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இலங்கைப் பொதுப் பயன்பாடுகள் ஆணைக்குழு
PUBLIC UTILITIES COMMISSION OF SRI LANKA

ඔබේ අංකය உமது இல. Your No.	අපේ අංකය எமது இல. Our No.	AP24/RA/CP/01/02	දිනය திகதி Date	July 22, 2024

General Manager
Ceylon Electricity Board
Sir Chittampalam A. Gardiner Mawatha,
Colombo 02

Dear Sir/Madam,

Grid Connection Code

Reference is made to your letter DGM/(CS&RA)/5-10 dated 8th July 2024 and my letter AP24/RA/CP/01/01 dated 24th June 2024 on Grid Connection Code.

In terms of Section 15(4)(h) of the Sri Lanka Electricity Act, No. 36 of 2024 read together with Section 17(f) of the Sri Lanka Electricity Act, No. 20 of 2009 and Condition 5 of the Electricity Transmission & Bulk Supply Licence granted to Ceylon Electricity Board, the Grid Connection Code approved by the Commission is forwarded herewith for immediate implementation.

Sincerely

Deputy Director General

06.වන මහල, ලංකා බැංකු වෙළඳ කුළුණ,
28. ශාන්ත මයිකල් පාර, කොළඹ 03.

06 ஆவது மாடி, இலங்கை வங்கி வர்த்தகக் கோபுரம்,
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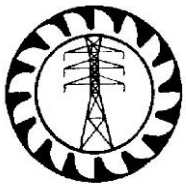
GRID CODE



TRANSMISSION DIVISION
CEYLON ELECTRICITY BOARD

July 2024 (Grid Connection Code)

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The Grid Code of Transmission Licensee

Introduction

The Grid Code of the Transmission Licensee, Ceylon Electricity Board, (hereafter referred to as the "Grid Code") has been formulated in terms of the provisions of Clause 3.1 (c) and 17(f) of the Sri Lanka Electricity Act, No 20 of 2009 (SLEA20), which require the licensees to implement and maintain technical or operational codes in relation to the Transmission System.

Physical laws that govern the behaviour of electrical power systems do not recognise Licensee boundaries. To plan and operate the system, it needs to be studied and analysed without regard to such boundaries. The Grid Code sets out the operating procedure and principles governing the Transmission Licensee and all Users of the Transmission System. It specifies the procedures for both planning and operational purposes to cover both normal and exceptional circumstances.

The Grid Code has to be revised and amended from time to time, as and when the situations Demand, to reflect the development of the transmission network, to comply with legislations, and to adopt appropriate good industry practices.

The primary objectives of the Grid Code are to establish an effective, transparent, non-discriminatory and coordinated approach for Planning and Operation of the Transmission System, and to ensure equitable management of technical matters in the interest of all the parties connected to the grid including Distribution Licensees, Transmission Customers, Generation Licensees and any other Users.

In the Grid Code, Users are categorised into,

(a) Generation Licensees with generation from conventional resources
(b) Generation Licensees with generation-based on intermittent resources
(c) Generation Licensees with embedded generators
(d) Distribution Licensees
(e) Transmission Customers

This Grid Code has to be read in conjunction with the Distribution Codes of each Distribution Licensee, if any, for complete and appropriate understanding of the requirements where applicable, especially with respect to interconnected or overlapping matters.
Currently, the Grid Code consists of (but not limited to) the following Codes, which individually and collectively form the framework of policies, procedures, practices and requirements of this Grid Code.

1. General Code

Cites the legal and regulatory framework for the implementation and maintenance of the Grid Code, and also specifies the general terms and conditions, and definitions applicable to the Grid Code.

2. Grid Planning Code

Describes the technical criteria, planning criteria and planning procedures followed by the Transmission Licensee in the planning and development of the Licensee's Transmission System. The Grid Planning Code also specifies the data and information the Users or Parties seeking connection to the Transmission System shall supply, for the Transmission Licensee to undertake planning and development of the Transmission System.

3. Grid Connection Code

Specifies the minimum technical criteria and procedures with respect to connection requirements that needs to be complied with by the Transmission Licensee and all Users or parties seeking connection to the Transmission System.

4. Grid Operations Code

Specifies operations criteria, guidelines, and procedures to be followed by the Transmission Licensee, and requirements to be followed by all Users of the Transmission System for coordinated operation of the Transmission System.

5. Generation Dispatch Code

Specifies rules and procedures to be followed by the System Operator to optimise the system Dispatch, the role of other Licensees and the role of the Transmission Licensee in this optimisation, the mechanisms to coordinate the real time operation of the system, and reporting requirements.

6. Grid Metering Code

Specifies technical criteria and procedures for tariff metering between the Transmission Licensee and all Users or parties seeking connection to the Transmission System.

Annex 1

Annex 1 to the Grid Code gives Rules and Procedures for the Grid Code Enforcement and Review Panel (GCERP). The Transmission Licensee will ensure that the GCERP is functional within 03 months from the notification of the concurrence of Public Utilities Commission of Sri Lanka (PUCSL) to the Grid Code submitted for approval of PUCSL.

The Transmission Licensee is committed to improve the efficiency and the effectiveness of the Transmission System. The Grid Code has been prepared to reflect power industry international best practices adapted to Sri Lanka. Therefore, as international norms and best practices evolve, the contents of the following Appendices too are subject to change. The latest version of each appendix will be available with the Transmission Licensee, and will be published in the Transmission Licensee's website.

Appendix A - Criteria

Appendix A specifies technical criteria of the Transmission System which maybe relevant to Users.

Appendix B – Data

Appendix B specifies technical information and data to be made available by Users to the Transmission Licensee, and information and data to be made available by the Transmission Licensee to the Users.

Appendix C – Procedure for Application for Grid Connection

Appendix C specifies the procedure for an application for a connection to the Transmission System.

1 GENERAL CODE

1.1 INTRODUCTION

This code contains provisions of a general nature that apply to the entirety of the Grid Code. These include legal and regulatory provisions, and definitions of common terms.

1.2 APPLICABILITY

The General Code is primarily applicable to the Transmission Licensee and to all Users.

1.3 OBJECTIVES

Primary objectives of the General Code are to,

(a) cite the legal and regulatory framework for the implementation and maintenance of the Grid Code,
(b) define procedures for revising/amending the Grid Code,
(c) define common terms and abbreviations used in the Grid Code,
(d) specify general rules for interpreting provisions in the Grid Code , and
(e) specify rules on communication between the Transmission Licensee and Users.

1.4 RESPONSIBILITIES

1.4.1 PUCSL

PUCSL shall be responsible for approving the Grid Code and amendments there to, as required from time to time. The Grid Code and amendments will be developed by the Transmission Licensee as and when necessary to reflect the changes in the regulatory framework and the development of the transmission network to comply with legislations and good industry practices, and the inspection functions for the implementation of the Grid Code.

1.4.2 TRANSMISSION LICENSEE

The Transmission Licensee will be responsible for the implementation and maintenance of the Grid Code in relation to the Transmission System, and to act in accordance with the established good industry practices.

1.4.3 USERS

Users shall be required to abide by the Grid Code, comply with the instructions and requests of the Transmission Licensee that may require in discharging Transmission Licensee's duties in implementation of the provisions of the Grid Code, and act in accordance with good industry practices.

Specific responsibilities of all parties, the Transmission Licensee, Users and PUCSL, in respect of each code, have been clearly specified and listed under each code.

1.5 HIERARCHY OF AUTHORITY

The authority of the Grid Code is derived from a hierarchy consisting of parliamentary legislation, Ministerial regulations and rules, Licenses and guidelines issued by the PUCSL. The hierarchy is presented in top-down order below:

i. Legislation

(a) The Public Utilities Commission of Sri Lanka (PUCSL) Act, No. 35, 2002

(b) Sri Lanka Electricity Act, No 20, 2009 ii.

Regulations issued by the Minister iii. Rules issued by PUCSL

iv. Grid Code

v. Distribution Code

vi. Contracts between parties

(a) Power Purchase Agreements (PPA) between Generation Licensees and the Transmission Licensee
(b) Power Sales Agreements (PSA) between the Transmission Licensee, Distribution Licensees and other Users
(c) Terms and conditions of delivery and acceptance of electricity between Generation Licensee and the Transmission Licensee
(d) Terms and conditions of delivery and acceptance of electricity between the Transmission Licensee and Distribution Licensees
(e) Connection agreements between Distribution Licensees and customers
(f) Internal codes of the Transmission Licensee and Distribution Licensees

The above hierarchy shall be applicable to the technical functions, in normal or emergency circumstances, covered by the Grid Code, but excluding matters of commercial nature, which have no technical implications.

1.7 ACTION IN UNFORESEEN CIRCUMSTANCES

In unforeseen and extraordinary circumstances, the Transmission Licensee will act in pursuance of any one or a combination of the following general requirements.

(a) Preservation or restoration of the integrity of the Transmission System.
(b) Avoidance of breakdown, separation or collapse (total or partial) of the Transmission System.
(c) Requirements of safety in all circumstances, including prevention of personal injury.
(d) Prevention of serious damage to Plant and/or apparatus.

The above shall also apply in the event of emergencies such as abnormal weather conditions, fuel shortages, war, national calamities and abnormal law and order situations.

1.8 PARTIAL INVALIDITY

If any provision or part of a provision of the Grid Code should become or be declared unlawful for any reason, the validity of all remaining provisions or parts of provisions of the Grid Code shall not be affected.

1.9 ACCURACY OF INFORMATION

The Transmission Licensee and all Users have a duty to provide such information as are necessary to facilitate compliance with requirements of the Grid Code. All parties are responsible to ensure accuracy of such information and data provided by them in accordance with the requirements of the Grid Code.

The Transmission Licensee has the right to verify such information and data provided by Users, and to request calculation methodologies, references and error estimations, where necessary, to ensure proper planning and operation of the Transmission System.

Failure of any party to provide reasonably accurate information and data, or any deliberate attempt to withhold such information and data or provision of inaccurate information and data, shall be considered to be non-compliance with the requirements of the Grid Code.

1.10 CONDITIONS OF DISCLAIMER

The Transmission Licensee, in planning and operating the Grid and in contributing to the planning and operation of the Grid, is required to rely on information provided by Generators, Distribution Licensees, and other Users, regarding their requirements and intentions. The Transmission Licensee will not be held responsible for any consequence arising from its reasonable and prudent actions on the basis of such information and data supplied by any of the Users.

Generators, Distribution Licensees and other Users shall not be held responsible for any consequence, which arises from the usage of any accurate information and data supplied by them to the Transmission Licensee.

1.11 CONFIDENTIALITY

Under the terms of the Grid Code, the Transmission Licensee will receive information and data from Users and vice versa. The Transmission Licensee or any User shall not, other than as required by the Grid Code or applicable rules, disclose such information and data to any other person without the prior written consent of the provider of the information and data.

1.12 PROCEDURE FOR SETTLEMENT OF DISPUTES

In the event of a dispute between the Transmission Licensee and another Licensee or any other party, on a matter covered in the Grid Code, the following procedure shall be followed.
The concerned parties shall discuss and attempt to arrive at an amicable settlement in terms of applicable rules/regulations. If an agreement cannot be reached, parties shall, after deliberations,

(a) formulate and implement a provisional working arrangement, which shall be implemented until a valid ruling is issued by PUCSL in accordance with the Electricity (Dispute Resolution Procedure) Rules,
(b) keep the GCERP informed of the provisional working arrangement within three days from the day such a provisional working arrangement has been implemented. (The GCERP shall submit its observations to PUCSL), and
(c) follow the applicable rules and regulations, and refer the unresolved dispute to PUCSL.

1.13 COMMUNICATION BETWEEN TRANSMISSION LICENSEE AND USERS

All communication between the Transmission Licensee and Users shall be in accordance with the provisions of the relevant section of the Grid Code.
Unless otherwise specifically required by the Grid Code, all communications shall be in writing, except where operation time-scales require oral, facsimile or electronic communication.

1.14 INTERPRETATION

1.14.1 DEFINITIONS

When a word or a phrase that is defined in the "Definitions and Abbreviations" is more particularly defined in another code of the Grid Code, and if there is any inconsistency between the two definitions, the latter of the two definitions shall prevail.

1.14.2 AMENDMENT OF STANDARDS

A reference to a standard shall include any revision, update or a replacement of that standard.

1.14.3 INFORMATION AND DATA

A reference to information shall include both information and data. Any reference to data shall include both information and data.

1.14.4 GENDER

Any reference to a gender shall include both genders.

1.14.5 INCLUDING

The word "including" or a grammatical variation thereof means "including but not limited to".

1.14.6 PARTY, PERSON OR ENTITY

Any reference to a party, person or entity shall include an individual, partnership, company, corporation, association, organisation, institution, or other similar groups.

1.14.7 SINGULARITY AND PLURALITY

Unless otherwise specified, singular shall include the plural and vice-versa.

1.15 NOMINAL VOLTAGE, NOMINAL FREQUENCY

Nominal Voltages in this Grid Code shall be 400,000 Volt (400 kV), 220,000 Volt (220 kV), 132,000 Volt (132 kV), 33,000 Volt (33 kV) and 11,000 Volt (11 kV), and the nominal Frequency shall be 50 Hz.

1.16 DEFINITIONS AND ABBREVIATIONS

In the Grid Code, the following words, abbreviations and expressions shall bear the meanings as indicated in the Table below.

TERM	DEFINITION
ac	Alternating Current
Active Energy	The electrical energy flowing or supplied by an electrical circuit during a time interval, being the integral with respect to time of Active Power, measured in units of watt-hours.
Active Power	Product of voltage and in-phase component of alternating current measured in units of Watt (W).

TERM	DEFINITION
Alternator	The electrical machine which is driven by a prime mover and generates ac electric power. The term "Generator" is reserved, and separately defined (please see the definition of "Generator").
Allowed Charges	Approved charges Licensees are permitted to levy from customers, prospective customers and the general public for carrying out work requested by them.
ALS	Automatic Load Shedding
Apparent Power	The product of voltage and alternating current measured in units of volt ampere.
Appendix	An appendix to the Grid Code.
Availability	The long term average fraction of time that a component or system is in service and satisfactorily performing its intended function.
Automatic Load Shedding	A scheme to disconnect Loads without manual intervention, implemented by the Transmission Licensee to prevent Frequency collapse in the Transmission System.
Authorized Person	As defined in clause C-3 in part 1 of 'System Operations Manual' of Transmission Licensees.
Auxiliary	Any item of plant and/or apparatus not directly a part of the energy conversion process in a Generating Unit, but required for its functional operation.
Automatic Voltage Regulator (AVR)	The continuously acting automatic equipment, controlling the terminal voltage of a Synchronous Generating Unit by comparing the actual terminal voltage with a reference value and controlling by appropriate means the output of an exciter, depending on the deviations.
Base Case (Plan)	Plan developed by adhering to the least cost principles including existing power plants of any description already in operation as of 1st January of the current year of the Plan and candidate power plants required to be included owing to Policy Guidelines in accordance with SLEA20.
Battery Energy Storage System	Battery Energy Storage System comprises batteries, chargers, power converters and related equipment for the purpose of storing electrical energy in the batteries during the charging process and discharging the stored electrical energy when required.
Battery Storage	A type of energy storage power station that uses a group of batteries to store electrical energy/to provide electrical energy back to the network, which could be a part of **Power Park Module** as well as standalone installation.
Black Start	The procedure for recovery from a Total failure or Partial failure, using the Black Start Capability of Generating Units.
Black Start Capability	The capability to start a Generating Unit and synchronise with the System without relying on the external power, using the Power Station's own generating capacity.
Captive Power Plant	A Generating Unit or a group of Generating Units which produces electricity for the own use of a Customer.
Commission	Public Utilities Commission of Sri Lanka (PUCSL) established under Act, No. 35, 2002.
Common Connection Point (CCP)	Multiple **Generating Units** (S**PVG units** or **WTG units**) connected to the Grid.

TERM	DEFINITION
Compensating Ramp Rate	A ramp rate setting of **Battery Storages** that may be used to reduce the impact of **Active Power** ramps of the **Power Park Modules**
Competent Person	As defined in clause C-2 in part 1 of 'System Operations Manual' of Transmission Licensees.
Connected Load	Aggregate of rated capacity of all apparatus including portable apparatus in the Consumer's premises which are supplied or declared by the Consumer to be taking supply from the system. This shall be expressed in kW or kVA.
Connection Agreement	An agreement between a User and the Transmission Licensee specifying the procedure for the design, review, construction and commissioning procedure the User's connection to the Transmission System, and the safety procedures, and maintenance program of the equipment used at the Interconnection Point.
Consumer/Customer	Any person or entity, either as the owner or lawful occupier, supplied with electricity by a Licensee/Supplier, and whose premises are for the time being, connected to the Licensee's Transmission or Distribution System having accepted to receive the electricity supply on the terms and conditions laid down by the Licensee. A consumer/customer includes a prospective consumer. The term "Customer" has the same meaning as "Consumer", as defined in SLEA20.
Contingency Reserve	Generating capacity that is intended to take care within a short interval of time to meet the Demand in case of the loss of the largest Synchronised generating unit or the largest power import source that is connected to the Grid through an external interconnection.
Contract Demand	Maximum real (kW) or apparent (kVA) power Demand agreed to be supplied by the Licensee/Supplier as stated in the declaration made by a Customer.
Control Person	As defined in clause C-4 in part 1 of 'System Operations Manual' of Transmission Licensees.
Declared Voltage	A voltage or voltages declared by a Licensee for the supply of electricity to a Customer.
Demand	The requirement for active power and reactive power unless otherwise stated.
Demand Forecast	The activity which estimates Demand on the Transmission System.
Dispatch	The issue of instructions by the Transmission Licensee to a Generating Plant pursuant to scheduling and Dispatch under the Grid Operations Code, and the term "Dispatched" shall be construed accordingly.
Dispatch Instructions	An instruction by the Transmission Licensee to a Generator to operate, issued in accordance with the Grid Operations Code.
Disconnect	The act of physically separating User's (or Customer's) equipment from the Transmission System.
Distribution Code	The document produced by Distribution Licensees pursuant to conditions of the Electricity Supply License.
Distribution Licensee	A person appointed through a License issued by PUCSL to carry out the functions of Distribution and Supply Business.

TERM	DEFINITION
Distribution System	The system consisting of lines owned and/or operated by a Distribution Licensee for the purposes of distribution of electricity from a Grid Substation to another Substation, or to or from any External Interconnection, or to deliver to Customers, including any plant and Apparatus and meters owned or used by the Distribution Licensee in connection with the distribution of electricity.
Driest Condition	Hydro energy potential during very dry condition.
Earthing	A way of providing a connection between conductors and earth by an Earthing Device.
Earthing Device	A means of providing a connection between a conductor and earth, being of adequate strength and capability, and conforming to applicable standards.
Embedded Generator	A single generating unit, or a group of generating units, connected to the distribution network, at voltages between 400 V and 33 kV.
Energy Park	An area identified and reserved for the development of IBRE, where facilities are available for collective connection to the Grid.
External Interconnection	A connection to a network outside the network of the Transmission Licensee.
Financial Year	Period commencing on the 1st day of January ending on 31st day of December of the same year.
Forced Outage	An outage of an equipment/system of which no notice can be given beforehand.
Frequency	The number of alternating current cycles per second (expressed in Hertz or Hz) at which a system is running.
Frequency Control	The function to control the Frequency of electricity served through the Transmission System.
Frequency Response Ramp Rate	A ramp rate setting of **Power Park Modules,** or **Battery Storages** used for **Primary Response** purpose.
Full Load	Maximum net electrical output of a Generating Unit after Auxiliaries, measured at the Interconnection Point.
GCERP	Grid Code Enforcement and Review Panel
Generating Plant	Plant comprising one or several electricity Generating Units (including equipment at the Interconnection Point) and all electrical installations required for operation of the plant.
Generating Unit	A single facility for the generation of electrical energy
Generator	A person or agency who generates electricity and who is subject to the Grid Code.
Generation Licensee	A person who has been granted a generation license by PUCSL.
Generator Reactive Performance Chart (Capability Curve)	A diagram which shows the MW and MVar capability limits within which a Generating Unit is expected to operate under steady state conditions in the manner prescribed by the manufacturer of the alternator.
Governor	The equipment fixed to Generating Unit that controls its speed
Governor Speed Droop	In relation to the operation of the Governor of a Generating Unit, the percentage drop in Transmission System Frequency which would cause the Generating Unit under free Governor action to change its output from zero to full load.
GOSL	Government of Sri Lanka

TERM	DEFINITION
Grid	The part of the Total System which is owned and operated by the Transmission Licensee, also referred to as the Transmission System
Grid Code	The Grid Code of Sri Lanka.
Grid Substation	There was no definition before. Need a definition: we propose "A facility at which electricity is converted from HV to MV"
Harmonic Voltage Compatibility Level	A maximum level under which the power grid can operate normally, taking into account the impact from nonlinear characteristics of equipment connected to the **Transmission System.** It represents a statistical measure of the overall condition of the **Power System** from a harmonic performance point of view**.**
Harmonic Voltage Planning Level	Maximum allowable voltage harmonic level at a specific point of connection and is relevant for the determination of any new **User** apportion.
High Voltage or HV	Voltage above 33,000 Volt (33 kV).
HV Apparatus	High Voltage electrical circuits forming part of a system.
Hydropower Station	A hydroelectric Power Station.
IEC	International Electrotechnical Commission
Interconnection Point	The point at which a Generating Plant, a Power import source, a Distribution Licensee system or a Transmission Customer system is connected to the Transmission System as specified in the relevant purchase/sales agreements, as applicable.
Intermittent Resource	The primary source of power for a Generating Unit that cannot be considered as controllable e.g. wind, wave or solar
Inverter Based Renewable Energy Technologies (IBRE)	Generating plants that produce electrical power using renewable energy resources with inverter based technologies
License	A License granted by PUCSL for the purpose specified.
Licensee	Licensee or License Holder is a person or business entity to whom a License or Authorisation is issued by PUCSL, under the Public Utilities Commission of Sri Lanka Act No 35 of 2002 and Sri Lanka Electricity Act No 20 of 2009, for carrying out Generation, Transmission, Distribution and Supply of electrical energy.
Limitation of Access	A permit issued by an Authorised Person defining the limits and nature of work which may be carried out in the vicinity of live apparatus.
Limited Frequency Sensitive Mode	A mode whereby the operation of the **Power Park Modules** is frequency insensitive except when the **System Frequency** exceeds the predefined frequency threshold, from which point Limited Frequency Response shall be provided. For **Power Park Modules** operation in **Limited Frequency Sensitive Mode** would require **Limited Frequency Sensitive Mode – Overfrequency (LFSM-O)** capability and **Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)** capability.
Limited Frequency Sensitive Mode – Over frequency (LFSM-O)	A **Power Park Modules** operating mode which will result in **Active Power** output reduction in response to a change in **System Frequency** above a certain value.

TERM	DEFINITION
Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)	A **Power Park Modules** operating mode which will result in **Active Power** output increase in response to a change in **System Frequency** below a certain value.
Licensee Information Submission System or LISS	A facility through which all Licensees are required to submit the required information on line to the PUCSL.
Load	The Active and Reactive Power, as the context requires, generated, transmitted or distributed, and all similar terms shall be construed accordingly.
Load Following Capability	The ability of a Generating Unit to operate, continuously adjusting its generating output in accordance with the Demand fluctuations, while maintaining its speed within specified limits.
Loss of Load Probability (LOLP)	The percentage of time during which the System Load exceeds the available Generation capacity in the System.
Medium Voltage or MV	Above 400 Volt, up to and including 33,000 Volt
Minister	Minister in charge of Power in the Democratic Socialist Republic of Sri Lanka
Operating Margin	Extra Generation capacity comprising Contingency Reserve and Operating Reserve, that is required in a System to cover uncertainties in plant availability, deviation of Demand from its Forecast value, loss of external connections, loss of Generation, weakness of the Transmission System and other factors so that the system is operated within the specifications and standards of the License.
Operating Reserve	The additional output from Generating Plant and/or the reduction in Demand which is available to respond to manage the mismatch between Generation and Demand.
Outage	In relation to a Generating Plant, a total or partial reduction in availability owing to failure or maintenance of the plant or its Auxiliary System; or an interruption in supply of fuel. In relation to the Transmission System, the removal of any part of the Transmission System owing to a breakdown or maintenance.
Output	The actual output at the Interconnection Point of a Generating Plant derived from data measured pursuant to the Grid Metering Code.
Overall Accuracy	The combined accuracy of meters and instrument transformers whose secondary circuits feed the meters.
Partial Failure	The condition existing when all generation as well as electricity supply from all external connections to a part of the Total System has ceased, causing loss of power to more than five (5) Grid Substations Transmission Customers. That part of the System is therefore cannot begin to function without the Transmission Licensee's directions relating to restoration.
Part Load	Condition of a Generating Unit which is loaded but is not running at its declared availability.
Party	Any person, corporate body, company, organisation, authority, firm or association subject to the provisions of the Grid Code.

TERM	DEFINITION
Permit to Isolate	A permit issued by the Control Person to release the apparatus from the service as requested by the Competent Person/Authorized Person as appropriate.
Permit to Work (PTW)	A permit signed and given by an Authorised Person to a person in charge of work defining the work to be carried out on any earthed HV Apparatus for the purpose of making known to such person exactly what apparatus is dead, isolated from all live conductors, discharged, connected to earth, and on which it is safe to work.
Planned Outage	An Outage in relation to a Generating Plant or items of Power Station Equipment which has been planned and agreed with the Transmission Licensee in advance of the year in which it is to be taken. Planned outage also means the outage of any part of the Transmission System which may affect supply to a Distribution Licensee's system or a Transmission Customer, which is intimated by the Transmission Licensee to the Distribution Licensee or the Transmission Customer.
Policy Guidelines	General Policy Guidelines issued with respect to fuel diversity and the preferred fuel for new electricity generation, as provided in section 5(2)(b) of SLEA20, and approved as provided for in section 5(3) of SLEA20.
Power Factor	Ratio of active power (kW) to apparent power (kVA)
Power Park Module	Multiple interconnected **Generating Units** (S**PVG units** or **WTG units**) that have a common **Connection Point** and utilize renewable energy as the primary energy source.
PPM	Power Park Module
Power Park Module User/Owner	An entity who owns/operates a power park module connected to **Transmission Licensees's** AC grid.
Power Purchase Agreement	The Agreement entered into between a Generator and the Transmission Licensee pursuant to which the Transmission Licensee, amongst other matters, agrees to purchase electrical energy from the Generator at an identified Interconnection Point between the Generator and the Transmission System.
Power Station	An installation comprising one or more Generating units owned and/or controlled by the same Generator, which may reasonably be considered as being managed as one entity.
PPA	Power Purchase Agreement
Protection	Provisions for detecting abnormal conditions on a system and initiating fault clearance, and activating alarms and indications.
Prudent Utility Practices	Any of the practices, methods and acts not specified in any specific standards, but has consistently shown results superior to those achieved with other means and generally accepted by the electric Utility industry as most appropriate to accomplish the desired results at a reasonable cost.
PUCSL	Public Utilities Commission of Sri Lanka incorporated under PUCSL Act, 2002.

TERM	DEFINITION
Reactive Power	The product of voltage and the quadrature component of alternating current measured in units of volt-amperes reactive (Var).
Reactive Energy	The integral with respect to time of the Reactive Power measured in units of volt ampere hour reactive.
Reference Case (Plan)	Plan developed by adhering to least cost principles including only existing power plants of any description already in operation as of 1st January of the current year of the Plan, new power plants that fulfil least-cost principles, but excluding candidate power plants required to be included owing to Policy Guidelines.
Renewable Energy Desk (RED)	A real time control and monitoring system in which the control and data collection functions of IBRE are carried out from a central station through a communications system. Based on this data and the system requirements System Operator can issue control instructions via this desk to respective IBRE where applicable.
Rotational Load Shedding	Planned Disconnection of Customers on a rotational basis during periods when there is a significant shortfall of generation required to meet the total Demand.
Resource Following Ramp Rate	A ramp rate setting of **Power Park Modules** used during Start-Up and normal operation.
Sanction for Test	A permit signed and given by an Authorised Person to a person in charge of testing any apparatus connected to the Transmission or Distribution System for the purpose of making known to such person exactly what apparatus is to be tested, and the condition under which the testing is to be carried out.
Safety Precautions	Methods and procedures adopted to ensure safety and avoid danger when working in a hazardous environment. In relation to working on HV Apparatus, this entails but is not limited to Isolation and/or Earthing.
Safety Procedures	The procedures specified within a safety management system.
Set-Point Ramp Rate	A ramp rate setting of **Power Park Modules, or Battery Storages** used for **Active Power** control during **AGC** control process.
Shutdown	The condition of the equipment when it is de-energized or disconnected from the Transmission System or the Distribution System.
Significant Incident	An event with a significant effect on either the Transmission System or a User's System, and usually entails one or more of the following operational effects: Tripping of plant and/or apparatus manually or automatically Voltage outside statutory limits System Frequency outside statutory limits System instability System overload Whether an event has a significant effect on a system is determined by the entity (Transmission Licensee or User) that owns that system.
Single Buyer	Transmission Licensee in relation to the Bulk Supply and Operations business.
SLEA20	Sri Lanka Electricity Act no 20 of 2009.

TERM	DEFINITION
Spinning Reserve	Unloaded generating capacity, which is Synchronized to the system and is ready to provide increased generation at short notice pursuant to Dispatch Instruction or instantaneously in response to a Frequency drop.
SPGM	Synchronous Power Generation Module
SPVG	Solar Photovoltaic Generation
Supervisory Control and Data Acquisition (SCADA)	A real time control and monitoring system in which the control and data collection functions are carried out from a central station through a communications system. System data is monitored and fed back to the central terminal continually, based on which control instructions are issued to all parts of the system. The communication system can be fibre optics, power line carrier, microwave or any other means of communication.
Synchronized	The condition where an incoming Generating Unit or system is connected to another system so that the Frequency and phase relationships of that Generating Unit or system, as the case may be, and the system to which it is connected are identical. The terms "Synchronize" and "Synchronization" shall be construed accordingly.
Synthetic Inertia	A facility or system service provided by a **Power Park Module** system to replicate the effect of inertia of a **Synchronous Generating Unit** to a prescribed level of performance during a frequency deviation.
System Operator	Transmission Licensee in relation to its Operations Business including System Control Centre of the Transmission Licensee performing functions of a load dispatch center and associated activities in planning, operations and control.
System Short Circuit Ratio (SSCR)	A measure of AC system strength at an interconnection point. It is typically defined as the ratio of the rated power of a piece of equipment (e.g. **Power Park Module** or **Synchronous Generating Unit**) to the short circuit power at the point of interconnection.
Transmission Customer	Customers/Consumers connected to the Transmission System and included in the License.
Transmission Licensee	Ceylon Electricity Board appointed through a license issued by PUCSL to carry out functions of Transmission Business and the Bulk Supply and Operations Business.
Transmission System	The system which is owned and operated by the Transmission Licensee and which consists (wholly or mainly)of High Voltage transmission lines and generating plant, and which is used for transmitting electricity from a Generating Plant to a Substation, from one Generating Plant to another or from one Substation to another, including all High Voltage transmission lines which are used to convey electricity to the premises of Transmission Customers (but shall not include any such lines which form part of any Distribution System).

TERM	DEFINITION
Total Failure	The condition of complete loss of generation in the Total System with no electricity supply from any External Interconnection. The Total System will not begin to function again without the Transmission Licensee's directions relating to Black Start.
Total System	The Transmission System and all systems of Users of the Transmission System connected directly or connected through the system of another Licensee.
Under-frequency Relay	An electric measuring relay intended to operate when its characteristic quantity (Frequency) decreases below the relay setting by decrease in Frequency.
Unserved Energy	The amount of energy which may not be served per year owing to generating capacity deficiencies or shortages.
User	Person or entity that is connected to the Transmission System. More specific definitions are identified in relevant codes.
User System or User's System	Any system owned or operated by a User including Generating Units, Distribution Systems and Customer equipment together with plant and/or Apparatus connecting them to the Transmission System.
Utility	Any person or entity engaged in the generation, transmission, sale, distribution or supply of electrical energy, as the case may be.
Virtual Metering Point	An effective point of measurement that may or may not be physically locatable, where active energy or reactive energy deemed to have been transferred through the point is derived from an algorithmic manipulation of the active energy and reactive energy data of one or more metering points.
Water Management Secretariat	The secretariat established to coordinate the management of surface water resources in Sri Lanka
WMS	Water Management Secretariat
WTG	Wind Turbine Generator

3 GRID CONNECTION CODE

3.1 INTRODUCTION

The Gird Connection Code (**GCC**) establishes minimum technical criteria with respect to design, connection, performance, protection and telecommunication requirements that need to be complied with by,

(a) the Transmission Licensee at the Interconnection Points,
(b) the Transmission Licensee when connecting new assets,
(c) Generation Licensees when seeking connection to the Transmission System or modifications of existing connections,
(d) Users when seeking connection to the Transmission System or modification of existing connections.

Establishment of such criteria will assure a safe, stable and secure Transmission System.

3.2 APPLICABILITY

GCC applies to the Transmission Licensee, all Users and all parties seeking connection to the Transmission System.

3.3 OBJECTIVES

Objectives of the **GCC** are to,

(a) specify technical, design and operational criteria at the Interconnection Points,
(b) specify data required by the Transmission Licensee from Users,
(c) specify data required by Users from the Transmission Licensee,
(d) ensure that the basic rules for connection to the Transmission System are clear and guarantee fairness and equality of treatment to all who request connections or modifications to existing connections, and
(e) ensure that any connection to the Transmission System will not cause unacceptable effects on the Transmission System or that it will not have any adverse effects on the User's system to be connected to it.

3.4 TRANSMISSION SYSTEM PERFORMANCE CRITERIA

The Transmission Licensee shall ensure that its system will operate in compliance with the limits given in relevant appendices to the GCC. Users who request new connections or modification of existing connections shall ensure that all their equipment will be able to be operated safely and reliably within the conditions specified in the relevant Sections of the Grid Code.

3.5 DECLARED VOLTAGE

Declared Voltages at the Interconnection Point shall be as given in **Appendix A Section 3.1,** whilst the nominal Frequency will be 50 Hz, with R-Y-B counter-clockwise phase rotation.

3.5.1 VOLTAGE LEVEL

Voltage level at which the User's installation is connected to the Transmission System will be decided by the Transmission Licensee based on the parameters of the User's system and the power to be injected or drawn out at the Interconnection Point.

3.6 SYSTEM POWER QUALITY

The Transmission Licensee will assess the power quality in the Transmission System with the parameters given below.

(a) Frequency variations
(b) Voltage variations
(c) Voltage waveform distortion
(d) Voltage fluctuations
(e) Unbalanced loading

3.6.1 FREQUENCY VARIATIONS

The Frequency of the system shall be nominally 50 Hz and shall be controlled within the limits of 49.5 Hz and 50.5 Hz unless abnormal conditions prevail. Under abnormal conditions, the system Frequency could fall or rise for system conditions specified in **Appendix A Table 3.1.B**. Users shall design their systems to operate under normal as well as abnormal conditions.

3.6.2 VOLTAGE VARIATIONS

The nominal voltages of the Transmission System will be as stated in the Grid Code. However, within the Transmission System, voltage may vary within the limits stated in **Appendix A Table 3.1.C.** Users shall design their systems to operate within these limits.

The Transmission Licensee and a User may agree to larger or smaller variations in voltage set out above in relation to a particular Interconnection Point, in so far as such a larger or smaller variation does not affect other Users.

3.6.3 VOLTAGE WAVEFORM DISTORTION

Allowed waveform distortion in the Transmission System is limited to that specified in **Appendix A Section 3.1(D)**. Users shall ensure that their connection to the Transmission System does not cause the level of distortion on the Transmission System at the Interconnection Point to exceed these limits. Prospective Users, who intend to connect their systems that generate harmonics, shall evaluate the production and propagation of harmonic distortion in the Transmission System and design their system so that distortions do not exceed the allowed limits. Such study reports shall be submitted to the Transmission Licensee. After each such User's System is connected to the Transmission System, the User shall measure and prove that distortions do not exceed the allowed limits.

3.6.4 VOLTAGE FLUCTUATIONS

Allowed voltage fluctuation in the Transmission System is limited to that specified in **Appendix A Section 3.1(E)**. Users shall ensure that their connection to the Transmission system does not result in exceeding the limits of fluctuation of supply voltage (producing flicker) on the Transmission System, at the Interconnection Point.

Users whose systems produce flicker, shall evaluate its effect on the Transmission System and design their system so that fluctuations do not exceed the allowed limits. Such study reports shall be submitted to the Transmission Licensee. After such a User's System is connected to the Transmission System, the User shall measure and prove that fluctuations do not exceed the allowed limits.

3.6.5 VOLTAGE UNBALANCE

Design of a User's system shall enable it to remain synchronised and connected to the Transmission System during an unbalance voltage condition, as specified in **Appendix A Section 3.1(F)**.

3.7 EQUIPMENT STANDARDS

All equipment used at the Interconnection Point, overhead lines, underground cables, Substations and User installations shall conform to applicable statutory obligations and comply with the relevant IEC standards. Where IEC standards are not available, the Transmission Licensee's specifications and publications shall be applicable. Prospective Users shall seek advice from the Transmission Licensee when necessary, in this regard, and the Transmission Licensee is required to comply with such requests.

The standards, publications and specifications referred to above shall be those prevailing at the time the plant or equipment was designed or manufactured. However, if any such equipment is reused or moved to a different location, then such standards, publications or specifications current at the time, shall become applicable.

3.7.1 BASIC IMPULSE LEVEL

Users shall ensure that their systems can withstand the impulse levels specified in **Appendix A Section 3.1(G)**.

3.7.2 POWER FREQUENCY WITHSTAND VOLTAGE

Users shall ensure that their systems can withstand the Power Frequency withstand voltages specified in **Appendix A Section 3.1(H)** for a period not less than one (1) minute.

3.7.3 SHORT CIRCUIT LEVEL

Users shall ensure the User's Systems can withstand the three phase short circuit levels specified in **Appendix A Section 3.1(I)**.

3.8 CURRENT DISTORTION LIMITS

The allowed current distortion limits are specified in **Appendix A Section 3.1(J)**. All Users shall ensure that their load current harmonic distortion does not exceed the allowed current distortion levels, at the Interconnection Point.

All Users and Prospective Users shall measure and evaluate the current harmonic distortion in the User's System or Generation system, and shall ensure that distortions do not exceed the allowed limits as specified in **Appendix A Section 3.1(J)**. Such measurement and study reports shall be submitted to the Transmission Licensee. After such new User's system is connected to the Transmission System, such User shall measure and prove that distortions do not exceed the allowed limits.

The method of measurement and preparation of study reports shall be as specified in **Appendix A Section 3.1(J).**

3.9 EMISSION LIMITS OF FLUCTUATING LOADS

The allowed emission limits are specified in **Appendix A Section 3.1(K)**. All Users shall ensure that the emissions from fluctuating loads do not exceed the allowed emission levels, at the Interconnection Point.

Users and prospective Users shall measure and evaluate the emission of fluctuations in the User's System and shall ensure that distortions do not exceed the allowed limits as specified in clause 3.11.1 of **Appendix A Section 3.1(K)**. Such measurement and study reports shall be submitted to the Transmission Licensee. After such new User's System is connected to the Transmission System, the User shall measure and prove that distortions do not exceed the allowed emission limits.

The method of measurement and preparation of study reports shall be as specified in **Appendix A Section 3.1(K).**

3.10 PROTECTION ARRANGEMENTS AND FAULT LEVEL CONSIDERATIONS

The Transmission Licensee shall ensure that its system is designed and operated in a manner to clear the abnormal conditions that may occur in the system in the minimum possible time, without causing any damages to the User's System or equipment.

The User shall ensure that all protection schemes on his side of the Interconnection Point are properly coordinated with protection systems of the Transmission System, and shall operate as required by the Connection Agreement, thus minimising adverse effects on the Transmission System during periods the User's plant and equipment remain connected to the Transmission System.

Protection schemes employed in the Transmission System and User's systems shall have appropriate backup protection schemes and breaker fail schemes. The Transmission Licensee shall provide all necessary information including maximum and minimum fault levels, maximum clearance times, auto-reclosing or sequential switching features to enable the User to design its protection system. Grid Users shall not change the protection relay settings without obtaining written permission from the Transmission Licensee.

Users shall obtain the approval of the Transmission Licensee for the protection systems and the protection settings employed in User's systems during the application process for connection.

3.11 NEUTRAL GROUNDING

The Transmission Licensee shall specify the grounding requirements of a system to be connected to the Transmission System to ensure that the User system grounding is compatible with that of the Transmission System.

3.12 METERING

Metering Equipment to be installed at Interconnection Points shall comply with the standards defined in the Grid Metering Code and provisions of the Connection Agreement.

3.13 SCADA & COMMUNICATION

A fully functional communication and SCADA System will be established and maintained by the Transmission Licensee.

The Transmission Licensee will provide the necessary facilities at the Interconnection Point for the User to upload data to the SCADA system and to receive control signals from the SCADA system in accordance with the Connection Agreement.

Communication and SCADA systems shall have the capability for the System Operator to carry out switching operations in the Transmission System and data acquisition. Voice and data communication facilities shall be secured against unauthorised access in accordance with the standards specified.

The above requirement shall also apply to all IBRE directly connected to grid substations.

3.14 SAFETY

All Users shall follow the procedures laid down in the Grid Operations Code on safety issues.

3.14.1 EQUIPMENT NUMBERING

All equipment used at the Interconnection Point including overhead lines, underground cables, Substations and User installations shall conform to the numbering and nomenclature of the Transmission Licensee.

3.15 MAINTENANCE

The Transmission Licensee and the User shall maintain all switchgear and equipment installed at the Interconnection Point according to well laid down programs. These shall not pose any threat to the safety of personnel or cause damage to other equipment.

Both the Transmission Licensee and Users shall be required to keep test records relating to the equipment installed by each Party, and shall make such records available whenever a request is made by the other Party.

3.16 SPECIAL CONNECTION REQUIREMENTS FOR GENERATING UNITS

All Generating Units other than the embedded generating units shall be centrally Dispatched and shall fulfil the following conditions:

3.16.1 FREQUENCY VARIATION CAPABILITY

Generating Units shall be capable of delivering the declared active and reactive power outputs within the system Frequency variations, specified in this **GCC.**

The Transmission Licensee and a User may agree to lower active power delivering capability when system Frequency falls below one percent (1%) of the rated Frequency.

Generating Units shall be protected against Frequency excursions outside the ranges specified in **Appendix A Section 3.2(A).**

3.16.2 VOLTAGE VARIATION CAPABILITY

Generating Units shall be capable of delivering the declared active and reactive power outputs within the voltage variations specified in **Appendix A Section 3.2(B)**.

3.16.3 POWER FACTOR VARIATION CAPABILITY

Generating Units shall be capable of continuously delivering the declared outputs at any point between the Power Factors of 0.8 lagging and 0.9 leading, in accordance with its reactive power Capability Curve, unless otherwise agreed in the Connection Agreement, and operate in voltage control mode to support dynamic reactive power requirements during disturbances.

3.16.4 UNBALANCED LOADING CAPABILITY

Generating Units shall be capable of being synchronised to the Transmission System during a load unbalance, in accordance with the relevant IEC standard.

In addition, under unbalanced fault conditions in the Transmission System or in a User's System, the Generating Units shall be capable of withstanding the resulting negative sequence loading and also remain connected to the Grid, until the appropriate protection scheme clears the fault.

3.16.5 LOAD FOLLOWING CAPABILITY

All Generating Units shall have the load following capability other than those exempted by the Transmission Licensee.

3.16.6 FAULT RIDE-THROUGH CAPABILITY

Generating Units shall be capable of remaining synchronised during and following any fault disturbance anywhere on the Transmission System which could result in voltage dips at the HV terminals of the generator transformer of no greater than 95% of nominal voltage (5% retained) for fault durations up to and including the fault ride-through times as defined in **Appendix A Section 3.2(C)** and voltage dips of no greater than 50% of nominal Voltage. (i.e. 50% retained) for fault durations up to and including the fault ride through times as defined in **Appendix A Section 3.2(C)** (see also fault ride through envelopes in **Appendix A Section 3.2(D)**). Following the fault clearance, the Generating Unit should return to pre-fault conditions subject to its normal Governor control system and Automatic Voltage Regulator (AVR) response.

Fault ride-through times given in Appendix A section 3.2 (C) and (D) will only serve as a guide.

The use of extraordinary Governor response and/or extraordinary AVR response to remain synchronised during and following a fault is prohibited unless specifically agreed with the Transmission Licensee.

3.16.7 BLACK START CAPABILITY

The Transmission Licensee shall decide on the generators where Black Start Capability is required. If any Generating Unit intends having Black Start Capability, then the Transmission Licensee shall be informed accordingly.

3.16.8 LINE CHARGING CAPABILITY

All Generating Units shall have line charging capability other than those exempted by the Transmission Licensee.

3.16.9 EXCITATION SYSTEM

Generating Units shall be equipped with a continuously-acting automatic excitation control system to control the open circuit terminal voltage within 10% of the declared voltage specified in this **GCC**, with facilities for disabling constant reactive power control or constant Power Factor control.

3.16.10 GOVERNOR RESPONSE

(a) Power and Frequency Control of the Generating Units shall be achieved with fast-acting prime mover speed Governor.
(b) The Governor shall have the capability to freely regulate the Frequency with adjustable Governor Speed Droop settings in the range of 2% to 10%.
(c) The inherent dead band shall not be more than ±0.05 Hz. There shall be an adjustable dead band in the range of ±1 Hz incorporated with droop characteristics for flexibility of operations.
(d) If and when the Generating Unit is required to operate in an islanded mode, then the Governor Control System shall ensure that the islanded system will operate within the system Frequency range specified in this **GCC.**

3.16.11 PERFORMANCE MONITORING FACILITY

Generating Units shall be provided with a high resolution performance monitoring/recording facility that shall include the following features:

(a) Governor Frequency response
(b) Transient and dynamic response of the Generating Unit in terms of real and reactive power output (MW and MVar)
(c) Frequency (Hz) and voltage (Volt) at the Generating Unit terminal and on the HV side of the generator transformer

3.16.12 REMOTE MONITORING FACILITY

Generating Units shall be equipped with necessary provisions for remote monitoring of its operating conditions, which shall include the following:

(a) Generating Unit output
(b) Loading on switchgear
(c) Protection relay operations
(d) Alarms, indications and events

3.16.13 PROTECTION RELAYING

Generating Units shall be provided with protection against grid disturbances/abnormalities and also against internal faults within the Generating Unit and associated switchgear, which shall include loss of excitation and pole slipping protection. Users shall obtain the approval of the Transmission Licensee for the protection systems employed in Users' Systems during the application process for connection. Relay setting calculations and the proposed system related settings shall be submitted to the Transmission Licensee for approval. Approved Generating Unit protection systems and relay settings shall not be changed without prior written permission from the Transmission Licensee.

3.16.14 SYNCHRONISING

Synchronising facilities for generating units shall be provided either at the Generating Unit circuit breaker or at the generator transformer HV circuit breaker, as required by the Transmission Licensee.

3.17 SPECIAL CONNECTION REQUIREMENTS FOR INVERTER BASED RENEWABLE ENERGY TECHNOLOGIES (IBRE)

3.17.1 REQUIREMENTS FOR ACTIVE POWER CONTROL AND FREQUENCY SUPPORT

3.17.1.1 Frequency ranges

I. Operating ranges

a) "The **power park module** shall be capable of staying connected to the **Transmission System** and remain continuously operable within the **System Frequency** range 49 to 51Hz". Decrease of output Active Power is permitted in the frequency range of 47 to 49 Hz.

b) "Minimum time period a **power park module** shall be able to operate for different frequencies deviating from a nominal value without disconnecting from the Transmission System is as follows:"

Frequency Range	Requirement
47 - 47.5 Hz	Operation for a period of at least 1 continuous minute is required each time the **System Frequency** is below 47.5Hz.
47.5 – 49 Hz	Operation for a period of at least 90 continuous minutes is required each time the **System Frequency** is below 49Hz.
49 – 51 Hz	Continuous operation is required.
51- 51.5 Hz	Operation for a period of at least 90 continuous minutes is required each time the **System Frequency** is above 51 Hz. Decrease of output power is not permitted.
51.5 – 52 Hz	Operation for a period of at least 20 continuous minutes is required each time the **System Frequency** is above 51.5Hz. Decrease of output power is not permitted.
52 – 53 Hz	Operation for a period of at least 20 continuous seconds is required each time the System Frequency is above 52Hz. Decrease of output power is not permitted.

The proposed requirements for power park module are depicted in Figure 3.17- 1.

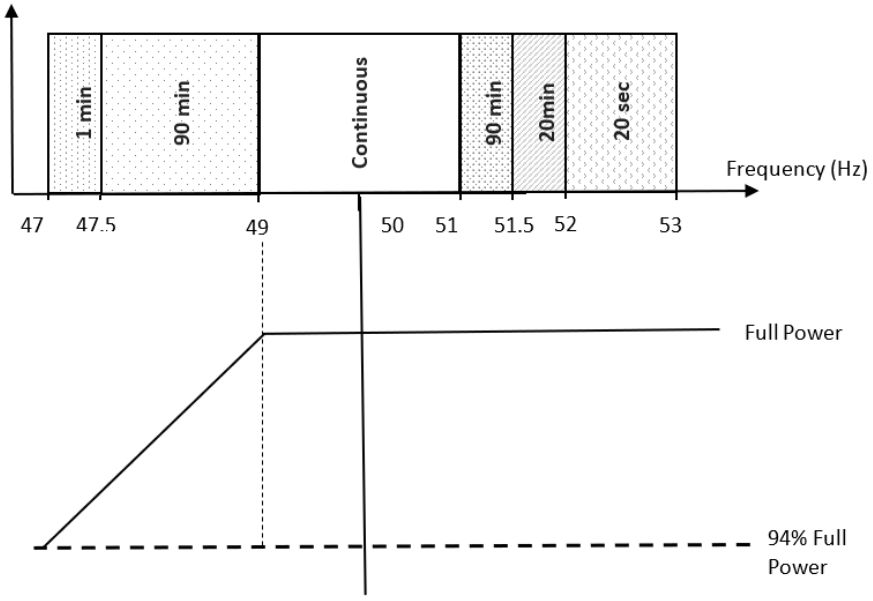


Figure 3.17- 1: Expected withstand durations and *real power capability during frequency Deviations*

The following points describe the requirements depicted in Figure 3.17- 1 further for clarity.

i The power park module is capable to operate within the frequency rage 47 – 53 Hz.

ii The power park module USER shall reduce the power level below this limit only upon instruction from the System Operator.

iii The above are minimum requirements. The power park module owner shall communicate their technical duration capability to Transmission Licensees including when the frequency is above 53 Hz.

II. Operation over a wider frequency range

Transmission Licensees may request a certain power park module owner to operate on wider frequency ranges or longer minimum times for operation if needed to preserve or to restore system security. If wider frequency ranges or longer minimum times for operation are

economically and technically feasible, the power park module owner shall not unreasonably withhold consent. This will be defined in the **Connection Agreement/Power Purchases Agreement (PPA)** between Transmission Licensees and the power park module owner, while ensuring that all the Regulations are also met.

III. Automatic disconnection

Without prejudice to Section I above, a power park module shall be capable of automatic disconnection at frequencies specified by Transmission Licensees.

IV. Active Power capability

The power park module shall be capable of maintaining it full power rating (or the operating power at the time of the frequency drop) if the frequency drop is not below 49 Hz.
Maximum 6% admissible active power output reduction is allowed from its operating point if the system frequency falls within 49 Hz to 47 Hz.

V. Active Power capability outside listed frequency ranges

The power park module shall maintain its full power capability when the frequency is between 50 Hz and 51.5 Hz. The power park module owner shall communicate their technical duration capability (over and above what has been stated in Section I above) to Transmission Licensees when the frequency is above 52 Hz.

VI. Protection settings

The protection settings of the power park module equipment connecting to the Transmission system should not violate the frequency limits provided in Section I above.

3.17.1.2 Rate of change of frequency withstand Capability

The power park module shall be capable of staying connected to the Transmission System and operable if the System Frequency changes at a rate between -2.5 Hz/s and +2.5 Hz/s (measured at any point in time as an average of the rate of change of frequency for the previous 500 ms).

In case of tripping due to activation of RoCoF, Transmission Licensees may direct that the Power Park Module should not be automatically connected if the frequency is above 50.5Hz. When the frequency is restored to below 50.5Hz following a tripping due to the activation of RoCoF, Transmission Licensees may direct that the reconnection will be initiated a delay of 5min from the time system frequency falls below 50.5Hz. Specific details will be determined on a case by case basis and informed to the PPM owner.

The requirements stated in above is the minimum requirement and Transmission Licensees may list additional requirements for specific connections if system studies indicate a need. Such requirements will be specified in the Connection & Interface Agreement/Power Purchase Agreement (PPA) or possible other ancillary service agreements as applicable.

3.17.1.3 Active power controllability; control range and ramp rates

All Power Plants above 5MW capacity must comply with the Active Power Control Capability as specified under this section.

The Active Power output under steady state conditions of any power park module directly connected to the Transmission System shall not be affected by frequency and voltage changes in the normal operating range.

I. Active power control capability

i. A power park module shall be capable of adjusting the transmitted active power following dispatch instruction from Transmission Licensees. Increase of active power output will be

limited by the maximum declared active power capacity. Power Park Module shall be capable of reducing the output to any value below its declared active power capacity.

It should be the responsibility of the Power Park Module Owner to Incorporate sufficient features and energy storage as necessary to meet Transmission Licensees criteria.

ii. The power park module shall be equipped with control functions to support system frequency control. Upon receiving a signal, the power park module shall be capable of modulating the power output within 100 ms or as agreed between Transmission Licensees and the PPM owner.

iii. Maximum and Minimum Power Step Size for Adjusting Active Power – Specific values may be specified by Transmission Licensees to the PPM owner.

II. Active power ramp rates

A power park module shall be capable of adjusting the ramping rate of active power variations within its technical capabilities in accordance with instructions sent by Transmission Licensees. Minimum acceptable values for each technology are indicated in below figures. These ramp rates are not to be confused with the resource side variation smoothing requirement set for PV plants. The settling time(Ts) shall be within 20-30 seconds and allowable set value tolerance shall be within -2% to +2%.

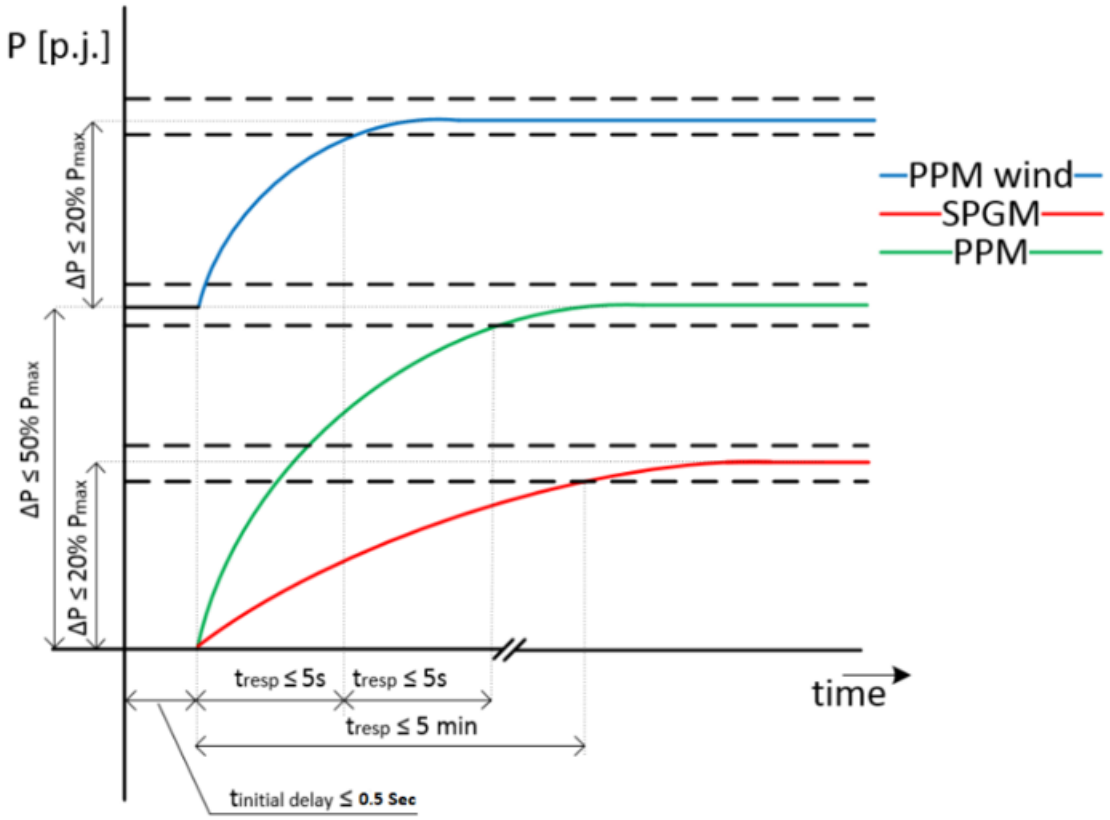


Figure 3.17- 2: Active power upward ramping rates

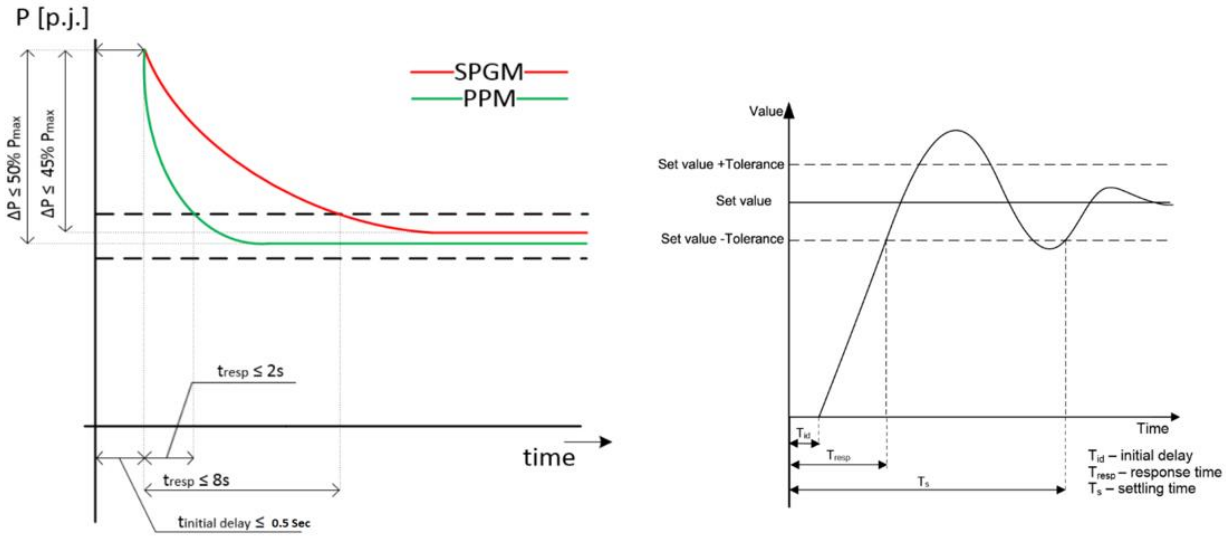


Figure 3.17- 3: Active power downward ramping rates [SPGM: synchronous power generation modules]

III. Active power control modes

If specified by Transmission Licensees, the control functions of a power park module shall be capable of taking RAS (Remedial Action Scheme) including, but not limited to, stopping the ramping and blocking FSM, LFSM-O, LFSM-U and frequency control. The triggering and blocking criteria shall be specified by Transmission Licensees. The modalities of that notification shall be determined and agreed between the Power Park Module owner and Transmission Licensees.

IV. Power control range

Figure 3.17- 4 shows the minimum active and reactive power (P-Q) requirements that the power park module shall comply with.

V. Active Power Dispatch during Operations

Despite the active power capability requirements specified under this section, final operation shall be based on operational instructions received from the national system control center (as long as such instructions are within the capability specified here)

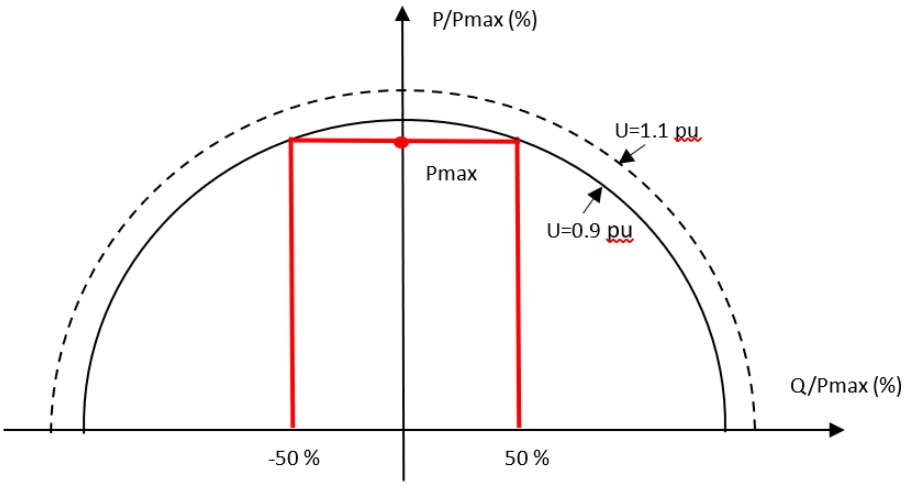


Figure 3.17- 4: Steady state active and reactive power limits

Note: Specific additional requirements may be determined by Transmission Licensees through system studies for specific projects. In such cases, Transmission Licensees may request a design with a wider reactive power capability. (Under reduced active power operation). This may include higher reactive power injection at reduced power output and reactive power injection up to the plant capacity at P=0.

3.17.1.4 Synthetic inertia capability

If requested by Transmission Licensees as a requirement, the Power Park module shall be capable of providing synthetic inertia in response to frequency changes, activated in low and/or high frequency regimes by rapidly adjusting the active power injected to or withdrawn from the AC network in order to limit the rate of change of frequency. The requirement shall at least take account of the results of the studies undertaken by the Transmission Licensees to identify if there is a need to set out the minimum inertia.

The principle of this control system and the associated performance parameters shall be agreed between Transmission Licensees and the park module owner. The performance shall be demonstrated through system studies.

3.17.1.5 Frequency Control

3.17.1.6 Primary Frequency Regulation Mode/ Droop Control (FSM)

Frequency Sensitive Mode (FSM)

Power Park Modules shall be able to operate at a specified power reference point under normal Transmission System conditions.
The Power Park Modules shall be able to contribute to frequency response for frequencies specified in this Grid Code. The power output shall be continuous at a specified ramp rate. The active power ramp adjustment shall be possible in the range specified by Transmission Licensees.

The Generator should be capable of operating within any of the following settings.

Parameters	Capability of the Plant	Set Point[1]
Frequency Dead band	0 to 0.5 Hz	0.01 Hz
Droop setting	2% to 9%	4%
Frequency response insensitivity	0.01 Hz-0.03 Hz	0.015Hz
Active power margin that must be maintained to allow for frequency response	- 10% to +10%	-5% to + 5%
Allowable delay for activation	0.5 s	
Reponses time for full deployment of full FSM active power range	10 s	

[1] If the final set point is different to the values specified in the table, such value will be communicated by Transmission Licensees at the time of the interconnection.

A typical FSM implementation is shown in Figure 3.17- 5.

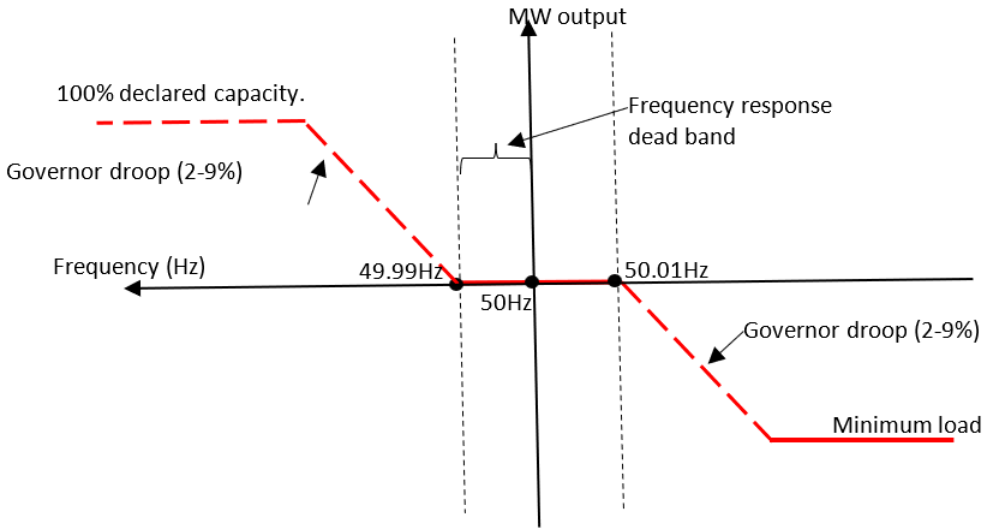


Figure 3.17- 5: Typical FSM settings

3.17.1.7 Limited Frequency sensitive mode [over-frequency (LFSM-O), under-frequency (LFSM-U)]

Limited Frequency Sensitive Mode (LFSM) shall be activated when the system is in an emergency state after a severe disturbance. The Power Park Modules shall have the Limited Frequency Sensitive Modes included in the design.

The generic settings for LFSM is given below and if any specific settings are required for a given Power Park Module, they shall be informed by Transmission Licensees on a case by case basis, based on specific system characteristics, expected operating conditions and the interconnection points.

- Step response time (typically 2s-5s).
- Settling time (typically 20s-30s).
- Set point tolerance (+-2%)

The LFSM-U is activated when the frequency is below 49.8Hz. The Power Park module shall be able to continuously increase the active power output to the agreed limit at a rate specified by Transmission Licensees.

The LFSM-O is activated when the frequency is above 50.1Hz. The Power Park module shall be able to continuously decrease the active power output to the agreed limit at rate specified by Transmission Licensees.

The agreed limit of real power reduction (or injection) shall be 7% or higher from the output power reference at the time of LFSM activation and is deployed with specified Droop(**s[%]**). The full reduction (or injection) capability shall be achieved in less than 10 s. The activation time shall be less than 2 s (unless otherwise agreed between Transmission licensee and the power park module owner). The specified droop is defined as below,

$$s[\%] = 100 \cdot \frac{|\Delta f| - |\Delta f_1|}{f_n} \cdot \frac{P_{ref}}{|\Delta P|}$$

Pref is power reference at the time of LFSM activation and DP is power deviation. Df is the frequency deviation, Df_1 is LFSM dead band (Upper/Lower),f_n nominal frequency (50 Hz).

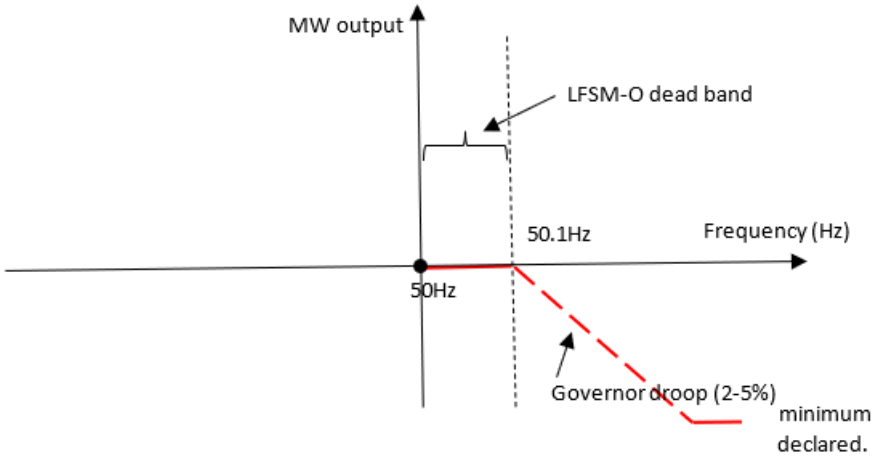


Figure 3.17- 6: Typical LFSM-O settings

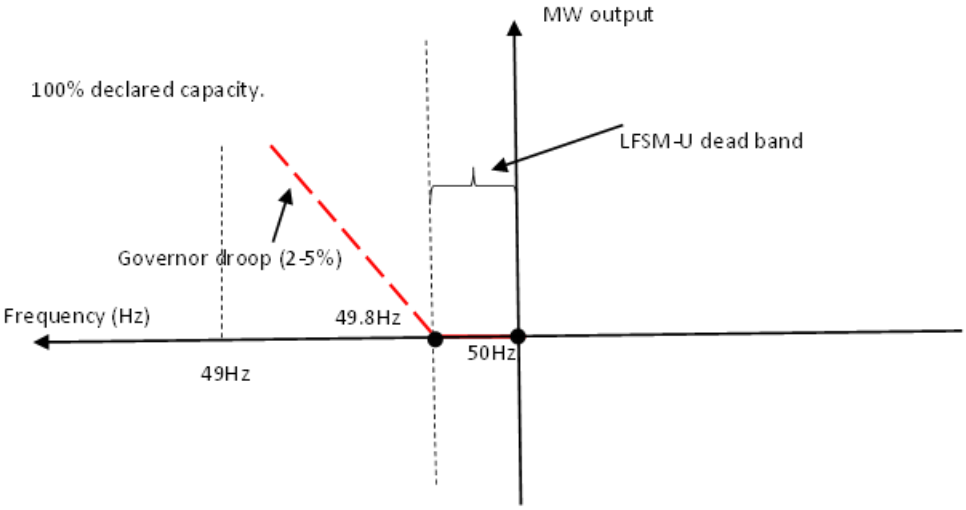


Figure 3.17- 7: Typical LFSM-U settings

3.17.2 Requirements for Reactive Power Control and Voltage Support

The Power Park module shall be capable of operating in the following modes as determined by Transmission Licensees.

1 Voltage control mode (the voltage droop shall be adjustable as specified by Transmission Licensees)
2 Reactive power control mode
3 Power factor control mode

A power park module shall be capable of operating in additional control modes specified by the Power Park Module Owner in coordination with the requirements of Transmission Licensees.

3.17.2.1 Voltage Ranges

I. Operating Range

The Power Park Module shall be capable of staying connected to the transmission system and remaining operable within the voltage ranges and time period defined as follows:

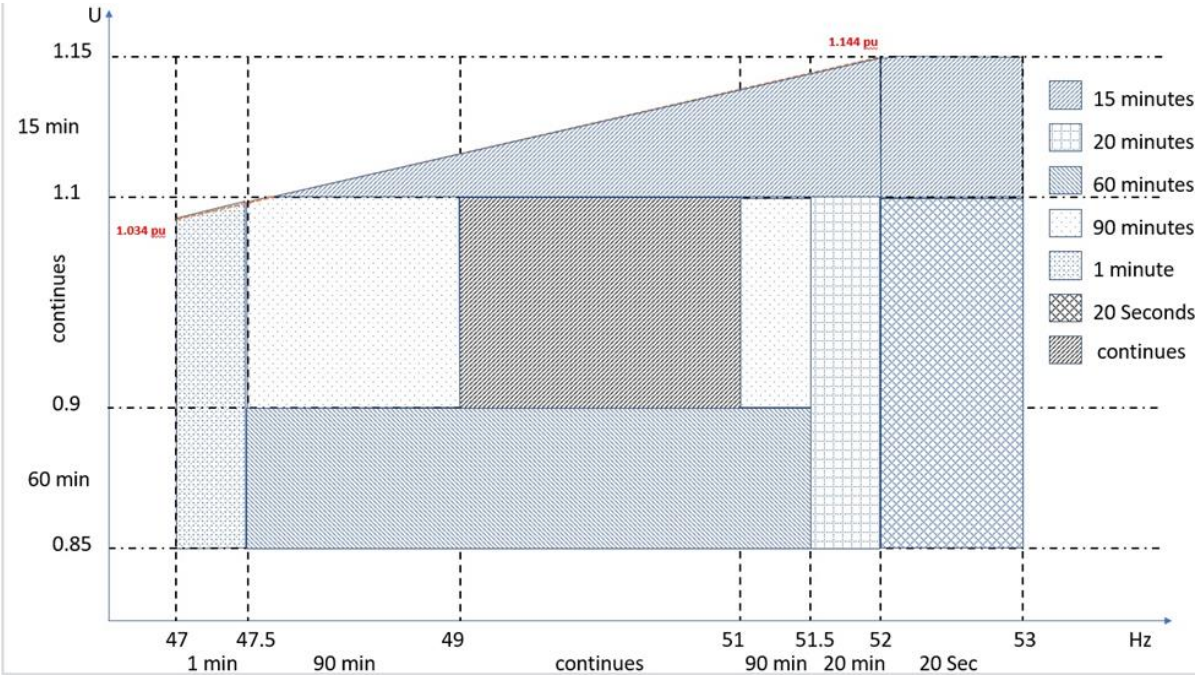


Figure 3.17- 8: Minimum time periods during which a power park module must be capable of maintaining operation at different frequencies without disconnecting from the grid.

Voltage Range (pu)	Time Period for Operation (s)
0.85pu – 0.9pu	60 minutes
0.9pu – 1.1pu	Unlimited
1.1pu – 1.15pu	15 minutes

II. Control Modes

The power park module shall be equipped with automatic voltage control capability, reactive power control capability and power factor control capability. The control slope on the automatic voltage control mode should be adjustable at the Connection point within a range specified by Transmission Licensees. Depending on system requirements Transmission Licensees will specify the mode of operation, control slope, voltage set point or power factor or reactive power set point.

3.17.2.2 Reactive Power Capability

Figure 3.17- 9 shows the minimum active and reactive power requirements that the Power Park module shall comply with. Requirements for specific projects will be provided by Transmission Licensees.

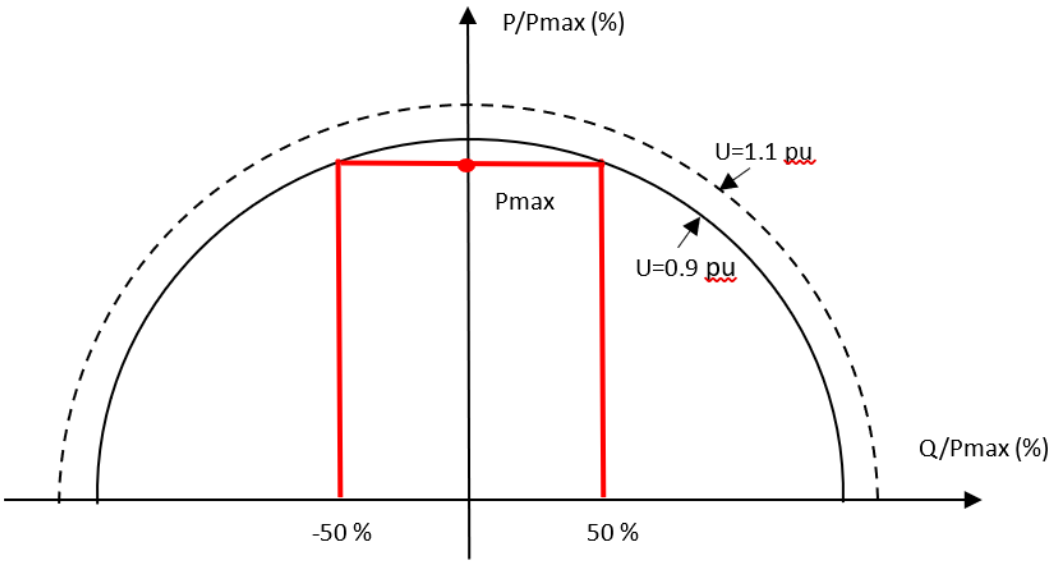


Figure 3.17- 9: P-Q capability that can be specified for power park module

I. Complying with the reactive power requirements

If the power park module cannot meet the reactive power exchange requirements as outlined above, the Power Park Module owner is expected to install additional equipment necessary to meet those requirements. The specific selection and design of such equipment shall be approved by the Transmission Licensees.

II. Reactive Power Support under reduced active power transfer

The power park module shall be able to utilize available equipment rating to supply reactive power in both leading and lagging directions.

For VSC-based power park modules, unless otherwise agreed based on specific system requirements, the converter shall be capable of providing up to 80% when the converter operates at zero active power.

In case the machine is required to operate at a lower active power output that what the plant is capable of in order to meet a given Q requirements requested by the System Operator.

3.17.2.3 AC Voltage, reactive power and power factor control modes

The power park module shall be able to provide automatic control at the Connection Point over the entire operating range of the Power Park module, without causing system instability.

The reactive power variation caused by the reactive power control operation mode of the power park module, shall not result in a voltage step exceeding the allowed value at the Connection point.

I. AC voltage control

Each power park module shall be capable of contributing to voltage control at the connection point utilizing its capabilities, while respecting reactive power capability and reactive power exchange with the AC network, in accordance with the following control characteristics:

Voltage set-point at the connection point shall be capable of being specified within the range (0.9 pu-1.1 pu), either continuously or in steps.

- It shall be possible to operate voltage control with or without a dead band around the set-point. The dead band shall be adjustable.
- Following a step change in the voltage, the power park module shall be capable of achieving 90% of the change in reactive power output within a rise time t1 specified by Transmission Licensees (typically 40ms or less).
- Voltage control mode shall include the capability to change reactive power output based on a combination of a modified voltage set-point and an additional instructed reactive power component (i.e. voltage-reactive power droop). The slope (i.e. voltage droop) shall be adjustable in the range (typically 3% -12%).

II. Reactive Power Control

The power park module shall be capable of operating at a designated reactive power value specified by the system operator as long as the same is within the reactive power capability of the Power Park Module.

III. Power Factor Control

The power park module shall be capable of controlling the power factor to a target at the connection point, while respecting Reactive Power Capability and Reactive Power Exchange with the network.

3.17.2.4 Priority to Active or Reactive power contribution

The power park module shall be capable of operating in the active or reactive power priority modes, as requested by Transmission Licensees, while meeting continuous operating rating and short-term overload ratings. This includes utilizing the full rating (continuous and short-term overload) of the inverter current capability and operating in zero active power transfer.

Taking into account the capabilities of the power park module, Transmission Licensees may inform on case by case basis whether active power contribution or reactive power contribution has the priority during low or high voltage operation. If not specified active power control shall have the priority.

3.17.2.5 Power quality and harmonic performance

I. Harmonic distortions, fluctuations, and flicker

Power park module owner shall ensure that its Power park module connection to the Transmission System does not result in a level of distortion or fluctuation of the supply voltage at the Connection point, exceeding the level specified by Transmission Licensees.

Power park module owner shall ensure that the Power park module is capable of staying connected to the Transmission system. The power park module shall remain operable within the voltage ranges and time period defined in the Grid Code.

The harmonic distortion, unbalance and flicker requirements shall comply with the requirements in the Grid Code and following applicable regulations or standards. The power quality requirements shall be met at the point of common coupling as well as in the surrounding ac network.

In addition to the requirements listed in the Grid Code, the harmonic analysis for Power park modules should consider the harmonic range from N=1 to N=100.

II. Harmonic apportionment

Transmission Licensees may allow only a portion of the total harmonic headroom available at a particular point of connection in order to facilitate future connections of generation and transmission equipment to the grid (only a portion of the available headroom should be allowed for a particular connection). Factor M defines the allotment to a particular connection.

$$V_{hr-user}^{h} = V_{hr}^{h} \times M$$

The value of M will be as specified in the applicable connection agreement for the specific Power Park Module. In case no value is specified the same should be considered as 0.25.

III. Voltage changes

Connection of power park module shall not lead to rapid voltage changes in the Transmission system exceeding 3% of the nominal voltage during the normal operation.

3.17.3 FAULT RIDE THROUGH / LOW VOLTAGE FAULT RIDE THROUGH (LVRT)

If the ac system experience voltage dips during system faults, the power park module shall stay connected so that the power transfer can resume without delays once the voltage recovers to levels within the specified operating ranges.

The Power Plant should provide at least 90% of its maximum available power or the active power corresponding to the Active Power set-point, whichever is lesser as quickly as the technology allows and in any event within 200 ms flowing a fault cleared within 140 ms and the voltage recovering to 90% of the system nominal voltage measured at the point of connection. For longer duration faults, the Power Plant should provide at least 90% of its maximum available power or the active power corresponding to the Active Power set-point, within 300 ms from the voltage recovering to 90% of the system nominal voltage measured at the point of connection.

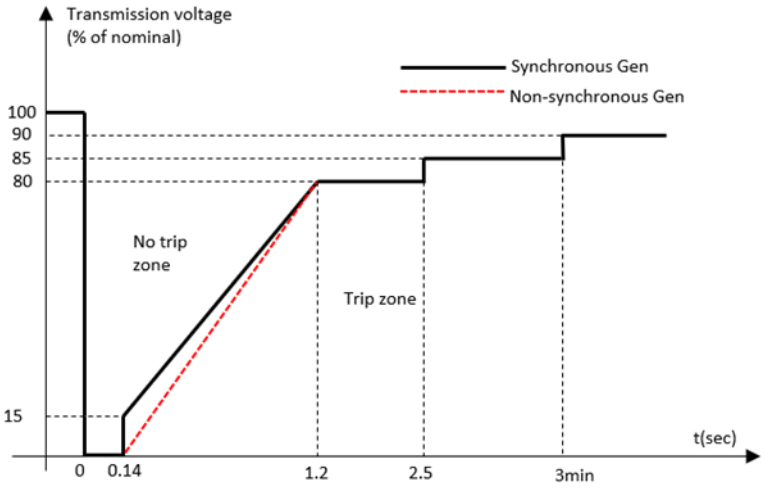


Figure 3.17- 10: Fault Ride Through requirement – Voltage duration curve

Short circuit current contribution during faults

Power Park Module shall be capable of contributing reactive currents to the Transmission system faults as shown in Figure 3.17- 11. If the Power Park Module is capable of contributing to fault exceeding the requirement shown in Figure 3.17- 11, the power park module owner should inform Transmission Licensees. The fault conditions shall be identified, for instance, through the detection of a low voltage at the point of connection. The specific short circuit contribution shall be agreed as part of the connection process. Transmission Licensees may request the contribution of positive, negative and zero sequence currents depending on the requirements of fault detection near the Connection point.

Unless a specific Power Park Module is excluded from contributing reactive currents during low voltage conditions by Transmission Licensees, all other Power Park Modules are required to provide short circuit current contribution as specified below.

- Voltage threshold for activation 90% of rated nominal voltage
- The characteristics (magnitude in relation to voltage dip) of the injected current in time domain
    - As a minimum, the reactive current injection shall be in proportion to the available voltage at the connection point.
    - The injected current shall utilize (up to) the full current rating of the Power Park Module
- Allowable activation delays (20ms - 40ms: in order for ac protection systems to detect faults without undue delays)

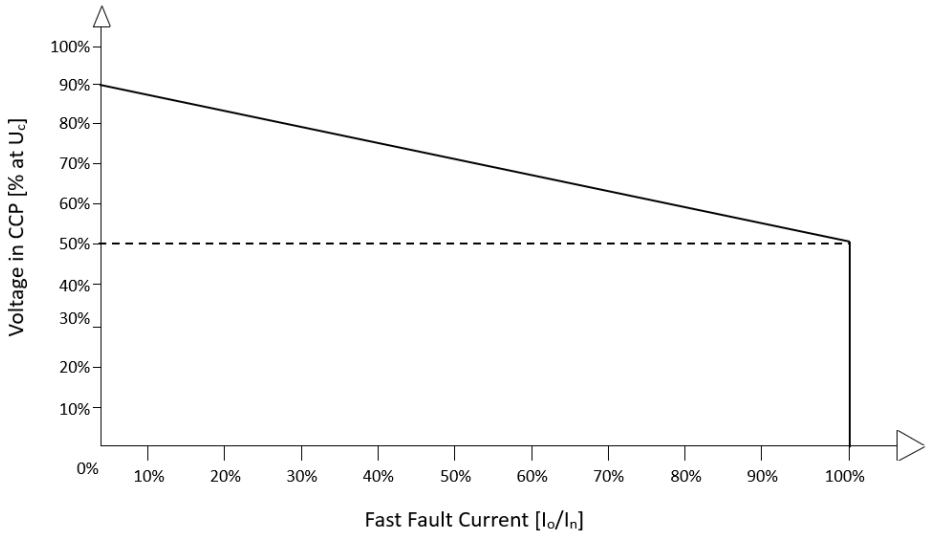


Figure 3.17- 11: Supply of fast fault current from a power park module

3.17.4 REQUIREMENTS FOR CONTROL

In addition to general requirements outlined in the Grid Code, the following Plant Performance Requirements shall be met by the power park module owner.

1 The connection of the power park module shall not negatively impact the operation of other dynamic devices in its close vicinity. The stable operation shall be demonstrated through appropriate RMS (PSS®E) and electromagnetic-transients-type (EMT) (PSCAD™/EMTDC™) simulation tools.
2 The connection of the power park module shall not result in transient and temporary over voltages that will impact existing generation, transmission and distribution equipment.
3 The connection of the power park module shall not lead to unstable or poorly damped system conditions (commonly referred to as control interactions).
4 The connection of power park module shall not adversely impact the torsional oscillations (sub-synchronous torsional oscillations and interactions (SSO/SSTI).
5 The power park module controls shall be equipped with inputs that can be used to facilitate power oscillation damping (POD) and sub-synchronous torsional interaction (SSTI) damping.

3.17.4.1 Control Interaction between the power park module and other dynamic devices (conventional generators, wind, photovoltaic, FACTS devices)

Control Interaction is a specific issue that can impact the coordinated operation of Power Electronic devices in a local area. Control systems of dynamic devices can interact in an undesirable manner resulting in unstable or poorly damped oscillations following system disturbances such as fault recovery. The power park module users shall design the equipment to avoid such undesirable interactions and the acceptable operation demonstrated through interconnection studies.

3.17.4.2 Power oscillation damping (POD)

The power park module shall be capable of contributing to the damping of power oscillations in the connected AC Transmission System.

The power park module owner shall provide all the required data to Transmission Licensees including those related to power park module Control system models, including the parameters of any small signal modulation controls such as power oscillation damping (POD) controls, or sub-synchronous oscillation damping controls.

3.17.4.3 Sub synchronous torsional interaction (SSTI) damping

Regarding the sub-synchronous torsional interaction (SSTI) damping control, the power park module shall be capable of contributing to electrical damping at torsional oscillation frequencies. The SSTI studies shall be undertaken by the power park module owner. The studies shall identify the conditions, if any, where SSTI exists and propose any necessary mitigation measures. Any necessary mitigating actions identified by the studies shall be reviewed by Transmission Licensees. The mitigating actions shall be undertaken by the power park module owner as part of the connection of the new power park module. The power park module owner shall provide all relevant data and models that allow such study to be performed to Transmission Licensees.

3.17.4.4 Converter operational robustness

The power park module, shall be capable of finding stable operation points with a minimum change in active power flow and voltage level, during and after any planned or unplanned change in the Power park module or AC Transmission System to which it is connected.

3.17.5 REQUIREMENTS FOR CONTROL AND PROTECTION PARAMETERS AND SETTINGS

3.17.5.1 Electrical protection scheme and settings

The electrical protection scheme and settings relevant for the power park module and the Transmission network shall be coordinated and agreed between Transmission Licensees and the power park module owner.

Electrical protection of the power park module shall take precedence over operational controls taking into account system security, health and safety of staff, the public and mitigation of the damage to the Power Park module.

Any change to the protection schemes or their settings relevant to the power park module and the Transmission System shall be agreed between Transmission Licensees and the power park module owner before being implemented.

3.17.5.2 Changes to Protection and Control Settings

The parameters and settings of the main control functions of a power park module shall be agreed between the power park module owner and Transmission Licensees.

The parameters and settings shall be implemented within such a control hierarchy that makes their modification possible, as required.

The power park module controls shall not lead to undesirable (control) interactions (unstable or poorly damped) with other dynamic plants in the vicinity of the point of connection.

The power park module owner shall be able to change the control parameters and/or protection settings of the power park module. These changes may be requested by Transmission Licensees. Those parameters shall include, but not be limited to:

- Real and reactive power control mode, as applicable.
- Frequency control, as applicable
- Frequency sensitive modes (FSM, LFSM-O, LFSM-U)
- Power oscillation damping capability (POD)
- Sub-synchronous torsional interaction damping capability (SSTI).
- Synthetic inertia, if applicable

Any change to the schemes or settings of parameters of the different control modes and protection of the power park module, including the procedure, shall be coordinated and agreed between Transmission Licensees and the power park module owner.

3.17.5.3 Priority Ranking of Protection and Control

A control scheme, specified by the power park module owner consisting of different control modes, including the settings of the specific parameters, shall be coordinated and agreed between Transmission Licensees and the power park module owner.

3.17.5.4 Changes to Protection Schemes and Settings - Coordination and Agreement

The power park module owner shall design and implement the control modes and protection schemes to be flexible. Making changes to the control modes and protection settings shall be possible, at the converter stations, with appropriate password protection for different authorized access levels.

3.17.6 DATA AND INFORMATION EXCHANGE BETWEEN POWER PARK MODULE OWNER AND THE Transmission Licensees

3.17.6.1 Exchanged Information

Regarding instrumentation for the operation, the power park module shall be equipped with an automatic controller capable of receiving instructions from the power park module owner. This automatic controller shall be capable of operating the units of the power park module in a coordinated way.

The following information shall be provided to Transmission Licensees from the power park module owner.

1. Typical SCADA signal requirement as per the System Control is attached as Annex I.I and Annex I.II.
2. Detailed high resolution forecast data to be sent to System Control for the PPM having curtailment facility.

The power park module controller shall be able to receive the following signals and commands from Transmission Licensees or the power park module owner based on communication with Transmission Licensees. Transmission Licensees shall specify the variable type and quality requirements of the supplied signals.

a) Start-up command
b) Active power order set-point
c) Frequency sensitive mode settings
d) Reactive power, voltage, or similar set-points
e) Reactive power control mode
f) Power oscillation damping (POD) control settings, if applicable
g) Synthetic inertia, if applicable
h) Normal and emergency blocking command
i) Ramp blocking command
j) Remedial Action Schemes status and settings
k) Active power flow direction command, if applicable
l) Fast active power reversal command, if applicable
m) Redundancy reductions and auxiliary power single source status
n) Other project-specific set-points and commands, as specified by Transmission Licensees.

The power park module owner shall specify any equipment needed to enable the remote selection of control modes and relevant set-points.

3.17.6.2 Parameter setting

Requirements are addressed in Section-6 titled "Requirements for Control and Protection Parameters and Settings".

3.17.6.3 Fault recording and dynamic system behaviour monitoring

The power park module owner shall be equipped with a number of digital transient fault recorders (TFR) with high-speed frequency response to record faults, disturbances and evaluate the dynamic performance of the Power Park module and its effect on the Transmission System. Each power park module shall also be equipped with one or more Sequence of Events Recorders (SER).

A power park module shall be equipped with a facility to provide fault recording and dynamic system behaviour monitoring of the following parameters for each of its units. The following quantities shall be monitored as a minimum:

a) AC voltages and currents (instantaneous and RMS)
b) DC voltages and currents
c) Active and reactive power
d) Frequency

e) Other site-specific parameters specified by Transmission Licensees including resource information

Transmission Licensees will specify the quality of parameters required from the PPM.

The particulars of the fault recording equipment referred to in this section, including analog and digital channels, the settings, including triggering criteria and the sampling rates, shall be agreed between the power park module owner and Transmission Licensees.

All dynamic system behaviour monitoring equipment shall include an oscillation trigger, specified by Transmission Licensees with the purpose of detecting poorly damped power oscillations.

The facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the power park module owner and Transmission Licensees to access the information electronically. The communications protocols for recorded data shall be agreed between the PPM owner and Transmission Licensees.

3.17.6.4 Fault and disturbance analysis

Refer Section 3.17.6.3 "Fault Recording and dynamic performance behaviour monitoring".

3.17.6.5 Simulation models

The Power park module owner shall provide all the relevant information details as listed in "Data and Model Requirement to be Complied by Inverter based RE Plants prior to be Interconnected to Transmission Licensees Network".

The power park module owner shall provide models that accurately represent the dynamic response of the model. The model shall include all site-specific protection, control and other parameter settings as applicable. Both RMS-type and EMT-type models shall be in PSS®E and PSCAD™/EMTDC™ formats, respectively. The proprietary information of the power park module Manufacturer that forms the model may be protected. However, the models shall have the flexibility to change parameters and select options that Transmission Licensees will have access to with the field equipment.

The POWER PARK MODULE OWNER shall provide the study results as per "Dynamic Plant Model Quality and Dynamic Response Test" in PSS®E and PSCAD™/EMTDC™ for review and agreement by Transmission Licensees. Those simulation studies shall be revised based on the actual system and Power Park module tests and adhere to the requirements for the Transmission System and Power park module per the power park module Technical Specifications, as well as the following requirements:

For the purpose of dynamic simulations, the models provided shall contain at least, but not limited to, the following sub-models, depending on the existence of the mentioned components: (a) power park module model b) AC component models; (c) DC system models; (d) Voltage and power controller; (e) Special control features if applicable (e.g. power oscillation damping (POD) function, sub-synchronous torsional interaction (SSTI) control); (f) Multi terminal control, if applicable; (g) Power park module protection models as agreed between Transmission Licensees and the power park module owner.

The power park module owner shall verify the models against the results of compliance tests carried out and a report of this verification shall be submitted to Transmission Licensees. The models shall then be used for the purpose of verifying compliance with the requirements of this Regulation including, but not limited to, compliance simulations and used in studies for continuous evaluation in system planning and operation.
The power park module owner shall submit Power park module recordings to Transmission Licensees, if

requested, in order to compare the response of the models with these recordings.

3.17.7 Requirements for Power System Restoration

Black start and capability to take part in isolated network operation

This feature is not applicable unless specifically requested by Transmission Licensees from specific Power Park Module.

Transmission Licensees may specify a Black Start feature for the Power Park module. In that case, the Power Park module shall be capable of operating in an isolated network in accordance with Black Start operation requirements.

The power park module owner shall comply with the Black start procedure and other requirements of Transmission Licensees. In addition, Transmission Licensees and the power park module owner shall agree on the capacity and availability of the black start capability and any other operational procedures.

The Power park module shall be able to synchronize with the AC system within the frequency limits set out in Section 3.17.1.1 and within the voltage limits specified in the Section 3.17.2.1 where applicable.

Wider frequency and voltage ranges may be specified by Transmission Licensees where needed in order to restore the AC Network security.

3.17.8 Testing, Monitoring and Compliance Review

The additional requirements considered for Power Park modules.

3.17.8.1 Testing and compliance

The Power Park module shall be designed and tested to meet the requirements of the Transmission System, operational requirements, performance studies and any Interconnection Agreements. Sufficient monitoring shall be provided to Transmission Licensees to determine that the Power Park module complies with those performance requirements.

3.17.8.2 Grid Connection Testing

In addition to the site acceptance tests, the power park module owner shall recommend, provide procedures and carry out compliance tests in line with Best Industry practices. The tests shall include, but not be limited to:

a) Harmonic voltage distortion measurements
b) Frequency response test
c) Reactive power compensation test
d) Voltage control test
e) Tariff metering tests
f) Fault ride through capability tests
g) Audible Noise measurements
h) Performance Guarantee requirements
i) Electro-Magnetic Interference measurements

These tests shall be performed at different active and reactive power levels (worst case also) to demonstrate the features and the stability of the Power park module with respect to Transmission Licensee's AC system.

The Power park module shall include any additional monitoring and recording required for the purpose of completing grid connection testing in the scope of supply.

The power park module owner shall coordinate grid connection testing with Transmission Licensees, including notification to all relevant parties and seeking approval for all test procedures prior the commencement of any system tests.

3.17.8.3 Non-Compliance

Should there be a concern or question of non-compliance the power park module owner shall meet with Transmission Licensees to discuss and resolve. If it cannot be resolved at that stage, the power park module owner shall perform testing with agreement from Transmission Licensees to demonstrate that the power park module complies. Should the plant scheme be deemed to be non-complaint, the power park module owner shall take the appropriate steps to rectify as soon as reasonably possible to re-establish compliance.

3.17.9 HANDLING DEVIATIONS

Given the evolving nature of inverter-based resource (IBR) technology, a request for any deviation from the requirements as specified in this document received from a PPM owner may be considered by Transmission Licensees on case-by-case basis. However, any disputes and final resolutions shall be taken up to GCERP or any PUCSL established mechanisms as applicable.

3.17.10 ANNEX I.I

Typical Signal List for Solar Power Station **Annex I.I**

Signal Description	Type of Signal	Signal Type Description For IEC 60870 - 5 - 104		User Data of Class
		Type ID No.	Description	
From each Generator Bay				
Status Indications				
Circuit Breaker Open/Close	DPI	31	M_DP_TB_1	Class 1
Bus Isolator Open/Close	DPI	31	M_DP_TB_1	Class 2
Line Isolator Open/Close	DPI	31	M_DP_TB_1	Class 2
Earth Switch Open/Close	DPI	31	M_DP_TB_1	Class 2
Generator Running/Stop	DPI	31	M_DP_TB_1	Class 2
Measurements				
Active Power (MW)	AI	13	M_ME_NC_1	Class 2

Reactive Power (MVar)	AI	13	M_ME_NC_1	Class 2
Current (A)	AI	13	M_ME_NC_1	Class 2
Voltage (kV)	AI	13	M_ME_NC_1	Class 2
Power Factor	AI	13	M_ME_NC_1	Class 2
Frequency (Hz)	AI	13	M_ME_NC_1	Class 2
Solar Irradiance	AI	13	M_ME_NC_1	Class 2
From Total Solar Plant				
Status Indications				
Plant Control NSCC / SAS/ Siyambalanduwa GS	DPI	31	M_DP_TB_1	Class 1
Operating Mode I	SPI	30	M_SP_TB_1	Class 1
Operating Mode 2	SPI	30	M_SP_TB_1	Class 1
Operating Mode n	SPI	30	M_SP_TB_1	Class 1
Active Power Controller Mode	SPI	30	M_SP_TB_1	Class 1
Reactive Power Controller Mode	SPI	30	M_SP_TB_1	Class 1
Voltage Controller Mode	SPI	30	M_SP_TB_1	Class 1
Power Factor Controller Mode	SPI	30	M_SP_TB_1	Class 1
Control Commands				
Select Operating Mode 1	SPC	45	C_SC_NA_1	Class 1
Select Operating Mode 2	SPC	45	C_SC_NA_1	Class 1
Select Operating Mode n	SPC	45	C_SC_NA_1	Class 1
Select Active Power Control	SPC	45	C_SC_NA_1	Class 1
Select Reactive Power Control	SPC	45	C_SC_NA_1	Class 1
Select Voltage Control	SPC	45	C_SC_NA_1	Class 1
Select Power Factor Control	SPC	45	C_SC_NA_1	Class 1
Active Power Set Point Command	AO	50	C_SE_NC_1	Class 1
Reactive Power Set point Command	AO	50	C_SE_NC_1	Class 1
Signal Description	**Type Of Signal**	**Signal Type Description For IEC 60870 - 5 - 104**		**User Data of Class**
		Type ID No.	**Description**	
Voltage Set Point Command	AO	50	C_SE_NC_1	Class 1
Power Factor Set Point Command	AO	50	C_SE_NC_1	Class 1
Measurements				
Total Plant Active Power	AI	13	M_ME_NC_1	Class 2
Total Plant Reactive Power	AI	13	M_ME_NC_1	Class 2
Plant Control Voltage	AI	13	M_ME_NC_1	Class 2
Plant Control Power Factor	AI	13	M_ME_NC_1	Class 2
Total Active Energy	AI	13	M_ME_NC_1	Class 2
Total Reactive Energy	AI	13	M_ME_NC_1	Class 2
No. of Running Solar units	AI	13	M_ME_NC_1	Class 2
Plant Availability Factor	AI	13	M_ME_NC_1	Class 2
Plant Factor	AI	13	M_ME_NC_1	Class 2
Total Available Capacity	AI	13	M_ME_NC_1	Class 2

Total possible generation (MW) with respect to Solar Forecasting	AI	13	M_ME_NC_1	Class 2

Legends:

DPI - Double Point Indication
SPI - Single Point Indication
DPC - Double Point Control Command
SPC - Single Point Control Command

AI - Measurements (Analog Input)
AO - Analog Output

C_DC_NA_1 :- Double Command
C_SC_NA_1 :- Single Command
M_DP_TA_1 :- Double Point Information with time tag
M_SP_TA_1 :- Single Point Information with time tag
M_ME_NC_1 :- Measured Value, short floating point number
M_DP_TB_1 :- Double Point Information with time tag CP56Time2a
M_SP_TB_1 :- Single Point Information with time tag CP56Time2a
M_IT_NA_1 :- Integrated Totals
C_SE_NC_1:- Set Point Command,Short Floating point
C_SC_TA_1 :- Single point Command with Timetag CP56Time2a
C_DC_TA_1:- Double point Command with Timetag CP56Time2a

3.17.11 ANNEX I.II

Typical Signal List for Wind Power Station

Annex I.II

Signal Description	Type Of Signal	Signal Type Description For IEC 60870 - 5 - 104		User Data of Class
		Type ID No.	Description	
Status Indications				
Wind Transformer(LV Side)				
CB	DPI	31	M_DP_TB_1	Class 1
Disconnector	DPI	31	M_DP_TB_1	Class 2
Earth Switch	DPI	31	M_DP_TB_1	Class 2
Wind Transformer(HV Side)				
CB	DPI	31	M_DP_TB_1	Class 1
Disconnector	DPI	31	M_DP_TB_1	Class 2
Earth Swith	DPI	31	M_DP_TB_1	Class 2
Unit Status(Running/Not Running)	SPI	30	M_SP_TB_1	Class 1
Unit shut down (Raise/Release)	SPI	30	M_SP_TB_1	Class 1
PControlStatus_PPC	SPI	30	M_SP_TB_1	Class 1
QControlStatus_PPC	SPI	30	M_SP_TB_1	Class 1
VControlStatus_PPC	SPI	30	M_SP_TB_1	Class 1
PFControlStatus_PPC	SPI	30	M_SP_TB_1	Class 1
LocalRemoteStatus_PPC(Station Control(Wind PS/NSCC)	DPI	31	M_DP_TB_1	Class 1
Alarms				
WT fault (Group Signal)	SPI	30	M_SP_TB_1	Class 1
Transformer Alarm (Group Signal)	SPI	30	M_SP_TB_1	Class 1
Bay Control(Local Remote)	SPI	31	M_SP_TB_2	Class 2
Protection Signal				
WT Trip (Group Signal)	SPI	30	M_SP_TB_1	Class 1
Transformer Trip (Group Signal)	SPI	30	M_SP_TB_1	Class 1
Measurements				
Wind Transformer(HV Side)				
Active Power	AI	13	M_ME_NC_1	Class 2
Reactive Power	AI	13	M_ME_NC_1	Class 2
Voltage	AI	13	M_ME_NC_1	Class 2
Current	AI	13	M_ME_NC_1	Class 2
Wind Transformer (LV Side)				
Active Power	AI	13	M_ME_NC_1	Class 2
Reactive Power	AI	13	M_ME_NC_1	Class 2
Voltage	AI	13	M_ME_NC_1	Class 2
Current	AI	13	M_ME_NC_1	Class 2

Signal Description	Type Of Signal	Signal Type Description For IEC 60870 - 5 - 104		User Data of Class
		Type ID No.	Description	
Controls Command				
Wind Transformer(HV Side)				
CB	DPC	46	C_DC_NA_1	Class 1
Disconnector	DPC	46	C_DC_NA_1	Class 1
Earth Switch	DPC	46	C_DC_NA_1	Class 1
Unit shut down Command from Park Control	DPC	46	C_DC_NA_1	Class 1
Protection Reset	SPC	45	C_SC_NA_1	Class 1
Wind Transformer (LV Side)				
CB	DPC	46	C_DC_NA_1	Class 1
Disconnector	DPC	46	C_DC_NA_1	Class 1
Earth Switch	DPC	46	C_DC_NA_1	Class 1
Protection Reset	SPC	45	C_SC_NA_1	Class 1
Wind Park				
Control Commands				
Park MW set point	AO	50	C_SE_NC_1	Class 1
Park Mvar set point	AO	50	C_SE_NC_1	Class 1
PControlMode_PPC	SPC	45	C_SC_NA_1	Class 1
QControlMode_PPC	SPC	45	C_SC_NA_1	Class 1
VControlMode_PPC	SPC	45	C_SC_NA_1	Class 1
PFControlMode_PPC	SPC	45	C_SC_NA_1	Class 1
Alarm Indications				
Station alarms (Group Signal)	SPI	30	M_SP_TB_1	Class 1
Measurements				
Park Active Power	AI	13	M_ME_NC_1	Class 2
Park Reactive Power	AI	13	M_ME_NC_1	Class 2
Park Availability factor	AI	13	M_ME_NC_1	Class 2
Park plant factor	AI	13	M_ME_NC_1	Class 2
Wind Energy Forecast (Park MW availability)	AI	13	M_ME_NC_1	Class 2
Energy Measurements				
Park Active Energy	AI	13	M_ME_NC_1	Class 2
Park Re-Active Energy	AI	13	M_ME_NC_1	Class 2

DPI - Double Point Indication
SPI - Single Point Indication
DPC - Double Point Command
SPC - Single Pont Command
BCP - Binary Coaded Measurement
AI - Analog Input
AO - Analog Out Put

C_DC_NA_1 :- Double Command
C_SC_NA_1 :- Single Command
M_DP_TA_1 :- Double Point Information with time tag
M_SP_TA_1 :- Single Point Information with time tag
M_ME_NC_1 :- Measured Value, short floating point number
M_DP_TB_1 :- Double Point Information with time tag CP56Time2a
M_SP_TB_1 :- Single Point Information with time tag CP56Time2a

M_IT_NA_1 :- Integrated Totals
C_SE_NC_1:- Set Point Command,Short Floating point
C_SC_TA_1 :- Single point Command with Timetag CP56Time2a
C_DC_TA_1:- Double point Command with Timetag CP56Time2a

3.18 SPECIAL CONNECTION REQUIREMENTS FOR EMBEDDED GENERATING UNITS

Embedded Generating Units shall fulfil the requirements and conditions stated in the Transmission Licensees Guide for Grid Interconnection of Embedded Generators, Part 1: Application, Evaluation and Interconnection Procedure and Part 2: Protection and Operation of Grid Interconnection, included in the Distribution Code.

Responsibility to fulfil requirements and conditions given in the Transmission Licensees Guide for Grid Interconnection of Embedded Generators, Parts 1 and 2 remains with Generators with Embedded Generating Units.

3.19 SPECIAL CONNECTION REQUIREMENTS FOR DISTRIBUTION LICENSEES

3.19.1 UNDER-FREQUENCY LOAD SHEDDING

The Transmission Licensee shall provide Under-frequency Relays for Automatic Load Shedding, where necessary, at Interconnection Points with Distribution Licensees and Transmission Customers.

3.19.2 CURRENT DISTORTION LIMITS

Distribution Licensees shall ensure that their load current harmonic distortion does not exceed the allowed current distortion levels, at the Interconnection Point. The allowed current distortion limits are specified in this **GCC**.

3.19.3 EMISSION LIMITS OF FLUCTUATING LOADS

Distribution Licensees shall ensure that their emission of fluctuating Loads does not exceed the allowed emission levels, at the Interconnection Point. The allowed emission limits are specified in this **GCC**.

3.20 SPECIAL CONNECTION REQUIREMENTS FOR TRANSMISSION CUSTOMERS

3.20.1 UNDER-FREQUENCY LOAD SHEDDING

The Transmission Licensee shall provide Under-frequency Relays for ALS, as necessary, at the Interconnection Point with a Transmission Customer.

3.20.2 CURRENT DISTORTION LIMITS

Transmission Customers shall ensure that their load current harmonic distortion does not exceed the allowed current distortion levels, at the Interconnection Point. The allowed current distortion limits are specified in this **GCC**.

3.20.3 EMISSION LIMITS OF FLUCTUATING LOADS

Transmission Customers shall ensure that their emission of fluctuating Loads does not exceed the allowed emission levels, at the Interconnection Point. The allowed emission limits are specified in this **GCC**.

3.21 PROCEDURES FOR APPLICATION FOR GRID CONNECTION

Procedure for application for grid connection is given in **Appendix C.**

APPENDIX A – CRITERIA

TABLE OF CONTENTS

GRID CODE CRITERIA

INTRODUCTION Appendix A – Criteria

Describes the Criteria used in the Grid Code. This Appendix A is cross-referred in the Grid Code.

EFFECTIVE DATE

This Appendix A to the Grid Code has been recommended by the Grid Code Enforcement and Review Panel (GCERP) to be effective from DD-MM-YYYY.

1 GENERAL CODE – CRITERIA

No criteria to be listed

3 CONNECTION CODE– CRITERIA

3.1 ALL USERS

(A) DECLARED VOLTAGE (GCC 3.5)

Declared Voltages at the Interconnection Point will be 11 kV,22 kV, 33 kV, 132 kV, 220 kV and 400 kV.

(B) FREQUENCY VARIATIONS (GCC 3.6.1)

Table 3.1.B: Frequency Variation

Frequency (Hz)	System Conditions
50.5 - 52.0	Emergency
49.5 - 50.5	Normal
47.0 - 49.5	Emergency

(C) VOLTAGE VARIATIONS (GCC 3.6.2)

Table 3.1.C: Voltage Variation

System Nominal Voltage (kV)	Variation
400 kV	± 10 %
220 kV	± 10 %
132 kV	± 10 %
33 kV	± 6 %

22 kV	± 6 %
11 kV	± 6 %

(D) VOLTAGE WAVEFORM DISTORTION (GCC 3.6.3)

Allowed Distortion is limited to indicative planning levels given in Table 2 of sub-clause 4.2.1 of IEC 61000 -3-6 (Harmonics).

(E) VOLTAGE FLUCTUATIONS (GCC 3.6.4)

Allowed fluctuation is limited to indicative values of planning levels given in Table 2 of sub-clause 4.2.1 of IEC 61000-3-7(Voltage fluctuation).

(F) VOLTAGE UNBALANCE (GCC 3.6.5)

Negative phase sequence load unbalance in accordance with IEC 60034-1.

(G) BASIC IMPULSE LEVEL (GCC 3.7.1)

Table 3.1.G: Basic Impulse Level (BIL)

System Nominal Voltage (kV)	BIL (kV)
400	1,425
220	1,050
132	650
33	170
22	125
11	95

(H) POWER FREQUENCY WITHSTAND VOLTAGE (GCC 3.7.2)

Table 3.1.H: Power Frequency withstand Voltage One (01) minute

System Nominal Voltage (kV)	Power Frequency Withstand Voltage (kV)
400	650
220	460
132	275
33	70
22	50
11	28

(I) THREE PHASE SHORT CIRCUIT LEVEL (GCC 3.7.3)

Table 3.1.I: Three Phase Short Circuit Level

System Nominal Voltage (kV)	Three phase Short Circuit Level (kA)
400	40.0
220	40.0
132	31.5
33	25.0

22	25.0
11	25.0

(J) CURRENT DISTORTION LIMITS (GCC 3.8)

Allowed Current Distortion by an individual User shall be limited to the current distortion limits described in clause 10 of IEEE 519-1992.

Measurement and evaluation of the current harmonic distortion shall be carried out in accordance with clause 9, 12 and 13 of IEEE 519-1992. Measurement and evaluation reports shall be prepared in accordance with IEEE 519-1992.

(K) EMISSION LIMITS OF FLUCTUATING LOADS (GCC 3.9)

Allowed emission is limited to the emission limits described in clause 6, 7, 8 and 9 of IEC 61000-37 (Voltage fluctuation).

Measurement and evaluation of emissions shall be carried out in accordance with IEC 61000-3-6. Measurement and evaluation reports shall be prepared in accordance with IEC 61000-3-7.

3.2 GENERATION LICENSEES WITH GENERATION FROM CONVENTIONAL RESOURCES

(A) FREQUENCY VARIATION CAPABILITY (GCC 3.16.1)

Table 3.2.A: Frequency Variation Capability

Frequency (Hz)	Duration
50.5 - 52.0	60 minutes
49.5 - 50.5	Continuous
47.5 - 49.5	60 minutes
47.0 – 47.5	30 seconds

(B) VOLTAGE VARIATION CAPABILITY (GCC 3.16.2)

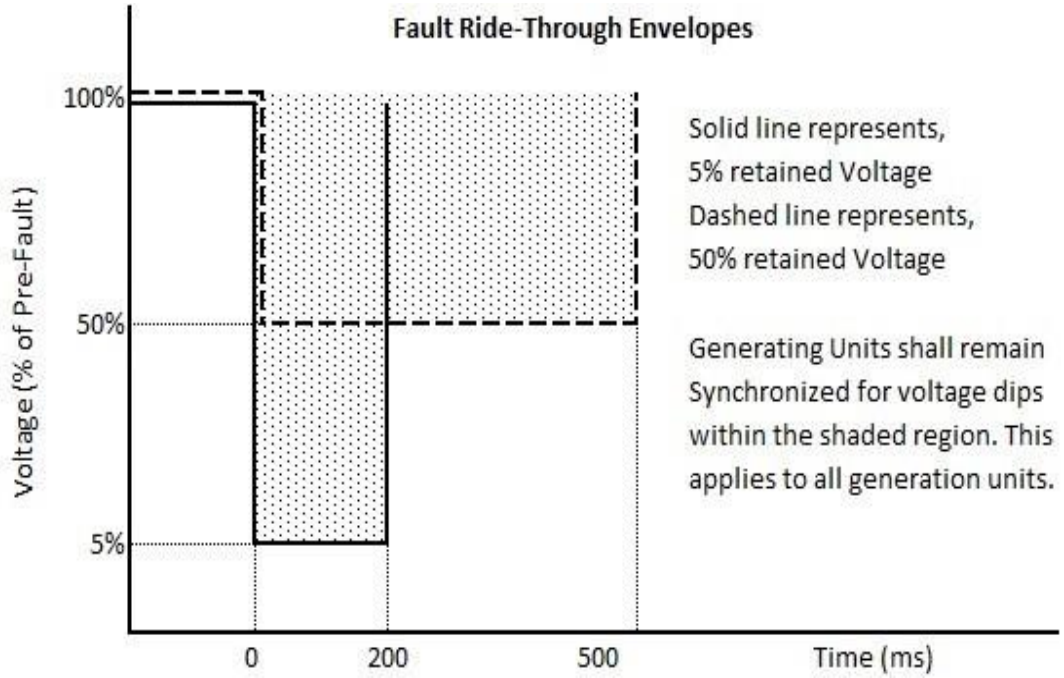
Table 3.2.B: Voltage Variation Capability

System Nominal Voltage	Variation
400 kV	± 10 %
220 kV	± 10 %
132 kV	± 10 %
33 kV	± 6%
22 kV	± 6%
11kV	± 6%

(C) FAULT RIDE-THROUGH CAPABILITY (GCC 3.16.6)

Voltage Dip Magnitude	Fault Ride-through Time
95% (5% retained)	200 ms
50% (50% retained)	500 ms

(D) FAULT RIDE-THROUGH CAPABILITY ENVELOPES (GCC 3.16.6)



3.3 GENERATION LICENSEES WITH INTERMITTENT RESOURCE BASED GENERATION SYSTEMS

3.3.1 POWER FACTOR VARIATION CAPABILITY AND REACTIVE POWER CAPABILITY

Refer Section 3.17 of this Grid Code.

3.3.2 POWER CURTAILMENT REQUIREMENTS (GCC 3.17.5)

Refer Section 3.17 of this Grid Code.

APPENDIX C – PROCEDURE FOR APPLICATION FOR GRID CONNECTION

INTRODUCTION

Appendix C – PROCEDURE FOR APPLICATION FOR GRID CONNECTION describes the procedure a prospective user has to adopt prior to connection the Grid.

EFFECTIVE DATE

This Appendix C to the Grid Code has been recommended by the Grid Code Review Panel (GCREP) to be effective from the DD-MM-YYYY.

1. ALL USERS

APPLICATION PROCEDURE FOR A NEW OR MODIFICATION OF A FACILITY

Any User seeking a new connection or modification of an existing connection shall submit a formal application to the Transmission Licensee along with the application fee for preliminary evaluation, approved by the PUCSL.

Details that shall be provided at various stages of the grid connection process are given in Appendix B.

1.1 APPLICATION PROCESSING

The Transmission Licensee shall establish a procedure to process the applications for new connections/modifications. It shall clearly identify the important events in the process from the time of submission up to the time of making the connection and the maximum lead time for completion of each event. This procedure shall be published in the Licensee website.

Broadly, the procedure for processing the application will include the following events. (a) Preliminary evaluation
(b) Grid impact assessment
(c) Submission of the offer to the applicant
(d) Applicant's acceptance of the offer
(e) Entering into the agreement for detailed studies and further processing
(f) Submission of information pursuant to the agreement entered into
(g) Detailed evaluation of the application
(h) Entering into connection agreement
(i) Submission of information prior to commissioning tests
(j) Commissioning tests
(k) Commissioning and connection
(l) Connection records

1.2 GENERATION LICENSEES WITH GENERATION FROM CONVENTIONAL RESOURCE

Any prospective generation licensee with generation from conventional resources, seeking a new connection or modification of the existing connection shall conform to the procedure approved by PUCSL in terms of the SLEA20.

1.3 GENERATION LICENSEES WITH INTERMITTENT RESOURCE BASED GENERATION SYSTEMS

Any prospective generation licensee with generation from conventional resources, seeking a new connection or modification of the existing connection shall conform to the procedure approved by PUCSL in terms of the SLEA20.

1.4 GENERATION LICENSEES WITH EMBEDDED GENERATORS

Any prospective generation licensee with embedded generators, seeking a new connection or modification of the existing connection shall conform to the procedure approved by PUCSL in each Distribution Code.

1.5 DISTRIBUTION LICENSEES

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1.6 TRANSMISSION BULK CUSTOMERS

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APPENDIX D: FORECAST DATA

As mentioned in clause 4.4.1, Generators and users shall provide measured and forecast data in the following manner;

This section details the 10-year demand forecasts that are required from each **User** of the **Transmission System** who is the **Distribution Control Centre (DCC)** in respect of each infeed from the **Transmission System.** This section applies equally to the **Transmission Customer.**

The **System Operator** shall notify each **User** upon request in advance of each load reading day.

The 10-year demand forecasts with monthly energy and peak demands should be submitted by the first week of September each year.

APPENDIX E: DATA TO BE PROVIDED BY IBRE

As per clause 5.4.2 –(g),

(a) All IBRE which have capacities greater than or equal to 5 MW shall provide the requested data (**section 3.17.6**) in real time through a **dedicated communication channel** to the System Operator .

(b) All IBRE which have capacities greater than 100 kW to less than 5 MW shall provide the following data in near real time through an appropriate communication channel to the System Operator.

1. Real power output Pn (MW).
2. Reactive power output Qn (MVar).
3. Terminal Voltage Vn (kV).