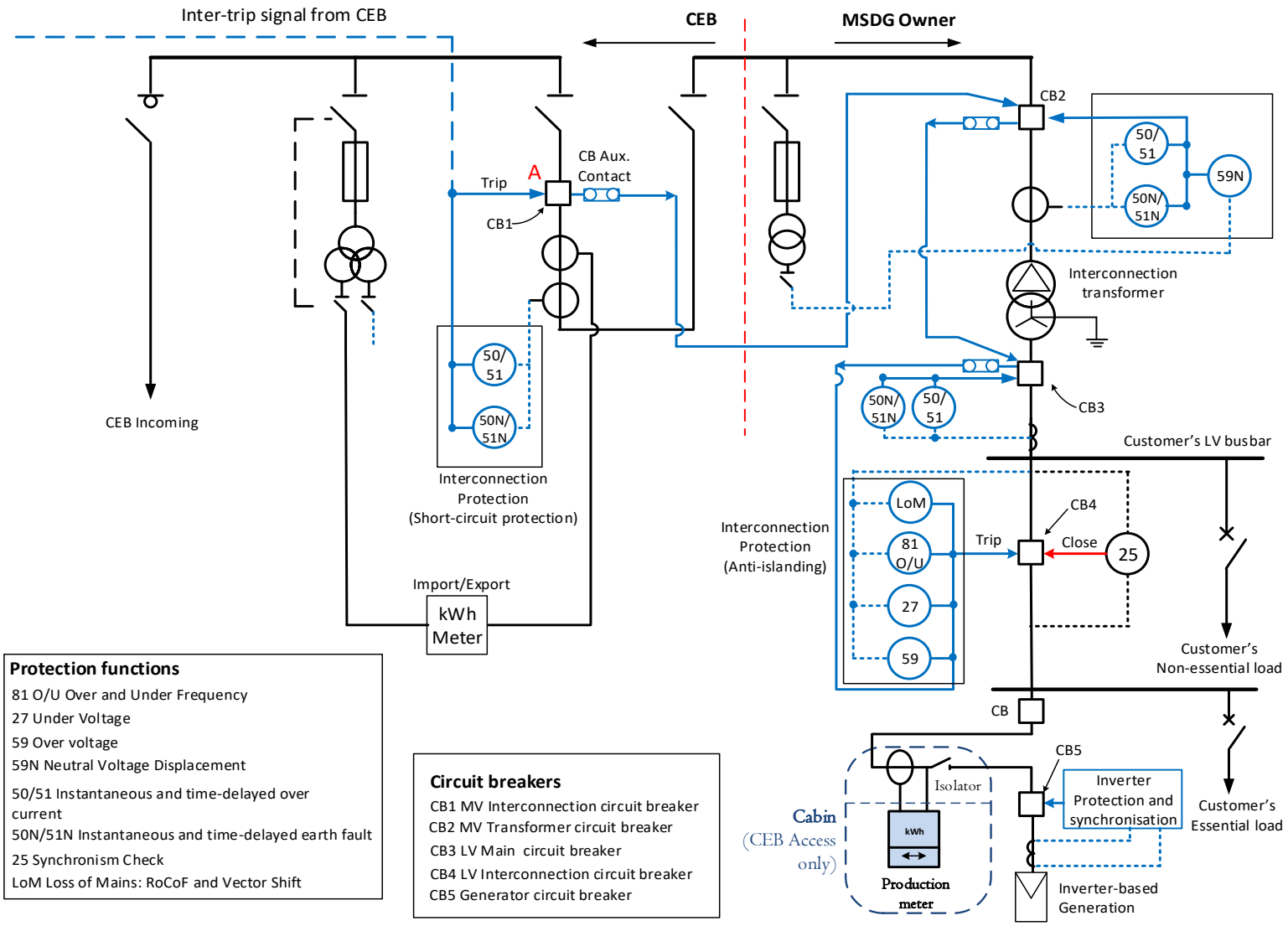
Position of authorised signatory: _____

Date: _____ Company Seal (Mandatory)

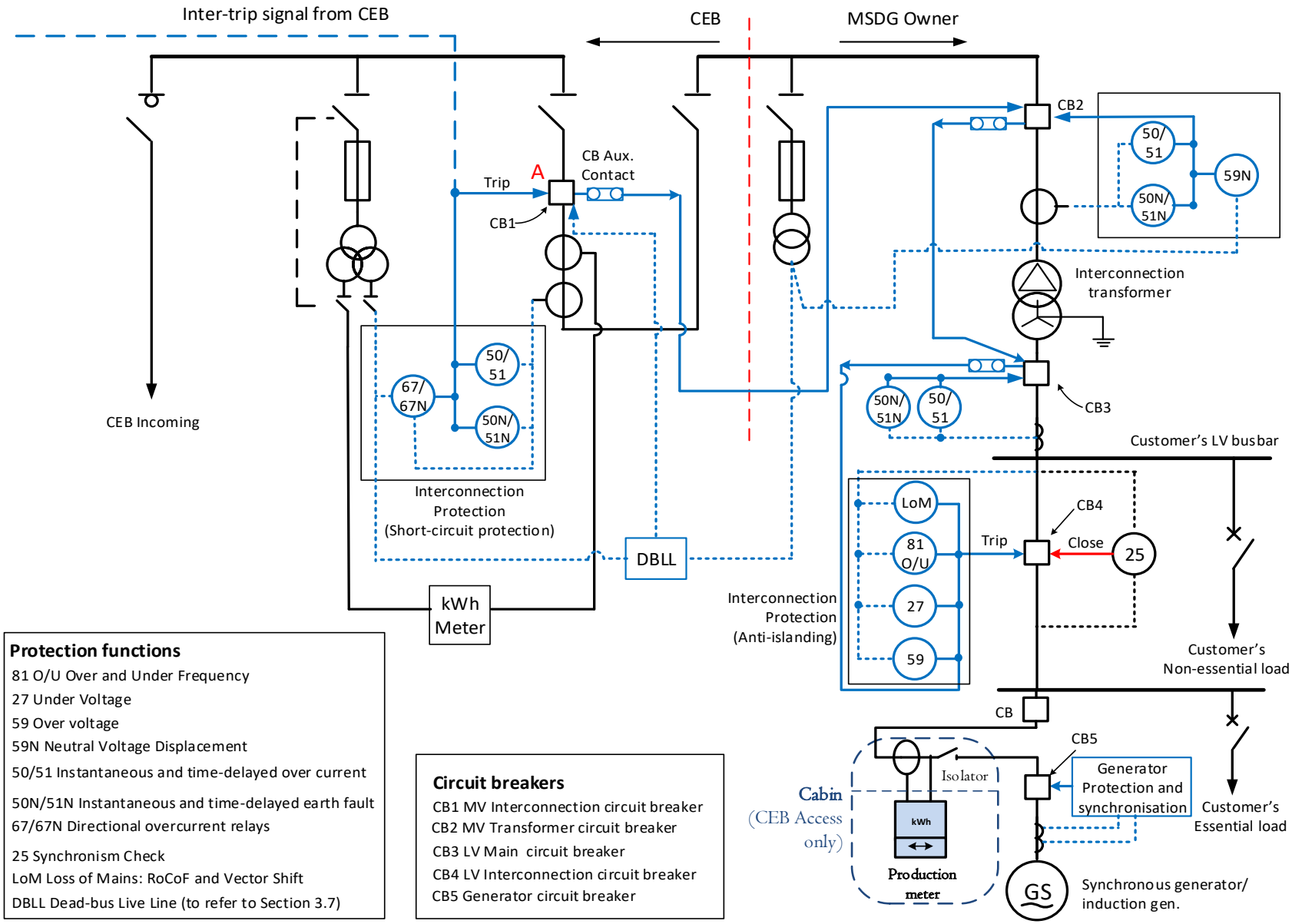
Typical 22 kV Switchgear Room



7.8 Annex 8 (a): Typical High Voltage Switchgear Panel and Protection Guideline for Inverter-based Generation



Annex 8 (b): Typical High Voltage Switchgear Panel and Protection Guideline for Synchronous and Induction machine-based Generators.



Note:

1. The above schematic diagram refers to a typical installation. The actual protection and inter-tripping requirements may vary depending on the particular setup of the plant under consideration.

2. The MSDG owner is responsible for providing the appropriate protection for his transformer and internal loads.

3. The inter-trip between CEB substation and the MSDG plant is required for MSDG equal to or greater than 1 MW. Refer to clause 3.6.4.

4. In case of synchronous and induction machine-based generators (Sec. 3.7):

    a. A Dead Bus Live Line (DBLL) relay is required to prevent electrical and remote closure of CB1 on an energised busbar.

    b. A key interlock shall be provided between CB1 and all the client's outgoing 22 kV circuit breakers. This interlock shall prevent mechanical closure of CB1 as long as any of the client's outgoing 22 kV circuits breakers is closed.

    c. The onus lies on the MSDG owner to provide the required check-synchronism relay on circuit breakers where there exists the possibility of closing the generator live on the CEB system.

5. Under normal setup, the NVD protection relay will be driven from PT on client side.

6. Exceptionally, where it is practically not possible to install PTs on client side, the NVD (client side) may be driven by the PT protection core (CEB side), via a set of test block on CEB side.

7. For new MSDG installations and Greenfield installations, PT on client side is mandatory.

8. In cases where the MSDG system has been designed to operate in islanding mode, inter-trip between CB2 and CB3 is required.

7.9 Annex 9: Communication Requirement

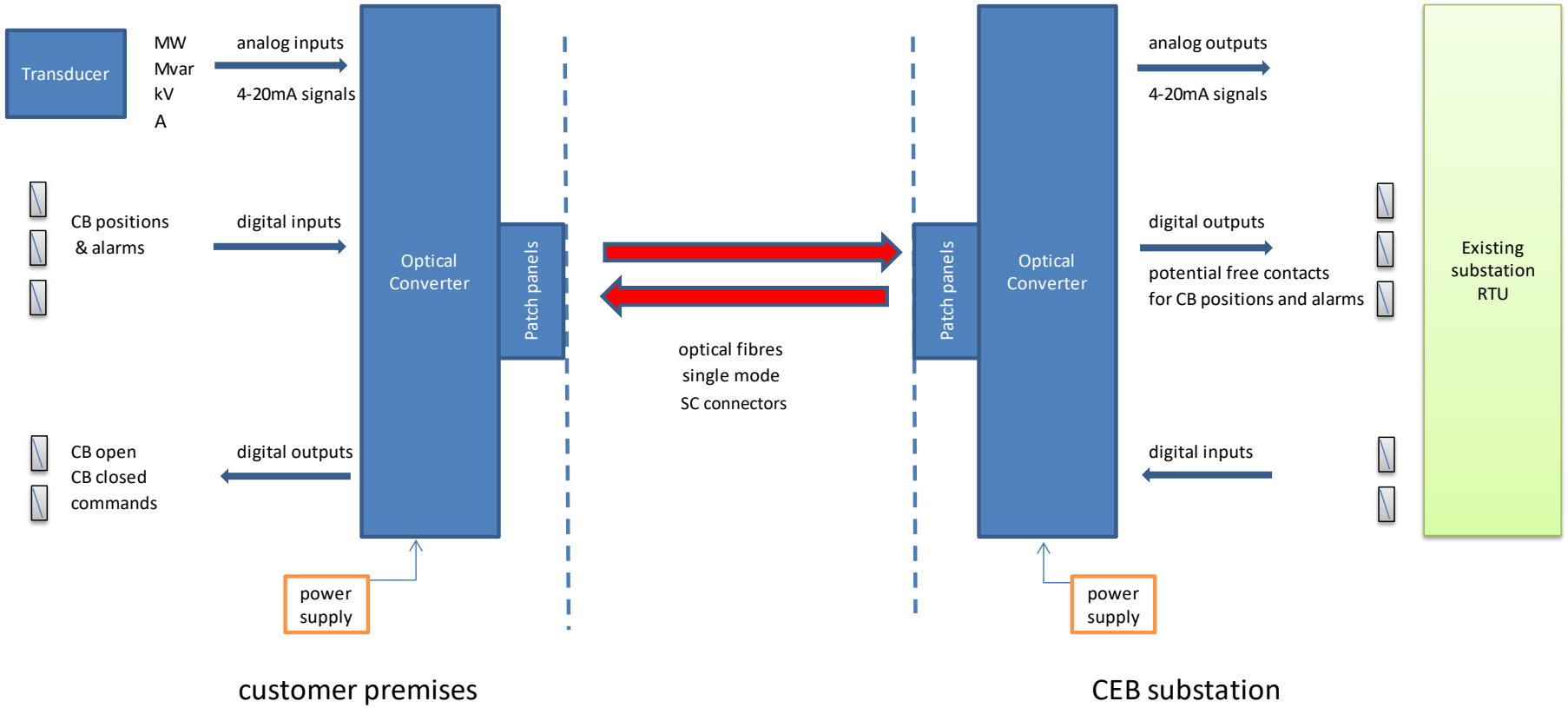


Figure A - 1 Communication channel setup

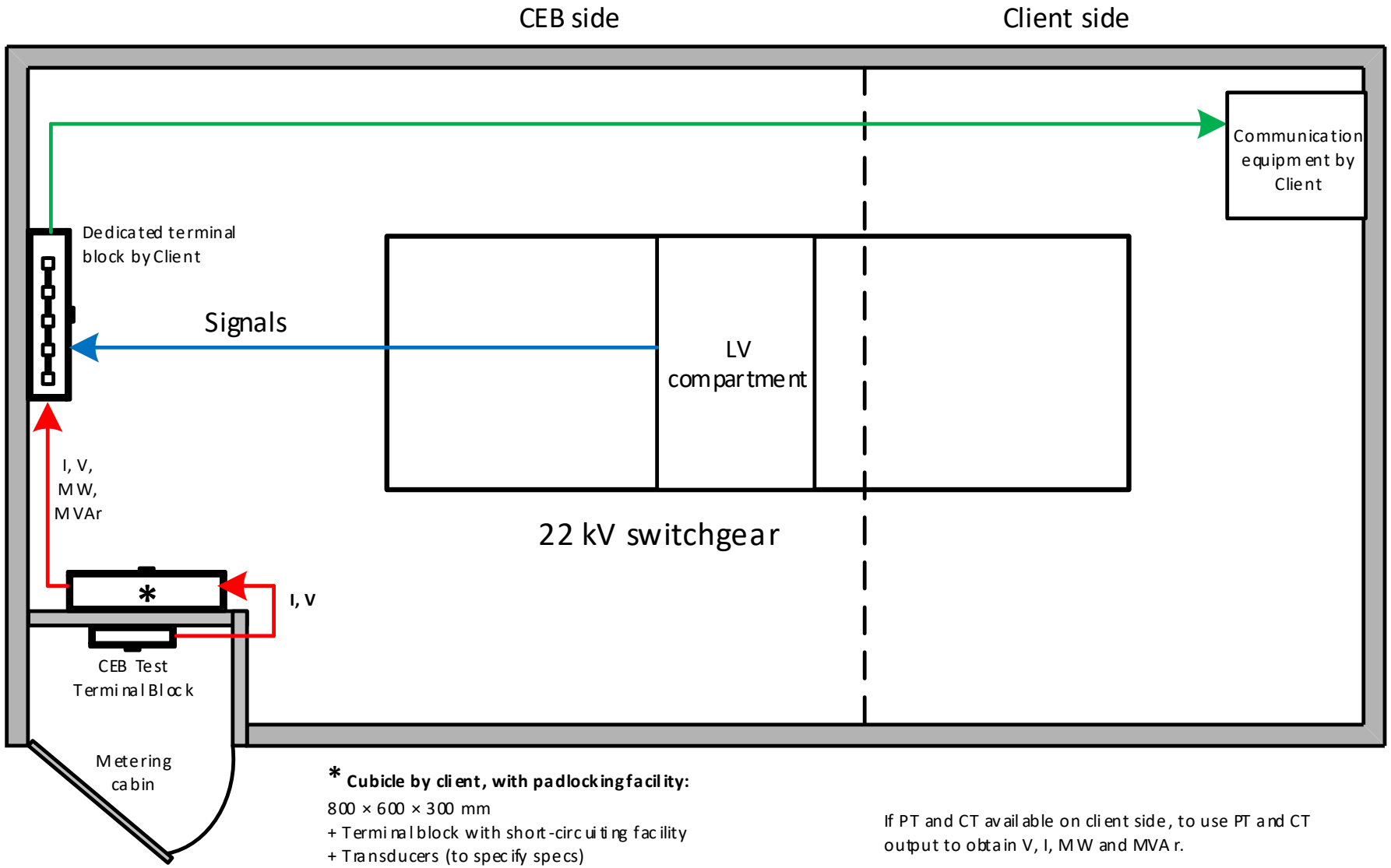


Figure A - 2 Communication channel layout

A. Analog / Digital Fiber Optic Converter

At least 4 **uni-directional** analog channels for monitoring of MW, MVAr and voltage + 1 spare

At least 10 digital channels for circuit breaker positions/status, alarm monitoring and for telecontrol of circuit breakers

Sampling method: True simultaneous sampling for all Inputs and Outputs. The I/O board for connecting external signals to the module should be included.

Analog outputs : 4-20mA

Digital outputs: volt free contacts

B. Optical Fiber

Single mode Fiber with ST connectors. Corresponding patch cords and patch panels complete with accessories to be included.

C. Power Supply:

48Vdc / 12V dc Volts, 3A low noise, linear, regulated power supply on CEB side.

D. Signal cable routing:

The signal cable from the switchgear LV compartment to the dedicated terminal block on CEB side shall be routed vertically from the LV compartment to the ceiling and along the ceiling and wall to the terminal block. The cable routing shall not hamper any maintenance on the MV switchgear.