CEYLON ELECTRICITY BOARD

License No: EL/T/09-002

GRID CODE

of Sri Lanka

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GRID CODE

TABLE OF CONTENTS

The Grid Code of Sri Lanka

Introduction

The Grid Code of Sri Lanka (hereafter referred to as "Grid Code") has been formulated in terms of the provisions of Clause 17(f) and 3.1 (c) of the Sri Lanka Electricity Act, No 20 of 2009 (SLEA 2009), which require the licensees to implement and maintain technical or operational codes; the Public Utilities Commission of Sri Lanka (PUCSL) to approve and regulate the implementation of such codes.

It specifies criteria, guidelines, basic rules, procedures, responsibilities, standards and obligations for the operation, maintenance and development of the Electricity Transmission System of Sri Lanka to ensure a transparent, non-discriminatory and economic access and use of the Grid, whilst maintaining a safe, reliable and efficient operation of the same to provide a quality and secure electricity supply as reasonably as practicable.

The Grid Code has to be revised and amended from time to time as and when the situations demand to reflect the changes in the regulatory framework and the development of the transmission network to comply with legislations and good industry practices.

The primary objectives of the Grid Code are to establish an effective, transparent, non-discriminatory and coordinated approach for operation, maintenance and development of the Transmission System, and to ensure equitable management of technical matters in the interest of all parties connected to the grid including distribution licensees, customers, generators and any other users.

This Code has to be read in conjunction with the Distribution Code for complete and appropriate understanding of the requirements, where applicable, especially with respect to the 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 enforcement of the Grid Code and also specifies the general terms and conditions, and definitions applicable for the Grid Code.

2. **Grid Planning Code**

Describes the technical and design criteria and procedures to be followed by the Transmission Licensee in the planning and development of its Transmission System. The Grid Planning Code also specifies the information users or users seeking connection to the Transmission System shall supply for the Transmission Licensee to undertake the planning and the development of the Transmission System.

3. **Grid Connection Code**

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

4. **Grid Operations Code**

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

5. **Generation Dispatch Code**

Specifies the rules and procedures the System Operator should follow to optimize the system operation, the role of other Licensees and the role of the Transmission Licensee in this optimization, the mechanisms to coordinate the real time operation of the system, and the reporting requirements.

6. **Grid Metering Code**

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

7. Grid Planning and Operating Standards Code

Specifies the technical standards, criteria and parameters used for resource planning, and for planning and operation of the Transmission System.

8. Grid Information and Data Exchange

Provides a summary of information and data requirements as required by the Transmission Licensee, listing the data and information to be exchanged between the Transmission Licensee and the Users.

1. GENERAL CODE

1.1 INTRODUCTION

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

1.2 APPLICABILITY

The Grid Code is primarily applicable to the Transmission Licensee in the capacity as the Asset Manager and Operator for the grid and to all Users of the Grid. This has been clearly defined under each code.

1.3 OBJECTIVES

The primary objectives of the General Code are to,

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

1.4 RESPONSIBILITIES

1.4.1 PUCSL

PUCSL shall be responsible for the enforcement of the Grid Code and also amend it 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.

1.4.2 TRANSMISSION LICENSEE

Transmission Licensee shall be responsible for the implementation of the Grid Code and 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 as the Transmission Licensee may require in discharging the Transmission Licensee's duties during implementation of the provisions of the Grid Code, and act in accordance with the established good industry practices.

Specific responsibilities of all parties, the Transmission Licensee, Users and the 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 Public Utilities Commission of Sri Lanka (PUCSL). The hierarchy is presented in top-down order below:

1. Legislation
    - The Public Utilities Commission of Sri Lanka (PUCSL) Act, No. 35, 2002
    - Sri Lanka Electricity Act, No 20, 2009
2. Regulations issued by the Minister
3. Rules issued by PUCSL
4. Grid Code
5. Distribution Code
6. Contracts between parties
    - Power Purchase Agreement (PPA) between Generation Licensees and the Transmission Licensee.
    - Power Sales Agreement (PSA) between the Transmission Licensee, Distribution Licensees and other Users
    - Connection agreements between Distribution Licensees and Customers
7. Internal Codes of the Transmission Licensee and Distribution Licensees

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

1.6 PROCESS TO REVIEW AND REVISE THE GRID CODE

Grid Code Enforcement and Review Panel (GCERP) is responsible for the review and revision of the Grid Code. Review of the Grid Code shall be carried out periodically and as and when required.

Recommendations of the GCERP comprising suggestions, changes, and amendments shall be submitted to PUCSL for their review and concurrence. Any changes or additions proposed by PUCSL will also be referred to the GCERP and processed through GCERP for incorporation in the Grid Code.

1.6.1 GRID CODE ENFORCEMENT AND REVIEW PANEL (GCERP)

PUCSL shall establish a Grid Code Enforcement and Review Panel (GCERP) to carry out the following functions:

(a) Positively contribute to the effective enforcement of the Grid Code
(b) Monitor and evaluate the working of the Grid Code and make recommendations to PUCSL for effective implementation.
(c) Review all suggestions and amendments proposed by any party and make suitable recommendations to PUCSL.
(d) Initiate and coordinate revisions and regular reviews to the Grid Code and make suitable recommendations to PUCSL for incorporation.
(e) Facilitate the publishing of the proposed amendments and the reasons for the recommendations.
(f) Facilitate the resolution of issues brought up by the members of the GCERP or by the PUCSL and submit its recommendations to PUCSL.
(g) Produce an annual report on the activities of the Panel.

The GCERP shall consist of nine members as follows:

(a) Two members representing the Transmission Business and Bulk Supply Operation Business of the Transmission Licensee, respectively.
(b) One member representing the Distribution Licensees who shall also be a member of the Distribution Code Enforcement and Review Panel (DCERP) as well.
(c) Two members representing the state-owned generators.
(d) One member representing privately owned generators of installed capacities exceeding 100 MW
(e) One member representing privately owned generators of installed capacities less than 100 MW

(f) One member representing the bulk supply customers served by the Transmission System.

(g) Director (Licensing) of PUCSL shall function as the Secretary to the panel.

Rules and procedures to conduct the business of the GCERP are given in Appendix 1, and the GCERP shall be required to comply with it at all times.

PUCSL shall ensure that the GCERP is functional within 30 days from the PUCSL approving the Grid Code.

1.7 RESPONSIBILITIES IN UNFORESEEN CIRCUMSTANCES

The Grid Code contains procedures to permit effective and equitable management of the Transmssion System, taking into account a wide range of operational conditions likely to be encountered under both normal and abnormal circumstances.

However, in unforeseeable and extraordinary circumstances, the Transmission Licensee will be required to act rationally and decisively in pursuance of any one or a combination of the following general requirements.

(a) The requirements of safety, including prevention of personal injury.
(b) The prevention of serious damage to Plant and/or Apparatus.
(c) The avoidance of breakdown, separation or collapse of the Total System.
(d) The preservation or restoration of the integrity of the Total System.

The above shall also apply in the event of emergency situations such as fuel shortage, 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 of the Grid have a duty to provide such information and resources as are necessary to facilitate compliance with requirements of the Grid Code. Therefore, all parties are responsible to ensure accuracy of such information provided by them in accordance with the requirements of the Grid Code.

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

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

1.10 CONDITIONS OF DISCLAIMER

The Transmission Licensee, in planning and operating the Grid/Transmission System and in contributing to the planning and operation of the Grid/Transmission System, must rely on information provided by Generators, Distribution Licensees, and other Users regarding their requirements and

intentions. Transmission Licensee shall not be held responsible for any consequence which arises from its reasonable and prudent actions on the basis of such information supplied by any of the Users.

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

1.11 CONFIDENTIALITY

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

1.12 PROCEDURE FOR SETTLEMENT OF DISPUTES

In the event of a dispute between the Transmission Licensee and another Licensee such as the Distribution or Generation 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, the parties shall, after deliberations

(a) formulate a provisional working arrangement, which shall be implemented until a valid ruling is issued by the PUCSL.
(b) Keep GCERP informed of the provisional working arrangement within three days from the day such a decision has been taken.
(c) Follow the applicable rules and regulations, and refer the unresolved dispute to PUCSL
(d) GCERP shall submit its observations on the issue to PUCSL.

The costs and expenses incurred by the GCERP in this regard shall be shared equally by the relevant Licensees.

1.13 COMMUNICATION BETWEEN THE TRANSMISSIONLICENSEE 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 or that particular definition shall prevail.

1.14.2 GENDER

Any reference to a gender shall include both genders.

1.14.3 PERSON OR ENTITY

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

1.14.4 SINGULARITY AND PLURALITY

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

1.14.5 INCLUDING

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

1.14.6 AMENDMENT OF STANDARDS

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

1.15 DEFINITIONS AND ABBREVIATIONS

In the Grid Code, the following words/abbreviations and expressions shall bear the meanings as indicated in Table 1.

Table 1.1 - Definitions and Abbreviations

TERM	DEFINITION
Accredited Chartered Electrical Engineer	An electrical engineer possessing earned professional qualifications awarded by a recognised institution in Sri Lanka or abroad, who has been accredited by the Transmission Licensee to inspect and certify that User systems fulfil the requirements of the Grid Connection Code, and other rules, regulations and standards as specified by the Transmission Licensee
Active Power or MW	Product of voltage and current and cosine of the phase angle between them measured in units of Watt (W) kilowatt (kW) = 10^3 W Mega Watt (MW) = 10^6 W Giga Watt (GW) = 10^9 W Tera Watt (TW) = 10^{12} W
Active Energy	The electrical energy produced, 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 or standard multiples thereof, that is :- 1000 Wh = 1kWh, 1000 kWh = 1MWh, 1000 MWh = 1GWh, 1000 GWh = 1 TWh = 10^{12} Wh
ac	Alternating Current
Alternator	The electrical machine which is driven by a prime mover and generates ac electric power. The term "Generator" is reserved for another meaning to avoid confusion (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.
Apparent Power	S = P + JQ. The magnitude is calculated by the formula S = $\sqrt{(P^2 + Q^2)}$ expressed in units of Volt-ampere (VA) or multiples such as kVA and MVA.
Apparatus	All equipment in which electrical conductors are used, supported or of which they may form part.
Appendix	An Appendix to a Section of 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. Also the steady-state probability that a component or system is in service.
Automatic Load Shedding	A Load shedding scheme implemented by the Transmission Licensee to prevent frequency collapse or other operational problems and to restore the balance between generation output and demand on the Transmission System.
Authorized Person	A competent person adequately trained and possessing knowledge and appointed in writing by a Distribution Licensee or the Transmission Licensee to carry out specific tasks and/or work on their systems or apparatus. The certificate of appointment shall state the class of operation and/or work the person is authorized to carry out and the part of the system to which it applies.
Auxiliary	The pumps, motors and other similar equipment required to operate in the power plant to enable a Generating Unit to be operational.
Automatic Voltage Regulator (AVR)	A continuously acting automatic excitation system to control the voltage of a Generating Unit measured at the Alternator terminals.
Black start	The procedure necessary for a recovery from a Total Shutdown or Partial Shutdown.
Breakdown	An occurrence relating to equipment of supply system which prevents its normal functioning.
Capability	The Capability of a Generating unit, expressed in MW, to generate electricity determined at the Interconnection point (after deducting consumption of auxiliaries)
Captive Power Plant	A Generating Unit or a group of Generating Units which produces electricity for the Transmission/Distribution Customer's or its owner's own use.
CCGT	Combined cycle gas turbine
CCGT Module	A group of Generating Units comprising one or more Gas Turbine Units and one or more Steam Units wherein the waste heat from the gas turbines is passed to the water/steam system of the steam units, thereby increasing the overall efficiency the Generator.

TERM	DEFINITION
CCGT Unit	A Generating Unit within a CCGT Module
Competent Person	A person who has sufficient technical knowledge or experience to enable him to avoid danger
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, kVA
Connection point	A point at which a User's Plant and/or Apparatus connects to the Transmission System.
Consumer/Customer	Any person or entity, either as the owner or lawful occupier, supplied with electricity by the 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 SLEA 2009.
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 synchronized 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 the customer.
Control Person	A person who has been authorized to carry out the work in SCC or a person who has to carry out similar tasks in a User installation.
Cost of Unserved Energy or Cost of Energy Not Served	The estimated average cost in USD per kWh to the economy by not supplying electricity on demand, used for establishing a reliability criteria for the Transmission System.
Declared Voltage	A voltage or voltages declared by a Licensee for the supply of electricity to a Customer.
De-Loaded	The condition in which a Generating Unit has reduced or is not delivering electric power to the System to which it is synchronized and the terms "De-Loading" and "De-Load" shall be construed accordingly.
Demand	The requirement for active power and reactive power unless otherwise stated
Demand Forecast	The process which specifies procedures to be followed and data to be supplied to the Transmission Licensee to enable the Transmission Licensee to forecast Demand on the Transmission System through time scales from the next hour to two years ahead.
De-synchronized	The act of taking out a Generating Unit from the transmission or distribution system to which it has been synchronized; similar terms shall be construed accordingly.
Dispatch	The issue of instructions by the Transmission Licensee to 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 Licensee's system.
Distribution Code	The document produced by Distribution Companies pursuant to conditions of the Electricity Supply License.
Distribution Network Control Centre (DNCC)	The centre established by a Distribution Licensee to monitor, control and coordinate the Distribution System operations, with its own operating personnel, Transmission Licensee, other distribution licensees and all Distribution System Users. Its responsibilities include collection/recording of system operational data and publication of the same.
Distribution Licensee	A person appointed through a license issued by PUCSL for the operation of a part of the Distribution System.
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

TERM	DEFINITION
	Apparatus and meters owned or used by the Distribution Licensee in connection with the distribution of electricity.
Development	A modification relating to a User's Plant and/or Apparatus already connected to the Transmission System.
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 generator, or a group of generators, less than 10 MW connected to the distribution network, at nominal voltages between 400 V and 33 kV.
Energy	Quantity of electrical energy measured in units equal to one kilowatt hour (kWh) or multiples thereof such as: 1000 Wh = 1 kWh 1000 kWh = 1 MWh 1000 MWh = 1 GWh
Event	An unscheduled or unplanned occurrence on the Grid/Transmission System including faults, incidents and breakdowns.
Event Logger (EL)	A device provided to record the sequence of operation in time, of the relays/equipment at a location during an event.
Event Recorder	A device provided to record the sequence of operation in time, of the relays/equipment at a location during an event.
External Interconnection	A connection to a network outside the network of a Licensee
Fault Locator (FL)	A device provided at the end of a transmission line to measure/indicate the distance at which a line fault may have occurred.
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 which is unscheduled or unplanned and of which no or short 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 the electricity served through the Transmission System
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	A Power Station subject to Central Dispatch
Generating Unit	Any Apparatus which produces electrical energy including a CCGT Unit.
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 the 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. The diagram shall indicate the output under different power factors.
Generator Terminals	The stator terminals of an alternator.
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.
Grid Code	The Grid Code of Sri Lanka.
High Voltage or HV	Voltage exceeding 33,000 Volt.
HV Apparatus	High Voltage electrical circuits forming part of a System.
Hydropower Station	A hydro-electric Power Station.
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.
Interconnection Point	The point at which a Generating Plant, Power import source, Distribution Licensee System or a Bulk Supply Customer System is

TERM	DEFINITION
	connected to the Transmission System as specified in the relevant purchase/sales agreements, as applicable. Interconnection point also defines the Operational Boundary between two systems.
Isolation Request	A form detailing the circuits to be isolated, which may be used where the apparatus of one Licensee is situated on the premises of, or controlled by, another Licensee.
kVA	kilovolt Ampere
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 Authorization 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 form issued by a senior Authorized Person or Authorized Person specially authorized to do so, defining the limits and nature of work which may be carried out in the vicinity of live apparatus.
Licensee Information Submission System or LISS	A facility through which all Licensees are required to submit the required information on line to the PUCSL.
Live	Electrically charged
Live Line Work	Work on high voltage apparatus, overhead line or underground cables with the conductors live, using approved insulated tools or equipment.
Load	The Active and Reactive Power, as the context requires, generated, transmitted or distributed, and all similar terms shall be construed accordingly.
Load Factor	Ratio of total amount of energy served during a given period to the total amount of energy that could have been served, had the contract demand/maximum demand been maintained throughout the same period. It is usually expressed as a percentage.
Load Following Capability	Defined as the capability of a Generating Unit to adjust its generating output in accordance with the demand fluctuations to enable Frequency Control.
Loss of Load Probability (LOLP)	The percentage of time during which the system load exceed the available generating capacity of the system
Medium Voltage	A voltage level of 11,000 Volt or 33,000 Volt
Metering	Tariff Metering and Operational Metering
Grid Metering Code	That part of Grid Code identified as the Grid Metering Code.
Minimum Generation	The minimum output, which a Generating Unit can safely generate continuously.
Must run generation	Generation that is not necessarily required owing to economic optimum but owing to performance standards or contractual requirements or resource constraints
MVA	Mega Volt Ampere = 1000 kVA
Operating Margin	Extra Generation capacity comprising Contingency Reserve and Operating Reserve, that is required in a system to cover uncertainties in plant availability, variation in Demand Forecast, loss of external connections, loss of Generation, weakness of Transmission System and other factors so that the system is operated within the specifications and standards of the License. The Transmission Licensee will issue timely instructions to Generators to hold the required reserves.
Operating Reserve	The additional output from the Generating Plant and/or the reduction in Demand which is available to respond/contribute to containing and correcting any Transmission System frequency deviation to an acceptable level in the event of a loss of generation, or a loss of import from an External Interconnection, or a mismatch between generating output and Demand.
Operational Boundary	The boundary between the systems of any two entities in the total system or network. It divides the responsibilities and facilities between the entities and defines jurisdiction, as identified by the Interconnection Point(s).
Outage	In relation to a generating plant, a total or partial reduction in availability due 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 due to breakdown or maintenance.

TERM	DEFINITION
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 Shutdown	The condition existing when all generation as well as electricity supply from all external connections to a part of the total system has ceased. That part of the system is therefore shutdown and cannot begin to function without the Transmission Licensee's directions relating to Black Start.
Part Load	Condition of a Generating Unit which is loaded but is not running at its declared availability.
Party	Any person, corporate body, company, organization, authority, firm or association subject to the provisions of the Grid Code.
Permit to Work (PTW)	A form of declaration signed and given by a Senior authorized person to a person in charge of work to be carried out on any earthed high voltage 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 which is intimated by the Transmission Licensee to the Distribution Licensee.
Power Factor	Ratio of active power (kW) to apparent power (kVA)
Power Purchase Agreement or PPA	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 identified interconnection points between the Generator and the Transmission System.
Power Station	An installation comprising one or more Generating units (even where sited separately) owned and/or controlled by the same Generator, which may reasonably be considered as being managed as one Power Station.
Protection	Provisions for detecting abnormal conditions on a System and initiating fault clearance and activating alarms and indications.
PUCSL	Public Utilities Commission of Sri Lanka incorporated under PUCSL Act, 2002.
Reactive Power or MVAr	The product of voltage and current and the sine of the phase angle between them measured in units of volt-amperes reactive (VAr) and standard multiples thereof i.e 1000 VAr = 1kVAr 1000 kVAr = 1MVAr
Reactive Energy	The integral with respect to time of the Reactive Power measured in units of volt ampere hours reactive or standard multiples thereof, that is: 1000 VArh = 1 kVArh 1000 kVArh = 1 MVArh
Recorder	An apparatus that stores a series of instantaneous readings at different times and intervals, and records the data obtained through a direct internal or external connection, feeding all such data into an instrument that allows such internal data to be retrieved at a future point in time.
Rotational Load Shedding or 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.
Sanction for Test	A form of declaration signed and given by a Senior authorized 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 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.

TERM	DEFINITION
SCADA	See "Supervisory Control and Data Acquisition"
SCC	System Control Centre of the Transmission Licensee performing functions of a load dispatch centre and associated activities in planning, operations and control.
Senior Authorized Person	An authorized person who has been appointed in writing by a Distribution Licensee or a Transmission Licensee or a Generation Licensee to issue and cancel a PTW, Sanction for Tests, Limitation of Access and Isolation requests. The certificate of appointment shall state the class of operation and/or work the person is authorized to carry out and the part of the system to which it applies.
Settlement Values	Values of Active Energy and Reactive Energy delivered, and the maximum demand occurring over a settlement period, as recorded by metering required by and operating in accordance with the Grid Metering Code, or as estimated or submitted in accordance with the Grid Metering Code. Settlement values are identified by the time at the end of the relevant settlement period
Shutdown	The condition of the equipment when it is de-energized or disconnected from the Transmission or Distribution system.
Single Buyer	Transmission Licensee in relation to the Bulk Supply business.
SLEA	Sri Lanka Electricity Act no 20 of 2009
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.
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 Frequency drop.
Spinning Reserve Capability	The ability of a Generating Unit to provide Spinning Reserve as specified in the relevant PPA.
Start-up	The action of bringing a Generating Unit from shutdown to the speed required by the Generating Unit to enable it to be synchronized to the Transmission System.
Static Var Compensator (SVC)	An electronically controlled electrical device for providing fast-acting reactive power, lagging or leading, on high-voltage electricity transmission networks.
Substation	An assembly of equipment including any necessary housing for the conversion, transformation, switching or control of electrical power.
Subsystem	Part of a System which by itself constitutes a system such as a type of equipment in a generating plant
Supervisory Control and Data Acquisition or 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 the system. The communication system can be telephone lines, radio, 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 frequencies and phase relationships of that Generating Unit or System, as the case may be and the system to which it is connected are identical and the terms "Synchronize" and "Synchronization" shall be construed accordingly.
Synchronous compensation	The operation of rotating synchronous Apparatus for the specific purpose of either the generation or absorption of Reactive Power.
System Operator	Transmission Licensee in relation to its Operations Business.
Transmission Customer	A Customer connected directly to the Transmission System
Total Shutdown	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.

TERM	DEFINITION
Total System	The Transmission System and all systems of Users of the Transmission System.
Transmission Licensee	A person appointed through a license issued by PUCSL for the operation of Sri Lanka's Transmission System.
Transmission System	The system which is owned and operated by the Licensee and which consists (wholly or mainly) of Extra High Voltage electric lines and electric plant and which is used for conveying electricity from a Generation Plant to a substation, from one Generation Plant to another or from one substation to another, including all Extra High Voltage electric lines which are used to convey electricity to the premises of Bulk Supply Consumers (but shall not include any such lines which form part of any Distribution System).
Under Frequency Relay	An electric measuring relay intended to operate when its characteristic quantity (frequency) decreases below the relay setting by decrease in frequency.
Unit Load Controller	A device which regulates the generation level when the Generating Unit is operating in a Frequency Sensitive Mode to ensure (so far as possible) that it does not exceed or fall short of previously set limits.
User	Person or entity that uses the Transmission System. More specific definitions are identified in the relevant Codes.
User 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.
VAr	A single unit of Reactive Power (Volt-ampere reactive)
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. The phrases "Virtual measurement point", "real metering point" and "real measurement point" are to be construed accordingly.
Water Authority	Mahaweli Authority of Sri Lanka or other authority such as the Department of Irrigation.

2. GRID PLANNING CODE

2.1 INTRODUCTION

The Grid Planning Code (GPC) specifies the technical and design criteria and the procedures to be applied by the Transmission Licensee in the

(a) Planning of investments on the Transmission System (Grid).
(b) Planning of investments on Generation expansion

The purpose of transmission development planning is to serve the Distribution Licensees and other customers with the required supply, ensuring the quality of supply is met as specified, at a pre-defined level of reliability.

The purpose of generation expansion planning is to serve the demand at a specified level of reliability, at the lowest possible long-term cost. Generation expansion planning shall be distinctly different from economic dispatch, which relates to operations planning with existing and committed power plants

2.2 APPLICABILITY

The GPC applies to the Transmission Licensee, all existing Transmission System Users, prospective Users, and parties who are authorized to carry out distribution/supply activities and are connected to the Grid.

2.3 OBJECTIVES

Objectives of the GPC are to,

(a) enable the Transmission system to be planned, designed and constructed to operate in an economical, safe and reliable manner, conforming to the relevant Acts of Parliament, Regulations, Rules, Licences and Guidelines, standard specifications including other relevant manuals, and construction standards,
(b) ensure that the electricity generation required at a specified reliability, to meet the system demand, is procured at the lowest possible cost,
(c) facilitate the use of the Grid by any person connected to or seeking connection to it,
(d) establish technical conditions and standards for acceptable performance at the interface between the Grid and Users' systems,
(e) facilitate the exchange of system data between Users and the Transmission Licensee, and
(f) to provide sufficient information for a User to assess opportunities for connection, and to plan and develop its system so as to be compatible with the Transmission System.

2.4 RESPONSIBILITIES

2.4.1 TRANSMISSION LICENSEE

The Transmission Licensee shall be responsible for,

(i) Identifying the Grid constraints and proposing solutions in respect of voltage levels, loading of equipment, switchgear ratings, power quality, system loss, reliability and security of supply.

(ii) planning the expansion of the Transmission system to meet the forecasted demand taking into consideration the impact of the increase in demand and the expansion of

(a) Distribution systems of the Distribution Licensees,
(b) Transmission Customers,
(c) Generating Units as recommended in the Long Term Generation Expansion Plan, and
(d) any other parties connected to the system.

(iii) planning the system ensuring that the Transmission system will have the capability to meet the laid down standards in relation to voltages, loading of switchgear, equipment ratings, power quality, system loss, reliability, and security of supply.

(iv) ensuring that the planned investments in the network as stated in (iii) above are prudent, optimal and timely, and that Transmission asset utilization is at acceptable levels.

(v) Preparation of the Transmission System Development Plan as laid down in this Code.

(vi) Preparation of the Long Term Generation Expansion Plan as laid down in this Code.

(vii) Reviewing and recommending the changes in planning standards on a periodical basis.

(viii) Monitoring the implementation of the planned proposals

2.4.2 USERS

Grid Users shall be responsible for,

(i) Submitting all data the Transmission Licensee will require for planning the Transmission system.

(ii) Keeping the Transmission Licensee informed of retirement of any Generators, and closing down of installations connected to the Grid, at least 12 months in advance

(iii) Making submissions for improving the planning function.

SECTION 1 – TRANSMISSION PLANNING

2.5 TRANSMISSION SYSTEM

The transmission system is connected with the Generating stations wherever these are located. Lines at HV (i.e. above 33 kV) are drawn between the following network locations:

(i) From a Generating station to another Generating station
(ii) From a Generating station to a Grid substation
(iii) From a Grid substation to another Grid substation
(iv) From a Grid substation to customers supplied at HV
(v) From captive power plants to Grid substations.

The Transmission Licensee who will own, operate and maintain the Transmission System shall in general follow the transmission planning criteria as outlined herein. The Total System, inclusive of loads and generating plants connected to it, is considered as an integral system and is designed to provide the required performance.

2.6 TRANSMISSION DEVELOPMENT PLAN

Transmission Development Plan is a statement that will address the following, but not limited to

(a) the capability of the Transmission system to meet the demand of current and future loads connected to or to be connected to the Transmission System,
(b) System constraints in meeting such demands in accordance with the defined Transmission Planning criteria,
(c) Short term and long term infrastructure needs, identified using the best possible engineering analysis to overcome such constraints, to accommodate recommended options in the Long Term Generation Expansion Plan and also to fulfil GOSL policy objectives,
(d) appropriate capital expenditure requirements for the implementation of the proposals in (c), with justification that such expenditure is commensurate with the benefits to be realized, thus striking a balance between the costs and the Transmission System performance.

2.6.1 TRANSMISSION PLANNING PROCESS

Transmission planning process will include the following steps.

(a) Initiation of a consultation process with stakeholders.
(b) Collection of load forecasts from the Distribution Licensees and Transmission Customers, and validation of the same
(c) Collection of information from the Generation Expansion Plan including those from the embedded generators connected to Distribution Systems
(d) Collection of Generation dispatch information including the scenarios for maximum hydro generation and maximum thermal generation
(e) Collection of information on Transmission projects on the completion dates etc., and updating the database
(f) Analysis of the capability of the existing Transmission System to meet the current and future demands under forecast maximum and minimum load conditions, in accordance with the Planning criteria to identify the system constraints.
(g) Carrying out system studies with alternate options and also the financial/economic analysis for each option.
(h) Selection of the optimal development plan.
(i) Consulting with stakeholders regularly, consider suggestions for improvements, perform necessary analysis, and formulate the final Transmission Development Plan.

2.7 PLAN BOUNDARIES

The Plan shall cover the boundaries of the Bulk Supply and Operations Business of the Transmission Licensee, namely:

Off-take from Generating Plant at the high voltage terminals, and delivery to Distribution Licensees and other Transmission Customers.

2.8 THE PLANNING PERIOD, FREQUENCY OF UPDATES AND DATE OF SUBMISSION

The planning period shall be ten (10) years, commencing from the first year after the year the plan is published.

The Transmission Licensee shall update the transmission plan at least once in two years. The plan shall be documented in the form of a report titled "Long-term Transmission Development Plan *start year – ending year*" (hereinafter referred to as the "the Plan"). The contents of the Plan are provided in section 2.15.

An updated "Long-term Transmission Development Plan" shall be submitted for the Commission's approval once in two years. In a year where a tariff filing is due, PUCSL may specify a different timing.

The Plan shall be submitted for review and approval by PUCSL not later than the 31st day of May, of the year in which an update to the Plan is due. PUCSL shall review the Plan for compliance with the guidelines provided herein, may request for clarifications and amendments, and approve the Plan. The Transmission Licensee shall publish the Plan on the Licensee's web site immediately after the Plan is approved by PUCSL.

2.9 SYSTEM DATA

Generators, Distribution Licensees and Transmission Customers already connected to the Grid and Generators/Consumers seeking connection to the Transmission System shall be required to furnish information and data to the Transmission Licensee as specified in this Code.

Such data is required for the following purposes:

(a) To update the data base for carrying out system studies and system planning for the Transmission System.
(b) To formulate the Transmission Development Plan.

(c) To review the progress of new projects and developments earlier approved within the Transmission Development Plan.
(d) To confirm compliance with the requirements under its License and under this Code.

The Transmission Licensee shall commission and maintain a Geographical Information System to store these data.

2.9.1 DATA TO BE PROVIDED BY THE TRANSMISSION LICENSEE TO SYSTEM USERS

If any User seeks clarification on the system design parameters, the Transmission Licensee shall provide such User with all necessary information.

The Transmission Licensee shall be entitled to charge the User requesting any Transmission System data any reasonable costs in providing the data and shall notify the User of such costs within a reasonable time, after receipt of a specific request.

Subject to the User paying the costs as notified within the specified time, the Transmission System data shall be furnished within a reasonable time depending on the nature and complexity of the data required.

2.9.2 RIGHT TO WITHHOLD INFORMATION

The Transmission Licensee shall be entitled to withhold any information related to the Transmission System if in its reasonable opinion the disclosure of such information would seriously and prejudicially affect its commercial interests. However, the Transmission Licensee shall not withhold the minimum data required by the User to carry out his business.

2.9.3 CONFIDENTIALITY OF DATA

All data supplied by the Transmission Licensee to any User or vice versa shall be treated as confidential and should not be divulged to a third party. The data shall be used only for the purpose for which it is furnished.

2.9.4 TRANSMISSION SYSTEM DATA

Transmission System data consists of salient features of the existing system and future system as contained in the Transmission Development Plan. Such data shall include the following:

(a) Data related to Grid Substations indicating 33 kV (in case of 220/132/33kV GSs), 11kV (in case of 132/11kV GSs) outlets as applicable.
(b) All data on the plant and equipment of the Transmission System.

2.9.5 GENERATING UNIT DATA

(a) Data related to the Generating Units as specified in Section 8 of this code ie Grid Code Information and Data Exchange (GCIDE)
(b) Data related to the Embedded Generating units as specified in the GCIDE.

2.9.6 DISTRIBUTION LICENSEE DATA

a. Distribution System Information

Distribution Licensees shall submit the single line diagram of their MV systems to the Transmission Licensee on an annual basis. In the alternative, Distribution Licensees may provide viewing and data downloading access to the Transmission Licensee from its Geographic Information System.

b. Load Forecast

Distribution Licensees shall submit the load forecast including spot load requirements by 31st March for their operational areas. Appropriate formats to be used by Distribution Licensees are given in the GCIDE.

2.9.7 TRANSMISSION CUSTOMERS

a. System Information

Transmission customers shall submit the single line diagram of their MV systems to the Transmission Licensee and update the same no sooner any changes are effected.

b. Load Forecast

Transmission customers shall submit the load forecast as requested by the Transmission Licensee by 30th November of each year. Appropriate formats to be used by Transmission Customers are given in the GCIDE.

2.9.8 GRID SUBSTATION-WISE LOAD FORECAST

The grid substation-wise load forecast shall be prepared for each year within the planning period. For each GS, the forecast shall provide the maximum demand, the demand coincident with the maximum demand of the Transmission Licensee's network and the minimum demand during off-peak hours. These forecasts shall be compatible with data submitted by the Distribution Licensees, Transmission Customers and the Transmission Licensee's System Control Centre.

2.9.9 GENERATION DISPATCHES

Maximum of two generation dispatch scenarios (i.e. maximum hydro generation and maximum thermal generation) shall be prepared.

System studies shall be carried out to ensure that the Transmission System has the capability to be operated without violating the prescribed Planning and Operating Standards under the maximum hydro generation and maximum thermal generation scenarios.

2.10 SYSTEM MODELLING

System modelling shall be conducted for each year of the plan period to assess the required and probable year of commissioning of a particular line or other equipment to fulfil the demand at the required level of quality and reliability, as specified in the Planning and Operating Standards Code.

2.11 SYSTEM STUDIES

The evolution of the Transmission System shall be based on detailed power system studies which shall include,

(i) Load flow studies
(ii) Contingency studies
(iii) Short circuit studies
(iv) Transient stability studies
(v) Steady state stability studies
(vi) Voltage stability studies
(vii) Protection system studies
(viii) Power quality studies

2.11.1 COMPUTER PROGRAMS

Studies shall be carried out by suitable computer aided programs, at the discretion of the Transmission Licensee. Efforts shall be made by the Licensee to maintain up to date, industry standard models for the simulation of the transmission system.

2.11.2 PLANNING CRITERIA

(a) The System shall be planned to maintain voltage and thermal loading criteria for a single contingency of the loss of one element i.e. one generator, one transformer or one transmission circuit. Prior to the contingency, all elements shall be considered to be in service.

(b) Optimum reactive power compensation in the Transmission System shall be determined by studies carried out to identify the location and amount of shunt compensation at GSs required for improvement of voltage profiles under peak load conditions.
(c) The voltage profile shall be planned under normal operating conditions, in accordance with the standards specified in Grid Planning and Operating Standards (Section 7).

2.11.3 SECURITY CRITERIA

After the outage of any one element (i.e. any one circuit of a transmission line or a transformer), the system should be able meet the demand while maintaining the bus bar voltage levels as stated in Grid Planning and Operating Standards (Section 7) and loading of all the remaining elements should not exceed their emergency ratings specified.

2.11.4 THERMAL LOADING CRITERIA

All individual circuit elements of the Transmission System have at least two thermal ratings in terms of load carrying capacities. These are

- Normal Cyclic Capacity (NCC),
- Short Term Emergency Rating (STER)

NCC becomes applicable under normal operating conditions, whereas STER is used under contingency situations. (Refer IEC 60853, 60826, 60949).

In addition to the above, network components too, have short time ratings (STR) with respect to the maximum fault currents, which defines the maximum amount and the duration fault current that the circuit elements are able to carry safely.

a. Normal Operating Conditions

The Transmission Licensee shall develop NCC for all equipment used in the supply of load, sufficient to avoid the following:

(i) excessive sag of transmission line conductors, leading to unacceptable clearance to ground.
(ii) overheating of transmission line conductors, leading to excessive damage owing to annealing, or insulation damage on underground cables.
(iii) overheating of power transformers and other substation equipment, leading to equipment damage.

b. Contingency Situations

The Transmission Licensee shall develop STER for all equipment used in the supply of load, sufficient to avoid the following:

(i) excessive sag of transmission line conductors, leading to unacceptable clearance over a defined period of overloading after the contingency.
(ii) overheating of transmission line conductors, leading to accumulated damage during the overload period which significantly shortens the life of the conductors.
(iii) overheating of power transformers and other substation equipment, leading to accumulated damage during the overload period which shortens the life of the equipment.

2.11.5 LOAD FLOW STUDIES AND CONTINGENCY STUDIES

Load flow studies on the Transmission System shall be carried out for every year for a planning window of 10 years. Reporting on the above analysis shall include the following:

(i) Analysis of the existing system under forecast maximum and minimum load conditions, and a review of the same for the past year.

(ii) Demand forecast, disaggregated to each Distribution Licensee and Transmission Customer delivery points and/or grid substations.

(iii) Analysis of performance of the existing system under the forecast demand to meet the voltage standards, thermal load standards, security standards.

(iv) Future development proposals for expansion, reinforcement and augmentation of the Transmission System which shall include, but not limited to, the following:

- Proposed new grid substations and substation augmentations
- Proposed transmission line/cable additions and reinforcements
- Network expansion and reconfigurations
- Reactive power compensation
- Any other improvements

(v) A comprehensive list of proposed large and small capital expenditure to be incurred in each year, and the specific impacts expected by each investment.

- Small capital expenditure shall be defined as expenditure, either on a line, a substation or associated transmission equipment, not exceeding LKR 500 million including all project-related expenditure, customs duty and taxes.

(vi) Unit block basis costs of transmission system components.

(vii) Costs of the proposed investments, and the annual investment requirements, with clear indications of

- investment requirements in each year
- taxes and other expenses expected
- system components

(viii) Analysis of the status of ancillary services, especially reactive power balance and spinning reserve, black start, line charging and the plan to address the related issues.

2.11.6 SHORT CIRCUIT STUDIES

Short circuit studies shall be carried out for each year in the planning window, to forecast three phase maximum and minimum fault levels and single phase fault levels, for all system nodes.

The main objective of these studies is to identify the under-rated switchgear, to carry out the necessary protection studies and to formulate action plans to remedy the situation. The Transmission Licensee shall keep the relevant system users informed of the fault level details.

Based on the above studies, the Transmission Licensee shall prepare a report explaining the effect of fault levels on system equipment and the remedial action proposed to ensure that all equipment used in the Transmission System are within the design limits.

Three phase and single phase design fault levels of the Transmission System and also of the Distribution system are given in the Table PC -1.

It is planned to limit the maximum three phase circuit currents at the 33 kV and 11 kV bus bars of any grid substation, in order to protect the elements in the downstream distribution network

Table PC-1: Allowable Maximum 3 phase Short Circuit Levels

Bus bar Voltage	Transmission or Distribution System	Maximum 3-Phase Fault Level (kA)	1-phase fault level (kA)
132 kV and above	Overhead	40.0	xx
	UG cable	40.0	xx
33 kV	Overhead	13.1	xx
	UG cable	16.0	xx
11 kV	UG cable	20.0	xx
	Overhead	xx	xx

2.11.7 TRANSIENT STABILITY STUDIES

Transient stability studies shall be carried out for single outage contingency of critical Transmission System components for forecast maximum and minimum load conditions. Based on these studies, appropriate generator controls and transmission system reinforcements necessary to maintain the transient system stability shall be identified.

2.11.8 STEADY STATE STABILITY STUDIES

Studies shall be carried out to identify the problems related to steady state stability and where necessary, shall advise the appropriate Grid Users on the safe operating practices or the installation of power system stabilizers/ improved AVRs.

2.11.9 VOLTAGE STABILITY STUDIES

Analysis on voltage stability shall be performed periodically to identify the suitable system operating measures such as maintaining an adequate voltage stability margin and spinning reactive power reserves as well as system design measures such as the use of reactive power compensation schemes, upgrading the AVRs and transformer tap changer controls.

2.11.10 LOAD SECURITY STUDIES

Security standards define the ability of the Transmission System to provide electricity to Users with a specified level of continuity and quality of supply.

Grid Planning and Operating Standards (Section 7) set out the levels of security required, classified into a range of Group Demands, connection types and the maximum interruption times permissible. The Transmission Licensee shall analyze the failures every quarter (3 months) and identify the instances where security criteria have not been met, and examine whether such situations have arisen due to deficiencies in system design.

Annually, the Transmission Licensee shall prepare a report identifying the instances where security criteria have not been met owing to its system inadequacies and actions proposed to remedy the situations along with a proposed time-bound plan to improve the security of supplies in the Transmission System.

2.12 PROTECTION SYSTEM STUDIES

The Transmission Licensees shall ensure that the protection schemes in the transmission system are capable of clearing the system faults within acceptable time durations. It is the responsibility of the Transmission Licensee to develop and upgrade protection schemes in the transmission system and include plans for such development and upgrading in the Long-term Transmission Development Plan.. Each user is required to submit data of User's System, current and forecast, required for planning the development and upgrading.

2.13 RELIABILITY STUDIES

The Transmission Licensee shall perform studies to determine the frequency and duration of interruptions in the Transmission System, as defined in the Grid Planning and Operating Standards (Section 7). Such data shall be segregated according to the outage caused owing to Transmission System faults, planned interruptions and upstream (Generation) failures, and planned shutdowns.

2.14 POWER QUALITY STUDIES

The Transmission Licensee is responsible for monitoring power quality of the Grid, and managing the system to achieve conformity with accepted industry standards for power quality.

Power quality shall be defined by the variations of voltage, current and frequency with respect to the accepted industry standards which are laid down in Grid Planning and Operating Standards (Section 7).

Power quality of the Transmission System shall be assessed by monitoring,

(a) System frequency
(b) Voltage magnitudes
(c) Harmonic frequencies
(d) Voltage imbalances
(e) Short duration and long duration voltage variations, and

(f) Phase displacement between the phases deviating from 1200 at different points in the Transmission system.

Voltage Imbalances

The degree of voltage unbalance in a three-phase system is defined as the ratio between the RMS values of the negative sequence component and the positive sequence component of the voltage.

Degree of voltage imbalance is also defined as:

$$\text{Voltage imbalance (\%)} = \frac{Maximum deviation from the average of the 3\text{-}phase voltages}{Average of\ the\ 3\text{-}phase voltages} \times 100$$

Voltage Fluctuations

Voltage fluctuations shall be defined as random or repetitive variations in the RMS voltage between 90% and 110% of the nominal voltage**.**

Harmonics

Presence of harmonics can cause damages to the equipment of the system users, and also will affect the performance of the Licensee's equipment. To minimize the likelihood of such disturbances and damages, the Transmission Licensee shall undertake studies to assess the harmonic contents, especially of Transmission customers, to ensure that maximum harmonic currents/voltages are within the standards laid down in Grid Planning and Operating Standards (Section 7).

the Transmission Licensee shall prepare a report on the quality of supply by measuring the harmonic levels at the connection point with Transmission System users and proposing actions to bring those within permitted levels.

2.15 TRANSMISSION DEVELOPMENT PLAN

The Transmission Licensee shall submit to PUCSL, a report titled "Long-term Transmission Development Plan *current year, current year +5 and current year+10*", which would consist of the following sections:

(1) Executive Summary
(2) Demand forecast
(3) Load Flow study and Contingency study Plan as specified in section 2.11.5.
(4) Short circuit study report as specified in 2.11.6.
(5) Excerpts from the Transient Stability Study Report identifying the system constraints and solutions
(6) Excerpts from the Steady State Stability Study Report identifying the system constraints and solutions
(7) Voltage Stability Study Report as specified in 2.11.9.
(8) Load security Study report as specified in 2.11.10.
(9) Reliability Study report as specified in 2.13.
(10) Report on protection performance of the Transmission system
(11) Progress and the revisions to the previous Development Plan
(12) Recommended Transmission Development Plan
(13) Single line diagram of the Transmission System indicating the existing and proposed lines, generating stations, substations and key equipment, for the current year+1, current year+5 and current year+10
(14) Map of Sri Lanka showing the existing Transmission System and the proposed System, showing lines, grid substations, and other key equipment, in the minimum, for the current year+1, current year+5 and current year+10.

SECTION 2 – GENERATION PLANNING

2.16 GENERATION EXPANSION PLAN

The Generation Expansion Plan shall address the following, but not limited to

(a) Determination of the economically optimal mix of generating units to meet the forecast demand at the specified reliability levels, for each year in the planning window.
(b) Analysis of the operations of the hydro-thermal system in each year in the planning window.
(c) Development of the most economical operating policy for reservoirs, hydropower plants, other renewable energy-based power plants and thermal plants
(d) Sensitiveness of the proposed Generation Expansion Plan to key input parameters such as fuel prices, demand forecast, discount rates, energy policy elements, desired reliability level, etc.

2.16.1 THE GENERATION PLANNING PROCESS

Generation planning process will include the following steps.

(a) Adoption of the demand forecast.
(b) Collection of information on the existing generation facilities, planned retirements and re-powering programmes, and Transmission System constraints.
(c) Establishing a consultation process with stakeholders.
(d) Study and examination of proposals/project concepts received from interested parties on the development of resources to meet the forecast demand.
(e) Selection of electricity generation technologies and prime sources of energy to be considered for inclusion in the Generation Planning exercise.
(f) Performing the generation planning exercise using the best available software modules and the preparation of a reference Plan.
(g) Policy and scenario analysis
(h) Selection of the optimal development plan
(i) Establish a consultation process with stakeholders, consider suggestions for improvements, perform necessary analysis, and formulate the final Generation Expansion Plan.

2.17 PLANNING PERIOD, FREQUENCY OF UPDATES AND DATE OF SUBMISSION

The planning period for Generation Expansion shall be twenty (20) years, commencing from the first year after the year the plan is submitted to PUCSL for review and approval. The Transmission Licensee may conduct studies covering more than twenty years, to smoothen out the "end effects", and to enable the development of robust recommendations for new generating plants, replacements, or upgrades to existing plants.

The Transmission Licensee shall update the Generation Expansion Plan at least once in two years. The plan shall be documented in the form of a report titled "Least-cost Generation Expansion Plan *start year – ending year*" (hereinafter referred to as the "the Plan"). The start-year shall be the *current year+1*, and the ending year shall be the *current year+20*.

The Plan shall be submitted for review and approval by PUCSL not later than the 30th day of April, of the year in which an update to the Plan is due. PUCSL will review the Plan for compliance with the guidelines provided herein, request for clarifications and amendments, and once so provided by the Transmission Licensee, approve the Plan. The Transmission Licensee shall publish the Plan on the Licensee's web site immediately after the Plan is approved by PUCSL.

2.18 PLAN BOUNDARIES

The Plan shall cover the boundaries of the Bulk Supply and Operations Business of the Transmission Licensee, namely:

> Off-take from Generating Plant at the high voltage terminals, and delivery to Distribution Licensees and other Transmission Customers.

Accordingly, all information about the demand forecast, existing generating plant and new generating plant shall be presented in Plans and the "Least-cost Generation Expansion Plan" as measured at the high voltage terminals. Capacity and energy required to meet the auxiliary requirements in generating plant and in step-up transformers at generating plant shall be included in the respective Power Purchase Agreements (PPAs).

2.19 DEMAND FORECAST

The Plan shall be prepared based on a demand forecast for the whole of Sri Lanka prepared by the Transmission Licensee in accordance with the forecasting guidelines provided in the Grid Code.

2.20 PLANNING CRITERIA

2.20.1 PEAKING AVAILABILITY

The unit peaking availability of hydropower plants and thermal plants shall be in accordance with the data furnished by the respective Generation Licensees, in accordance with the respective PPAs. For new power plants considered as candidates, prudent information shall be used.

2.20.2 POWER SUPPLY SECURITY STANDARDS

To ensure that the generation reserve is sufficient to meet the demand, even if one or more units are out of service for scheduled maintenance or in the event of non-availability of adequate hydropower generation capacity during the dry period, adequate reserve capacity shall be built into the system for both capacity and energy. The key criteria for generating system security shall be the following:

Criterion	Value
Loss of Load probability (LOLP)	Minimum: 0.5% Maximum: 1.5% Typical: 0.8%
Reserve Margin	Minimum: 10% Maximum: 35% Typical: 15%

2.21 ECONOMIC PARAMETERS

2.21.1 REFERENCE DATE FOR COSTS

All cost estimates shall reflect economic conditions as on 1st January of the first year of the Plan. The cost shall exclude taxes and duties.

2.21.2 COST DATABASE

Capital and operating cost estimates of existing power plants and new generating units planned for system addition shall be developed by the Transmission Licensee.

The Transmission Licensee shall ensure that the operating costs of existing power plants are updated prior to commencing studies, in accordance with the PPAs and SPPAs with all Generation Licensees. The PPAs and SPPAs should have been previously approved by PUCSL.

In the case of candidate power plants, the Transmission Licensee shall ensure that the most up to date information from feasibility studies, pre-feasibility studies and other studies will be used. The required studies shall be commissioned periodically by the Transmission Licensee, to ensure that the cost database is updated prior to commencing the studies.

2.21.3 PLANT ECONOMIC LIFE

For planning studies, the economic life of new generating plants shall be assumed as follows.

Plant Type	Economic Life (Years)
Hydroelectric	50
Steam	30
Open Cycle Gas Turbine	20
Combined Cycle Gas Turbine	30

The remaining economic life of existing generating plant or plants that are in the process of being built, will be limited to the duration of the PPA.

2.21.4 COST OF UNSERVED ENERGY/COST OF ENERGY NOT SERVED

The value of unserved energy shall be considered in the economic analysis to develop the Plan, and for each sensitivity study. For the first submission of the Plan, the value of unserved energy shall be 0.3 USD/kWh.

The Transmission Licensee shall conduct a review of the value of unserved energy at least once in four years, and update such value through economic analyses and customer surveys.

To meet the requirements of Distribution Licensees in assessing the economic value of power interruptions, studies by the Transmission Licensee shall report results for the Authorised Areas of each Distribution Licensee or for each Province of Sri Lanka.

2.21.5 REFERENCE YEAR FOR PRESENT VALUE ANALYSIS

For discounted cash flow analyses, the reference year shall be the first year of the Plan.

2.22 PLANNING MODELS

The Transmission Licensee shall select a suitable software package to model the demand and the generating system, and to generate and analyse the alternative combinations of power plants, and to conduct scenario studies.

2.23 DEVELOPMENT OF THE REFERENCE (BASE) CASE

The Plan will develop and present a reference case (ie the base case) generation expansion plan, under the following criteria:

(a) All capital costs expressed in constant currency terms, expressed in currency at the reference date, in economic terms (border prices)
(b) All fuel prices assumed to remain constant as of the reference date, and expressed in economic terms (border prices)
(c) An economic discount rate of 10% per year.
(d) All other economic parameters remaining constant over the planning period
(e) Any policy guidelines, technology options, and forced/natural operating patterns that would cause new investments or PPAs that would not contribute to the least-cost objectives, would not be considered in developing the reference (base) case
(f) All existing and candidate power plant costs shall include the cost of meeting the Sri Lanka Environmental standards, as applicable.

The reference (base) case will be the least cost plan, and this plan and a complete analysis of the plan in terms of year-by-year investment requirements, fuel requirements and costs, capacity and energy balance, shall be provided.

Investment requirements for the reference (base)case shall be provided both in economic terms and in financial terms.

2.23.1 CONSIDERATION OF NON-DISPATCHABLE POWER PLANTS

Existing non-dispatchable power plants of any description already in operation as of 1st January of the first year of the Plan, shall be included in developing the reference (base) case, if such plants operate on a PPA/SPPA approved by PUCSL. The payments for energy under such PPAs shall be externally calculated, clearly shown and included in the calculation of costs of the reference (base) case.

Candidate non-dispatchable power plants required to be included owing to policy guidelines issued by the Commission or any of the Transmission Licensee's own policies, shall not be included in the reference (base) case, unless the Transmission Licensee can demonstrate that such power purchase costs shall not violate the least-cost objective of developing the reference (base) case. If such power plants are to be included, the Transmission Licensee requires to develop a plan and a sequence of such power plant additions, and demonstrate that the reference (base) case will continue to be least cost even after the addition of such non-dispatchable power plants.

2.23.2 SENSITIVITY STUDIES

The Plan shall develop and present a number of sensitivity studies to examine the sensitivity of the reference (base) case plan to variations in key input parameters. The variations to be modelled shall include, but not be limited to variations in,

- discount rate
- load forecast
- fuel prices fluctuations

The Plan should present the inputs and results of the sensitivity studies, and compare the key variations against the reference (base) case.

2.24 POLICY ANALYSIS AND SCENARIO ANALYSIS

Prior to commencing policy and scenario analyses, the Transmission Licensee shall communicate to PUCSL, the list of such scenarios to be analysed, such that the Commission may comment on such analyses planned.

2.24.1 POLICY ANALYSIS

The Plan shall include analysis of policies required as a consequence of (i) policy guidelines issued by the Commission, or (ii) general policies and strategies required to fulfil the requirements given in the Sri Lanka Electricity Act, the License, or the National Energy Policy, or (iii) specific interventions by which the Transmission Licensee can demonstrate that the resulting plan may be of lower cost than the least-cost reference case.

Examples for policies to be analysed are (a) meeting a specified strategic fuel mix in generation by a given milestone year, (b) meeting a target ratio of non-conventional renewable energy included in the generation mix, (c) interventions to modify the load profiles by such strategies as demand-side management, and (d) interconnections with other countries.

Each policy analysis shall result in a revised generation expansion plan, evaluated using the same economic parameters as those used in developing the reference (base) case.

2.25 GENERATION EXPANSION PLAN

The Transmission Licensee shall submit to the Commission, a report titled "Least-cost Generation Expansion Plan xxxx to xxxx", which would consist of the following sections:

1. Development of the demand forecast
2. Performance of the existing generating system including a review of at least the past five years
3. Analysis of the hydroelectric generating system including a review of at least the past five years
4. Costs and characteristics of candidate power plants

5. Development of the reference case (base case expansion plan)
6. Analysis of the results
7. investment plan, energy/capacity balance, dispatches
8. Sensitivity Studies
9. Policy analysis and scenario analysis
10. The Recommended Expansion Plan

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 the

(i) Transmission Licensee at the Connection sites,
(ii) Transmission Licensee when connecting new assets including dc Converter stations to its Transmission System,
(iii) DC Converter stations seeking connection to the Grid or modification of existing connections,
(iv) Generation Licensees when seeking connection to the Grid or modifications of existing connections, and
(v) Grid Users when seeking connection to the Grid or modification of existing connections.

Establishment of such criteria will assure a safe, stable and secure Transmission System and will also ensure a transparent and non discriminatory process for connection to all prospective grid Users.

3.2 APPLICABILITY

GCC applies to the Transmission Licensee, all Generators, dc converter station owners, all distribution Licensees, all Grid users and all parties seeking connection to the Grid.

3.3 OBJECTIVES

Objectives of the GCC are to,

(a) specify the technical, design and operational criteria at the point of connection,
(b) specify the data required by the Transmission Licensee from Users,
(c) specify the data required by User from the Transmission Licensee,
(d) ensure that the basic rules for connection to the Grid 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 Grid will not cause unacceptable effects on the Grid or the Grid 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 standards given in Section 7 (Grid Planning and Operating Standards) and the customers 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 Section (Grid Operation and Planning standards) referred to above.

3.4.1 STANDARD VOLTAGE AND FREQUENCY

Standard voltages at the connection point will be 132 kV or 220 kV, whilst the frequency will be 50 Hz with R-Y-B counter-clockwise phase rotation.

3.4.2 POWER QUALITY AND SECURITY STANDARDS

3.4.2.1 FREQUENCY VARIATIONS

(a) Nominal frequency of the Sri Lanka Power System is 50 Hz and the statutory limits for variations shall be within ±1% as given in the Grid Planning and Operating Standards.

(b) Under emergency conditions, frequency may vary between a high of 52.5 Hz and a low of 47.5 Hz.

3.4.2.2 VOLTAGES VARIATIONS

(a) Standard transmission network voltages will be 132 kV and 220 kV.
(b) At the Interconnection Point, long duration voltage variations will remain as stated in Grid Planning and Operating Standards (Section 7).
(c) Short duration voltage variations shall not exceed the limits given in the Table GPC 1.
(d) Transient voltage will exceed the above limits.

Table GCC 1- Voltage Variations Allowed

Nominal Voltage	Voltage variation	Period
132 kV	Define	Define
220 kV	185 kV to 245 kV	5 Seconds

3.4.3 VOLTAGE WAVEFORM

Voltage waveform distortions are defined in terms of harmonic levels and phase unbalances, and all equipment in the system and those connected to the Grid shall be capable of withstanding the distortions specified in Section 7 (Grid Planning and Operating Standards).

All Transmission System Users shall ensure that the distortions caused due to the operation of a User's system shall not exceed the levels specified in Section 7(Grid Planning and Operating Standards).

3.4.4 VOLTAGE FLUCTUATIONS

At any connection point voltage fluctuations shall not exceed the limits specified in Section 7(Grid Planning and Operating Standards).

3.4.5 VOLTAGE UNBALANCE

Maximum negative sequence component of the Transmission System voltages shall remain below the limits specified in Section 7(Grid Planning and Operating Standards) and shall be in compliance with IEEE Standard C37.102-1995: *IEEE Guide for AC Generator Protection*

3.4.6 NEUTRAL GROUNDING

The Transmission Licensee shall ensure that the Transmission System neutral at voltages higher than 132,000 Volts be earthed with an Earth Fault Factor lower than 1.4, or that the rated frequency component of the voltage of the healthy phase shall not exceed 140% of the phase to earth voltage under single phase or two phase to earth fault conditions.

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.

3.4.7 EQUIPMENT STANDARDS

All equipment used at the Connection 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 Licensee specifications and publications shall be applicable. Prospective Users shall seek advice from the Transmission Licensee when necessary in this regard, and the 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 specification current at the time, shall become applicable.

3.4.8 MAINTENANCE STANDARDS

The Transmission Licensee and the User shall maintain all switchgear and equipment installed at the connection 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 maintenance records relating to the equipment installed by each Party, and shall make such records available whenever a request is made by the other Party.

3.5 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 Connection Point shall operate with sensitivity, dependability, discrimination and speed, as required by the Connection Agreement, thus minimizing adverse effects on the grid during periods his plant and equipment remain connected to the Grid.

Protection schemes employed in the Grid shall have appropriate backup protection schemes and breaker fail schemes. The Transmission Licensee shall provide all necessary information such as maximum/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. Taking all the above into consideration, Users shall ensure that all equipment used in its system have ratings compatible with the Licensee's design fault levels. Users and the Transmission Licensee shall agree on the protection settings during the application process for connection.

3.5.1 FAULT CLEARANCE TIMES

Fault clearance times from fault inception to the circuit breaker arc extinction shall be in accordance with the values shown in the Table GCC 2.

Table GCC 2- Maximum Allowable fault Clearance Time

Transmission system voltage	Maximum allowable fault clearance time (ms)
132kV	xx
220kV	xx

3.5.2 METERING

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

3.6 VOLTAGE LEVELS, CONNECTING POINT AND OWNERSHIP BOUNDARIES

3.6.1 VOLTAGE LEVEL

Voltage level at which the User's installation is connected to the Grid will be agreed upon between the Transmission Licensee and the User as required, based on the power to be injected or drawn out at the Connection Point.

However, if Grid System Impact Assessment studies show that connection at a certain voltage level will lead to degradation of performance of the Grid, the Transmission Licensee shall propose an appropriate voltage level for the connection.

3.6.2 CONNECTION POINT

The Connection Point shall be the User's load side terminals of the Transmission Licensee-owned metering equipment. The connection point shall be controlled by appropriate switchgear, which shall be capable of withstanding the prospective short-circuit current at the Connection Point.

3.6.3 OWNERSHIP BOUNDARIES

The ownership of plant or apparatus beyond the Connection Point will be the responsibility of the Users.

3.7 COMMUNICATION AND SCADA

3.7.1 COMMUNICATION sYSTEM FOR MONITORING, CONTROL & METERING

The communication System shall be so as to facilitate the exchange of information in the form of voice and data to satisfy the requirements specified under each Code of the Grid Code. The responsibility for establishing the complete system shall lie with the Transmission Licensee and Users as stated in each Code of this Grid Code

3.7.1 SCADA SYSTEM FOR MONITORING, CONTROL & METERING

The SCADA System shall be capable of exchanging required system information specified under each Code of the Grid Code between Transmission licensee and Users. The responsibility of establishing the complete system shall lie with the Transmission licensee. The Users shall be responsible to provide compatible interface with the system for exchanging required system information as stated in each Code of this Grid Code.

3.8 SAFETY

All Users and the Transmission Licensee shall follow the procedures laid down in the Grid Operations Code on Safety issues.

3.9 SPECIAL REQUIREMENTS FOR GENERATORS

All Generating Units other than the embedded generators shall be centrally dispatched and shall fulfil the following conditions:

3.9.1 FREQUENCY VARIATIONS

(a) Generating Units shall be capable of continuously supplying the declared outputs within the frequency range of 49.5 Hz to 50.5Hz.
(b) Under emergency conditions, the Grid frequency may vary between a high of 52.5 Hz or a low of 47.5Hz and the Generating Units shall be required to operate continuously and remain in synchronism during such situations.
(c) Generating Units shall be protected against frequency excursions outside the range specified in 3.9.1 (b).

3.9.2 POWER FACTOR VARIATIONS

Generating Units shall be capable of continuously delivering the declared outputs at any point between the power factors of 0.85 lagging and 0.95 leading, in accordance with its reactive power capability curve, unless otherwise agreed in the Connection Agreement.

3.9.3 VOLTAGE VARIATIONS

Generating Units shall be capable of delivering the declared active and reactive power outputs within the voltage variations specified in 3.4.2.2, provided the system stability is maintained.

3.9.4 UNBALANCED LOADING

(a) Generating Units shall be capable of withstanding unbalanced loading in accordance with IEEE Standard C37.102-1995: *IEEE Guide for AC Generator Protection*

(b) In addition, under unbalanced fault conditions in the Grid or in a User system, the Generating Unit shall be capable of withstanding the resulting negative sequence loading and also remain connected to the Grid, until appropriate protection scheme clears the fault.

3.9.5 LOAD FOLLOWING CAPABILITY

All Generating Units other than dedicated base load Generating Units shall have the load following capability.

3.9.6 EXCITATION SYSTEM

Generating units shall be equipped with a continuously-acting automatic excitation control system to control the terminal voltage within 5% of the voltage specified in 3.4.2.2, with facilities for disabling constant Reactive Power Control or constant Power Factor Control.

3.9.7 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 3% to 5%.
(c) Governor dead band shall be within the range of ±0.05Hz
(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 frequency range specified in 3.4.2.1 a.

3.9.8 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 voltages (Volt) and at the generating unit terminal and on the high voltage side of the generator transformer

3.9.9 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

3.9.10 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. All relay setting calculations and the proposed settings shall be submitted to Transmission Licensee for approval. Transmission Licensee shall ensure that the relay settings so approved will not be detrimental to the Transmission system stability or endanger the generating units. Approved Generating Unit protection relay settings shall not be changed without prior written permission from the Transmission Licensee. They also shall be provided with back-up protection for Trasnmssion System Protection as specified in relevant IEEE Standards.

3.9.11 SYNCHRONIZING

Synchronizing 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.

3.9.12 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.

3.9.13 LINE CHARGING CAPABILITY

Transmission Licensee shall decide on the Generators where line charging capability is required.

3.10 SPECIAL REQUIREMENTS FOR DISTRIBUTION LICENSEES AND TRANSMISSION CUSTOMERS

3.10.1 UNDER FREQUENCY LOAD SHEDDING

Transmission Licensee shall provide Under Frequency Relays for automatic load shedding at the Connection Point with a Transmission Customer and where necessary at Connection Points with the Distribution Licensees.

3.11 SPECIAL REQUIREMENTS FOR WIND TURBINE DRIVEN GENERATORS

3.11.1 FREQUENCY VARIATIONS

(a) Generating Units shall be capable of continuously supplying the declared outputs within the frequency range of 49.5 Hz to 50.5Hz.
(b) Under exceptional circumstances, the Grid frequency may vary between a high of 52.5 Hz or a low of 47.5Hz and the Generating Units shall be required to operate continuously and remain in synchronism during such situations delivering the declared time based outputs.

3.11.2 VOLTAGE VARIATIONS

(a) Generating Unit shall operate and deliver the declared output within a voltage range of ±10% of the nominal voltage at the Connection point.
(b) Generating Unit outputs shall be in accordance with the declared time based out puts for voltages outside the range defined in 3.11.2a.

3.11.3 VOLTAGE WAVEFORM

Generating Unit shall comply with the Section 7 Planning and Operating Standards (Reference IEC61400-21)

3.11.4 LOW VOLTAGE RIDE THROUGH LVRT AND UNBALANCED LOADING

(a) Generating Unit shall have LVRT capabilities as declared. LVRT shall require a certain degree of unbalanced loading, which the Generating Unit shall be capable of delivering.

(b) In addition, under unbalanced fault conditions in the Grid or in a User system, the Generating Unit 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.

3.11.5 OTHER REQUIREMENTS

Capabilities in respect of Active power regulation, Frequency Control and Reactive power control shall be as declared.

3.11.6 SPECIAL REQUIREMENTS FOR EMBEDDED GENERATORS IN DISTRIBUTION SYSTEMS

The interconnection requirements for embedded generator units are given in Appendix II. The interconnection requirements for embedded generator units less than 10 MW are given in the relevant sections of the Distribution Code.

3.12 PROCEDURES FOR APPLICATION FOR GRID CONNECTION

3.12.1 APPLICATION PROCEDURE FOR NEW OR MODIFICATION OF A GENERATING FACILITY

Any User seeking a new connection or modification of the 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 for Generators, dc converters and Transmission Customers, at various stages of the Grid Connection process are given in Section 8 Grid Code Information and Data Exchange.

3.12.2 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 program shall be published in the Licensee website.

Broadly, the program 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

3.12.3 PRELIMINARY EVALUATION OF THE APPLICATION

The Transmission Licensee shall start processing the applications within 14 days from the submission of the duly completed application form and request the applicant to submit any relevant information he has not forwarded. If the Licensee does not communicate with the Applicant within 30 days from the submission of the application, the applicant can presume that the application has been accepted for processing.

3.12.4 GRID IMPACT ASSESSMENT STUDIES (GIAS)

Upon completing the preliminary evaluation as required by 3.12.3, Transmission Licensee shall conduct Grid Impact Assessment Studies for all new applications/modifications. This study will mainly focus on the following:

(a) Grid performance with the new connection
(b) Protection system coordination
(c) Suitability of the voltage level
(d) Fault level implications
(e) Power quality

If the GIAS shows that any proposed connection/modification will result in the degradation of the Grid, then the Licensee shall inform the applicant accordingly, citing the reasons for rejection, and where possible proposing suitable alternative measures to eliminate or to mitigate the adverse effects to acceptable levels. The Licensee shall make all possible efforts to reach agreement on the proposed development and if such an agreement can not be reached, the application shall be rejected.

Also, the Transmission Licensee may reject the application, if the acceptance of the application will lead the Transmission Licensee to be in breach of the SLEA, License conditions, regulations or rules enacted under SLEA or any other rule relating to safe and secure operation of the Grid. In

the event of such a rejection, the Transmission Licensee shall give the reasons for rejection quoting relevant statute or statutes.

The Applicant has the right to appeal to PUCSL for redress, against the decisions of the Transmission Licensee.

3.12.5 SUBMISSION OF THE OFFER

If the Transmission Licensee is satisfied that the application for the new connection/modification is in compliance with the requirements stated above, Applicant shall be informed of the acceptance of the proposed development along with the following:

(a) Indicative connection costs, in accordance with the "Allowed Charges" approved by PUCSL,
(b) Detailed studies the Transmission Licensee intends carrying out and the costs for the same.
(c) Proposed Agreement for further processing of the Application which shall include the following statements.

(i) The Applicant shall provide all data in accordance with the GCIDE and also any other relevant information requested by the Transmission Licensee.
(ii) The Transmission Licensee shall provide all necessary information to the Applicant in accordance with the statutory obligations and as required by this Code.
(iii) The Transmission Licensee and the Applicant will agree on the operational boundary.
(iv) The Applicant and the Transmission Licensee shall comply with the provisions of the Grid Code by letter and spirit.
(v) The Applicant will make the requisite payment within 30 days from signing of the Agreement.

In the event that Licensee and the Applicant cannot agree on any of the items referred to in (a) or (b), the Applicant has the right to bring the matter for the attention of the PUCSL

3.12.6 APPLICANT'S ACCEPTANCE OF THE OFFER

The Applicant shall accept the offer by entering into an agreement as described in 3.12.5 and making the payment within the stipulated period which shall not be less than thirty days from the date of the offer.

If the above conditions are not fulfilled, it shall be considered as that the Applicant has no further interest in pursuing with the development, and the Transmission Licensee shall not take any further action in processing the Application.

3.12.7 DETAILED EVALUATION OF THE APPLICATION

Upon the Applicant fulfilling the conditions in 3.12.6, Transmission Licensee shall carry out all studies necessary, and the results of the studies may include the following:

(a) The preferred locations and alternate locations where the facilities under the proposed development may be connected to the Grid.
(b) Any modifications and/or additions needed to the Grid (including earthing systems) to accommodate the proposed development.
(c) The major connection equipment that should be furnished under the scope of the proposed development,
(d) Revenue metering and telemetry
(e) Communication requirements, Operational control facilities and maintenance requirements,
(f) Approximate schedule and lead times for the Transmission Licensee to perform its design, material procurement, construction and connection.
(g) An estimate of costs for additions and modifications to the Grid,
(h) Preliminary Project Requirements Diagram that illustrates the above items.

3.12.8 CONNECTION AGREEMENT

Upon the Applicant and the Transmission Licensee agreeing on all aspects related to the connection of the proposed development to the Grid, the two parties shall enter into a "Connection Agreement", which shall include the following:

(a) Applicant and the Transmission Licensee shall comply with the provisions of the Grid Code by letter and spirit.
(b) Certificates issued by an Accredited Chartered Electrical Engineer/s that the design and the installation comply with the requirements of the applicable regulations, standards, codes etc. and the installation is safe and ready for connection.
(c) The Applicant shall submit all reports containing technical and financial information as specified in this Code including the certificates/documents in accordance with the statutory and regulatory obligations.
(d) The Connection Agreement shall also state the obligation of the Applicant to submit the relevant "as constructed" details to the Transmission Licensee prior to Commissioning.
(e) In the event that the information submitted under (d) is different to what has been submitted previously and if the Transmission Licensee is of the view that fresh studies have to be done, then the Applicant shall agree to bear the cost of such studies.
(f) Testing and commissioning program for the connection
(g) List of names and telephone numbers of the Applicant's authorized representatives.
(h) Safety Manual for the Applicant's facility, and the proposed safety schemes for the operation of the Connection Point equipment
(i) Proposed maintenance program for the Connection Point equipment belonging to the Applicant.

3.12.9 COMMISSIONING AND CONNECTION

Upon entering into the Connection Agreement and fulfilling its conditions to the satisfaction of the Transmission Licensee, commissioning tests shall be carried out. On the successful completion of the commissioning tests, Licensee shall issue a Technical Completion Certificate (TCS) for the connection.

If the Transmission Licensee finds the commissioning tests are not successful, it may refuse to issue a TCS or issue a conditional TCS specifying the new tests or changes to be carried out.
Physical connection to the Grid shall be effected, within ten days from the issue of the TCS.

3.12.10 CONNECTION POINT INFORMATION

In addition to the records that are kept, as detailed in Section 2 (Grid Planning Code) both the Transmission Licensee and the User shall compile a Connection Point Document (CPD).

It shall include the following.

(a) Single line diagram of the connection point
(b) Equipment and their ownership at the connection point
(c) Ratings of the equipment used at the connection point
(d) Authorized officers for operation and safety
(e) Operational procedures and the parties responsible for operation
(f) Names of Officers who prepared the CPD, the dates and their signatures

Whenever changes are effected at the connection point, appropriate entries shall be made in the CPD, with the names, signatures of the officers who have done such changes and the dates on which such changes have been introduced.

The above information shall also be stored in the Licensee GIS.

4. GRID OPERATIONS CODE

4.1 INTRODUCTION

The Grid Operations Code (GOC) of the Grid Code specifies criteria, guidelines, procedures and requirements to be followed by the Transmission Licensee and all Users for coordinated operation of the Transmission System.

4.2 APPLICABILITY

GOC applies to the Transmission Licensee, Distribution Licensees, Transmission Customers, Generators including embedded generators, all grid Users and all parties who are authorized to carry out generation, distribution/supply activities and are connected to the Grid.

4.3 OBJECTIVES

Objectives of the GOC are to ensure,

(a) safe and efficient operation of the Transmission System under both normal and abnormal situations in accordance with the statutory requirements and standards specified in this Code,
(b) that the Transmission System is operated satisfying the minimum security standards specified, maintaining system stability,
(c) that the performance of the Transmission Licensee assets meet the needs of the users,
(d) that the operation of User's plant and equipment will have no adverse effect on the Transmission System, and
(e) that the Transmission Licensee and Users have an unambiguous understanding of each others' roles and responsibilities in relation to the operation of the Transmission System.

4.4 RESPONSIBILITIES

4.4.1 TRANSMISSION LICENSEE

The Transmission Licensee shall be responsible for the following:

(i) Specifying the data to be supplied by the system Users for the preparation of the Demand Forecast for operational planning.
(ii) Preparing the demand forecast on active and reactive power requirements of the Transmission System within the specified timescales.
(iii) Operating the Transmission System at optimum economic efficiency and in accordance with the standards specified in this Code and the statutory requirements.
(iv) Coordination of planned outages and unscheduled outages to maintain the reliability and security of the Transmission System in accordance with the standards specified.
(v) Reporting on operations and events.
(vi) Investigating and preparing reports on significant incidents.
(vii) Preparing and implementing an asset management program to ensure that all plant and equipment installed in the Transmission System are maintained in good working order providing a safe and secure environment for the workforce, Users and the public, and also to ensure that the plant and equipment will remain functional throughout the declared lifetime with no value degradation
(viii) Designing, installing, commissioning and maintaining the protection system ensuring discriminative fault clearance and safety of plant and equipment at all times.
(ix) Investigating all partial or total Shutdowns and implementing work programs to avoid recurrence of the same.
(x) Preparing a Safety Manual and coordinating, establishing, and maintaining of Safety Precautions in accordance with the same, to allow work or Testing to be done on the Transmission System and also across the Connection Point boundaries.

4.4.2 USERS

Users shall be responsible for the following.

(i) Provide all required data by the Transmission Licensee as specified in this Code.
(ii) Ensure that plant and equipment at the User's facility meet the requirements of the standards specified in this Code.
(iii) Operate User's system and equipment at the Connection point in accordance with the agreed procedures to ensure that they will not cause any adverse impact to the stability, security and reliability of the Grid.
(iv) Take timely action to remedy situations that may arise in the user's plant and equipment which affect Licensee System adversely.
(v) Cooperate with the Transmission Licensee to mitigate/overcome abnormal operating situations of the Transmission System by carrying out Transmission Licensee's instructions with regard to operation of User's plant and equipment

4.5 OPERATIONS PLANNING

4.5.1 GENERAL CONSIDERATIONS

The System Operator has the responsibility of system operations planning, including planning of reservoir operations[1], forecast of energy balance and identification of generation resources expected to be available to supply the forecast demand with adequate reserve, considering system constraints and meeting the required performance standards.

The optimization function shall be to minimize overall generation and transmission costs while complying with the required performance standards and security of supply for the different planning periods.

The plans should be based on the long term load forecast produced by the Single Buyer[2], short term load forecasts produced by the System Operator, expected transmission constraints informed by the Transmission Licensee, and generation availability and reserve informed by the Generators.

These plans will be indicative and have the purpose of providing each Licensee and PUCSL, with adequate information to evaluate the expected demand and supply balance, and the impact of system constraints and unavailability.

The plans will represent, with the available data and the best knowledge of the System Operator, indicative expected results of system operations including, among others:

(a) Load forecasts
(b) Generation and availability
(c) Reservoir levels and water availability for power generation (in conjunction with the Water Management Secretariat)
(d) Transmission constraints
(e) Must run generation
(f) Risk of shortages or surpluses, including the risk of spilling.

The System Operator will not be responsible for any deviation between these projections, the actual generation and energy balance, since actual conditions may differ from the projections owing to uncertainties in hydrological conditions, load forecasts and forced outages.

4.5.2 PLANNING HORIZONS

The System Operator will produce plans of expected system operation for the following horizons:

[1] Subject to decisions by the Water Management Secretariat

[2] Load forecast responsibility should be a matter of another regulation establishing roles and responsibilities of different licensees in the elaboration and provision of information for building up nation-wide demand forecasts for each planning horizon under the Single Buyer's and System Operator's purview.

- **Year Ahead**: The purpose of the Year Ahead Plan is to define the optimal allocation of hydro resources along the year to minimize the total generation and transmission costs, to coordinate the maintenance plans for generation and transmission to minimize the risks of non-supply and to forecast the generation costs to be transferred to the end user tariffs.

  This plan will be prepared once in six months for the year ahead[3], at least two months before the commencement of the planning period[4]. When a Tariff Filing is due (such as in June 2011 for the period 2012-2015), this plan will be prepared by the Filing Date as informed by PUCSL, and updated on the scheduled date, two months ahead of the planning period.

- **Month Ahead:** The purpose of each Month Ahead Plan is to revise and eventually re-define the reservoir operations based on actual conditions that prevailed until the end of the previous month, and co-ordinate with other water users about the generation requirements.

- **Week Ahead**: The purpose of the Week Ahead Plan is to coordinate maintenance outages, plan hydropower generation and assist Licensees to anticipate possible conditions and constraints in order to make efficient decisions on matters that affect system operations, fuel requirements and other system conditions during the following week.

The System Operator will define the data required to prepare these plans, and the Licensees and Users will be obliged to supply it. The System Operator should draft procedures indicating the data that each Licensees will provide, and the associated time-schedules and formats.

4.5.3 WATER MANAGEMENT AND RESERVOIR PLANNING

The System Operator shall be responsible for coordinating with the Water Management Secretariat the use of the water to be made available for being administered by the power sector for hydropower generation.

This coordination shall be made consistently with the planning horizons, and the results of each coordination meeting, will be inputs for the operation planning associated to each one of them.

Based on the coordination results, the System Operator shall centrally administer a planning process for optimizing the use of the water made available for being administered by the power sector for hydropower generation, including how to use the reservoirs with a storage capacity that allow yearly, seasonal or monthly regulation of outflows. Generators with hydropower generation, have the right to participate in this reservoir planning process.

In cases where special measures are required owing to specific features of certain hydraulic systems, the System Operator may delegate to the involved Generators the coordination with the relevant water authorities and any other water users, of the management of constraints on reservoir inflows or outflows.

The System Operator will determine the reservoir operation using the proper dispatch models as described in the Code for each planning horizon.

With the available data, trends and forecasts, the System Operator will develop scenarios for hydrology, thermal availability, load forecast and all other matters that may affect the relationship between consumption and the cost of supply, in order to determine the optimal use of reservoirs and hydropower generation associated.

4.5.4 YEAR AHEAD PLAN

The System Operator shall develop the Year Ahead Plan using a medium and long term operation planning optimization model to define the economic allocation of hydropower resources made available for power generation and conduct a hydro thermal optimal dispatch, subject to the performance criteria as established in the Grid Code.

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[3] Such as Jul-Dec 2011, Jan-Jun 2012.

[4] eg: Jul-Dec 2011 plan to be provided by end May 2011.

(a) Required Information

Before the end of each year, the System Operator will request the following Licensees the indicated information

Single Buyer	**Demand:** Year-ahead load forecast, total and discriminated by delivery points to each Distribution Licensee and Transmission Customer, including monthly energy demand, peak capacity and typical load curves
	Generation: Generator's Contract Prices
	Embedded generation: Load forecast shall be net of this generation. However for the sake of improving optimization of system costs, Distribution Licensees should be required to provide the Single Buyer with discriminated information about each embedded power plant located in their authorized areas, for the Single Buyer to inform it to the System Operator.
Generators	Annual Maintenance Plan and other foreseen restrictions Fuel availability and fuel prices (if so considered in the PPA)
Transmission Licensee	Annual Maintenance Plan, transmission restrictions, Ancillary Service requirements, new transmission capacity to be commissioned during the year, decommissioning, etc.
Hydropower Stations	reservoir security constraints and restrictions due to other water users or environmental reasons reservoir operation and dispatch restrictions due to downstream obligations; rainfall forecasts if any (specially in the case of small hydropower stations); upstream and downstream water restrictions due to other users or environmental restrictions.

Note: Year means the 12-month period covered in each Year-ahead plan.

(b) Results

The System Operator shall compile the expected energy balance and system operation for the 12 months of the Year Ahead Plan, which shall include, at the minimum, the following results for each month:

(i) Load forecasts.
(ii) Expected energy balance.
(iii) Indicative generation plan and fuel requirements.
(iv) Indicative maintenance plans for generation and transmission assets.
(v) Expected reservoir operations.
(vi) Expected shortages (or risk of shortages) with an estimation of the energy not served.
(vii) Expected risks of spilling of water and renewable energy resources.

The System Operator shall be responsible for the coordination of the generation and transmission system maintenance. The System Operator must analyze the Generators and the Transmission Licensee maintenance requests, and evaluate their effects on the planned operation, mainly operating costs and the risk of failure. With the aim of optimizing the operation and minimizing the risk of supply restrictions, the System Operator shall define the maintenance schedule, coordinating with the Licensee(s) the changes necessary to their respective maintenance requests.

(c) Year Ahead Operation Planning Optimization Model

The Year Ahead Operation Planning Optimization Model shall be a security constrained economic dispatch model in which the objective function shall be to optimize the total generation and transmission costs, while considering the security and performance standard constraints established in this Grid Code.

The model must be approved by PUCSL and its characteristics be known to all Licensees. The System Operator cannot make changes to the model without prior authorization from PUCSL.

The System Operator shall model the transmission system and its restrictions on the basis of existing equipment and the data supplied and reported by the Transmission Licensee, in terms of expansions under construction with informed scheduled date of commissioning, and the additions foreseen in the Long-term Transmission Development Plan.

The model shall meet the following minimum requirements.

(i) Allow adequate modeling of demand and its random variations, in terms of both energy and load curve shapes.
(ii) Allow adequate representation of the transmission network and the restrictions that may significantly affect the operation and generation demand balance for the period under study.
(iii) Allow adequate modeling capacity for:
    - hydropower generation and its characteristics and constraints
    - thermal generation of different technologies, burning different type of fuels
    - non-conventional renewable energy-based generation
(iv) Allow adequate modeling of the restrictions resulting from the minimum performance standard criteria, including must run generation, and meet the requirements for ancillary services on the network.

The model, as well as its manuals shall be available for review by all Generation and Distribution Licensees, and Transmission Customers. In case there is any software license costs, the same shall be borne by the relevant Generation or Distribution Licensee, or the Transmission Customer.

(d) Timing and Publication

No later than 30th day of April and 31st October each year, or any other date specifically stated by PUCSL in years when Tariff Filings are scheduled, the System Operator shall prepare the provisional version of the Year Ahead Plan. This version shall be sent to PUCSL for approval.

The Year Ahead Plan shall be accompanied by the input information provided by the Water Management Secretariat and the Licensees. In case the System Operator has used different information or assumptions, this decision needs to be justified and reflected in the Plan.

PUCSL may request clarifications within 15 days of submission of the Year Ahead Plan, or request the System Operator to introduce changes or amendments.

In the event PUCSL requests clarifications, changes or amendments, the System Operator shall respond to them within a maximum period of seven (7) days.

Once PUCSL approves the Year Ahead Plan, the System Operator shall post the Plan on its website for public access[5].

4.5.5 MONTHLY UPDATED PLAN

The System Operator shall issue a monthly update of the remaining months of the Year Ahead Plan for the current year, aimed at adjusting the economic positioning of hydro resources made available for power generation and to obtain an updated hydro thermal optimal dispatch plan subject to the performance criteria established in the Grid Code.

The Monthly Updated Plan shall be developed using the same Year Ahead Operation Planning Optimization Model.

(a) Required Information

Before the end of each month, the System Operator shall require the Licensees to update the information supplied for the Year Ahead Plan.

Based on this information, the System Operator shall analyze and update the expected energy balance and system operations plan for the rest of the year, and prepare an update of the Year Ahead Plan.

[5] Posting for public information shall be only after the initial preparations are completed, according to the Roadmap for Implementation.

The System Operator shall prepare the Monthly Update Plan based on the same criteria used to prepare the Year Ahead Plan, but using more accurate information regarding water flows, generator outages, fuel prices and load forecasts.

The report with the Monthly Update Plan shall also include a summary of the results and conditions in the previous month and during the current year, including an analysis of the deviations that occurred from the Year Ahead Plan, as well as their causes.

(b) Timing and Publication

No later than 15 days before the end of the month, the System Operator shall submit to PUCSL, the updated Year Ahead Plan for the remaining months until the completion of the current year.

The updated Year Ahead Plan shall be accompanied by the input information provided by the Water Management Secretariat and the Licensees. In case the System Operator has used different information, this decision needs to be justified and reflected in the Plan.

By the same date, the System Operator shall post the updated Plan in its website for public access[6].

4.5.6 WEEK AHEAD PLANS

The System Operator shall prepare the Week Ahead Plan using a medium term operations planning optimization model to define the economic location of hydro resources available for the week within each day of it, considering

(i) the maintenance requests for the week consistent with the approved annual maintenance plan, and
(ii) the balance between the available energy resources and the demand for the week,

with the aim of minimizing the non-supply risk and satisfying the performance standards established by the Grid Code.

The Week Ahead Plan is aimed at determining the production for each hydro plant unit in the week and type of day, based on expected demand, transmission restrictions, performance standard requirements, the operating restrictions, forecasts and constraints in rivers and reservoirs.

(a) Required Information

Before the end of each week, the System Operator will require the Licensees to update the information supplied for the Month Ahead Plan.

Additionally each Generator shall submit to the System Operator:

(i) Requests for modifications to the maintenance outage plan, if any
(ii) Fuel availability and any related constraints
(iii) Updated information on generator availability

For the preparation of the Week Ahead Plan, the System Operator shall take into consideration:

(i) The results and data of the Monthly Update Plan;
(ii) Updated load forecasts
(iii) Generator availability
(iv) Upstream and downstream hydro restrictions, if the generator is aware of any transmission and operational constraints
(v) Security and quality of service standards

[6] Posting for public information shall be only after the initial preparations are completed, according to the Roadmap for Implementation

(b) Results

Based on this information and using a hydro optimization and dispatch model, the System Operator shall prepare a Week Ahead Plan which should minimize the total operation cost of the week to supply the forecast load.

The Week Ahead Plan shall contain, at least:

(i) best estimation on load forecast (with probable hourly load profiles)
(ii) expected energy balance
(iii) maintenance outages planned for the week
(iv) Indicative weekly and daily generation of each power plant
(v) expected reservoir levels and risk of spilling (if any)
(vi) identification of expected conditions with shortages or inadequate reserve margins

(c) Medium Term Operation Planning Optimization Model

The Medium Term Operation Planning Optimization Model shall be a security constrained economic dispatch model and shall perform sequential optimization of hydro resources with the objective function to minimize the production cost subject to the performance standards criteria as established in the Grid Code, and must meet the following minimal requirements:

(i) allow to represent hourly load curves.
(ii) allow a detailed representation of the transmission network and its restrictions.
(iii) allow detailed modeling of the hydroelectric resource availability and its restrictions, and of the thermal resources, conventional and non-conventional (renewable) availability, and its restrictions.
(iv) allow detailed modeling of restrictions imposed by safety and quality of service standards, including must-run generation or forced machines, and requirements arising from frequency regulation and voltage control

The Week Ahead Economic Dispatch Model must be approved by PUCSL and its characteristics be provided for the information of all the Licensees. The System Operator shall not introduce modifications to the model without the prior authorization of PUCSL.

The model, as well as its manuals will be available for review and study the Generation and Distribution Licensees and Transmission Customers. In case there is any software license costs, the same shall be borne by the Party requesting such review.

(d) Week Ahead Notification and Publication

At 15 hrs of the last working day of a week, the System Operator shall notify the Licensees the results of the Week Ahead Plan.

The Week Ahead Plan shall be accompanied by the input information provided by the Water Management Secretariat and the Licensees. In case the System Operator has used different information or assumptions, this decision need to be justified and reflected in the Plan.

By the same date, the System Operator shall post the updated Week Ahead Plan in its website for public access[7].

4.6 TRANSMISSION ASSET MANAGEMENT

The following shall be the components under transmission asset management.

(a) Preventive maintenance programme

[7] Posting for public information shall be only after the initial preparations are completed, according to the Roadmap for Implementation. Please see the Appendix to the Generation Dispatch Code.

Systematic inspection of the Transmission System assets, on a quarterly basis or more frequently, to identify incipient failures, record equipment condition, and determine need for partial or complete refurbishment of equipment.

(b) Predictive maintenance programme

Corrective action as a result of inspection, condition monitoring and remedial measures identified.

(c) Corrective maintenance programme

Unplanned maintenance that needs immediate attention

(d) Network refurbishment programme

Implementing suitable measures to extend the life of existing assets or upgrading them, thereby deferring or eliminating the need for major capital expenditure for new transmission assets.

4.6.1 PLANT AND EQUIPMENT DATABASE

The Transmission Licensee shall establish a Plant and Equipment database, which will consist of the details of all plant and equipment installed in the Transmission System. All the apparatus starting from a pole/tower will have a unique identification address. Each line of a double circuit line also will have unique identification codes and such codes shall be marked on the respective apparatus/pole/tower.

4.7 MAINTENANCE PLANNING

The maintenance personnel shall prepare the following maintenance plans.

(a) Three year Maintenance Plan
(b) Annual Maintenance Plan
(c) Monthly Maintenance plan
(d) Weekly operations/outage plan

The Three year maintenance plan shall be a rolling plan prepared for the three succeeding years. The date of submission shall be 1st March each year.

The annual maintenance plan shall be developed based on the schedule of the first year of the three year plan. These shall be submitted to PUCSL and the relevant parties by 1st of March each year.

In accordance with the Distribution Code, the Distribution Licensees shall submit to PUCSL, their three year plan by 30th November each year.

The Monthly maintenance plan shall be based on the annual maintenance plan, follow up maintenance plan and the remedial maintenance plan (see their definitions later in this code), and shall identify all maintenance tasks to be undertaken in each week of a calendar month and shall be prepared at least two months ahead. This plan shall be submitted to the Distribution Licensees and finalized.

4.8 PREVENTIVE MAINTENANCE PROGRAMME

The Transmission Licensee shall prepare and implement a maintenance program to ensure that all plant and equipment installed in the Transmission System are maintained in good working order to meet the needs of the users.

Following shall be taken into consideration when preparing the maintenance program which shall

(a) Maintenance tasks in respect of each item in the database
(b) Maintenance frequency
(c) Work standards
(d) Check lists
(e) Collection of system data
(f) Reporting procedures

Maintenance program shall be implemented, monitored and progress reported through a reporting scheme where the information shall flow from the lowest level to the highest level of the Transmission Licensee management. A GIS coupled to a customized asset management system shall be used for this purpose.

4.8.1 MAINTENANCE TASKS

Maintenance tasks to be performed in respect of each item shall be identified.

4.8.2 MAINTENANCE FREQUENCY

Frequency at which a maintenance task has to be carried out shall be determined considering the task, the apparatus concerned, and the location.

4.8.3 WORK STANDARDS

Man hours required to complete a unit of each maintenance task is extremely important and Transmission Licensee shall work out such works standards.

4.8.4 CHECK LISTS AND REPORTING FORMATS

To ensure that all maintenance tasks are properly carried out, workmen on duty shall be issued with checklists to report the status of the apparatus and the work they have carried out. These shall be filled by the workmen and handed over to the officer in charge of the job.

Check lists will depend on the maintenance task and at times a simple check list will not provide a complete picture. In such instances, in addition to the check lists all necessary test data need to be collected.

4.8.5 REPORTING PROCEDURES

The reporting procedure shall ensure that information flow is established from the lowest levels to the highest levels of Transmission Licensee management at pre-determined time intervals.

4.8.6 ASSET MANAGEMENT PROGRAM COSTS

With all described above being identified, total man hours required to carry out the asset management program and hence the total cost shall be determined.

4.8.7 PREPARATION, SUBMISSION AND APPROVAL OF THE MAINTENANCE PROGRAM

Preparation of the planned maintenance programme shall begin at the lowest entity of the Transmission Licensee management. It has to be submitted to the next level in the management who will approve the programme and submit the same to his superior officer for information.

Progress of the maintenance programme shall be submitted on agreed formats to enable the officer in charge of operations in the Transmission Licensee to receive a concise summary, to enable him to assess the progress of the maintenance work in relation to the planned program.

4.9 PREDICTIVE MAINTENANCE PROGRAM

Defects or abnormal conditions of system assets shall be identified during the preventive maintenance program, some of which the maintenance staff will rectify. Defects that cannot be rectified through the preventive maintenance programme and any other defects that have been found through other means shall be rectified systematically by preparing a follow up programme.

4.10 CORRECTIVE MAINTENANCE PROGRAMME

Transmission System assets can fail owing to various reasons such as manufacturing defects, accidents and deterioration. Such failures will mostly take place without any prior indications.

The Transmission Licensee shall attend to these failures and restore the electricity network to normal condition with the least possible delay.

4.11 OUTAGE PLANNING

To maintain the Transmission System reliability and system security levels in accordance with the specified standards and to maximize Grid operational flexibility, a well coordinated Generation and Transmission outage program shall be established. The final Transmission and Generation outage program shall be prepared in a coordinated manner, considering outage plans of Distribution Licensees and other Transmission System Users to ensure that the least number of Users is affected by the outages.

Generation Licensees shall have a planning window of 3 years for the outage programs and those shall be submitted to the Transmission Licensee by 30th November of each year. Program for the third year (Year 3) will mostly be indicative with tentative dates for the outages, which will make the Transmission Licensee aware of the general availability of plant and equipment, and the periods each unit will be out of service. The second year (Year 2) will be a plan rolling over from the third year schedule and hence will provide more definitive information. Current year (Year 1) outage plan will consist of committed monthly and weekly plans.

In addition, Generation Licensees may request for Generation Unit outages under Short Term Outage Program, Unplanned Outage Program and Forced Outage program as described in Articles 4.12.2, 4.12.3 and 4.12.4 of the Grid Code.

The Distribution Code requires the Distribution Licensees to implement a 3 year maintenance program which needs to be submitted by 30th November of each year. Other Users of the Transmission System also shall be required to submit their maintenance programs by November 30th each year.

Weekly operations/outage plan will consist of detailed plans of switching operations/outages to be undertaken to complete maintenance tasks planned for a particular week in the monthly plan.

4.12 GENERATOR OUTAGE PLANNING

Each Generation Licensee shall submit their 3 year outage plan to the Transmission Licensee by 30th November each year. However, Generation Licensees may require outages outside the planned program, which the Transmission Licensees may allow subject to the conditions stated in this Code.

4.12.1 THREE-YEAR PROGRAM

Each Generation Licensee shall provide the following information for each one of the three years, namely Year 1 (next year), Year 2 and Year 3:

(a) Generating Units to be taken out of service and their capacities
(b) Outage periods for each unit with starting/ending times and dates
(c) Brief description giving reasons for the outages requested
(d) Flexibility of the outages planned, stating whether the outage plans could be deferred or advanced, and if flexible, the period for deferment/advancement
(e) If inflexible, justify the same.
(f) For outages planned for first and second year, confirmation that the proposed outages have been included in the previous Outage Programs.

Upon receipt of the three year Generation Outage program, the Transmission Licensee shall conduct reliability and security analysis of the Transmission System giving due consideration to the,

(a) Forecast demand
(b) Operating margin and
(c) Transmission System constraints

for each of the three years, to ascertain whether the plans submitted can be accepted. It shall also examine the effect of the outages on reservoir storage levels in rainy/dry seasons to ensure that spilling of reservoirs or ponds are avoided.

Transmission Licensee may permit a Generation Licensees to take an outage of a different Generating Unit in place of another Generating unit for which an outage has already been approved, provided, the Transmission Licensee is satisfied that such a decision will not affect the system reliability and security as described above.

In allowing the inflexible outages, the Transmission Licensee shall satisfy itself, that reasons and justifications submitted are acceptable.

If at any time the analysis conducted shows that the reliability or security of the Transmission system is compromised, the Transmission Licensee shall make all efforts to resolve them through mutual discussions. It shall use the powers granted under License only as a last resort.

Accordingly, the Transmission Licensee having taken all efforts to accommodate the requests of the Generation Licensees, shall arrive at the Final outage program which shall include the following:

(a) Generation Unit identity and capacity
(b) Date and time of the planned outage for each unit for the Years 1,2 and 3
(c) Flexible and Inflexible Outages
(d) Generating Units that will be available
(e) Demand forecast and the Operating margins
(f) Changes made to the proposed Generation outage program, submitted by the generation Licensees.

The Transmission Licensee shall forward the approved three year Generation Outage Program to all Generation Licensees by 31st December. If there are any disputes on the program, those shall be resolved in accordance with Dispute Resolution Regulations under PUCSL.

4.12.2 OUTAGE PROGRAM FOR UNFORESEEN SITUATIONS

In the Year 1 (current year), a Generation Licensee may request an outage for its generation unit/units by giving at least 7 days notice providing following information:

(a) Generating Unit/s to be taken out of service and their capacities
(b) Outage periods for each unit with starting/ending times and dates
(c) Brief description giving reasons for the outages requested

Outages granted under this program shall not exceed 48 hours.

On receipt of an outage request under this program, the Transmission Licensees shall analyze the proposed outages considering the following:

(a) Capability of the generators to meet the Peak demand
(b) Transmission system constraints
(c) Operating margin
(d) System security and reliability levels.

If the analysis shows that outage will not have any harmful effects on the Transmission System, permission shall be granted for the outage and the Generation Licensee shall be informed accordingly in writing, within 48 hours from the receipt of the request.

In cases, where Transmission Licensee is of the view that Outage request cannot be accommodated, it shall hold discussions with the relevant Generation Licensee and propose and agree for alternative dates/times for the outage, within 72 hours from the time of receipt of the request.

4.12.3 OUTAGES FOR EMERGENCIES

Generation Licensees may require outages to attend to urgent needs for its plant and equipment and may make a request from the Transmission Licensee for the same, providing information as stated in Article 4.12.2.

The Transmission Licensee shall make all efforts to grant the request of the Generation Licensee and inform its decision to the Generation Licensee orally, and confirm the same in writing within 24 hours from the receipt of the request.

4.12.4 FORCED OUTAGES

Within 30 minutes of occurrence of a forced outage, a Generation Licensee shall inform the Transmission Licensee the cause of the outage, and shall also inform the estimated date and time by which the generator can be made available, as expeditiously as possible.

Within 24 hours of the occurrence of the outage, the Generation Licensee shall provide a report of sufficient detail, describing the reasons for the outage, the date/time of the generating unit/s availability, levels of availability, (ie full or partial).

The Transmission Licensee shall have the right to inspect the Generating Unit and all records under such situations, on any business day at any reasonable time.

The Generation Licensees shall make all efforts to conduct the repairs and to make it available at the shortest possible time.

4.13 RELEASE OF GENERATING UNITS

A Generation Licensee shall make a written request to the Transmission Licensee for the release of a Generating unit in accordance with the approved Planned Outage programs and shall not withdraw any Generating Units from the Grid without obtaining express permission from the Transmission Licensee.

When such a request is made, the Transmission Licensee shall make all efforts to comply with such requests, but may withhold the permission if it would result in insufficient Generation capacity or jeopardize the system security/reliability.

Request for permission to withdraw a generating unit and Permission issued by the Transmission Licensee shall be on standard formats to be prepared by the Transmission Licensee and following data shall be included.

(a) Date of request
(b) Outage planning program reference
(c) Generating Unit Identity
(d) Capacity
(e) Period of the outage
(f) Starting and ending time of the outage.
(g) Name and Designation of the officer requesting permission
(h) Name and Designation of the officer granting permission

4.14 MAKING GENERATING UNITS AVAILABLE AFTER AN OUTAGE

Generation Licensees shall endavour to complete their repair/maintenance/improvements within the approved outage period, and shall inform the Transmission Licensee at least 3 days before the expiry of the outage period, on the probability of making the Generating Unit available on the due date.

Whilst carrying out the targeted tasks, if the Generation Licensee has any reason/evidence to believe that the Generating Unit cannot be made available on the due date, the Transmission Licensees shall be informed accordingly at the earliest, indicating the date and time the Generating Unit can be made available with all relevant information substantiating the request for extension of time allocated.

In such situations, the Transmission Licensees may inspect the Generating Unit/s under repairs to verify the information and grant or reject approval for the request for extension and act in accordance with the regulatory obligations.

4.15 TRANSMISSION OUTAGE PROGRAM

The Transmission outage program shall have a three year planning window, and it shall be prepared taking into consideration of the Transmission System refurbishments, planned developments, the three year maintenance plan and also the maintenance/development plans of the Grid Users, especially the Distribution Licensees. The Generation Outage Plan will take precedence over the Transmission Outage Plan.

As in the case of the Generation Outage Plan, Year 3 will be indicative with tentative dates, year 2 will be rolling over from the Year 3 program, and the Year 1 will be the committed outage plan.

The Transmission Outage Program shall be finalized by the Transmission Licensee by 31st December, in consultation with the Generators and all Transmission System Users, as far as possible accommodating the User requirements, given in their maintenance/outage Plans.

4.16 IMPLEMENTING OUTAGE PROGRAMS

In accordance with the outage planning procedures specified in the foregoing, all Licensees shall prepare the monthly/weekly outage programs to carry out the targeted tasks.

These programs shall be taken up for consideration at regular meetings on a given weekday, with the participation of the representatives of all Licensees that will include the Control Engineers of the Transmission Licensee, representatives of the Generation Licensees, Control Engineers of the Distribution Licensees and representatives of their maintenance departments and decide on the outage program for the week/month..

Licensees shall agree on the number and the frequency of such meetings, which may be weekly, fortnightly or monthly.

4.17 SYSTEMS CONTROL CENTRE (SCC)

The main responsibilities of SCC include

(a) Economic dispatching of generation
(b) Operating the Transmission System to ensure reliability, security, stability and directing/carrying out switching operations
(c) Maintaining SCADA systems
(d) Recording, archiving operational information from SCADA systems and other sources and making the information available in appropriate formats.
(e) Arrange alternate supplies during failures and planned outages
(f) Accepting new apparatus to the Transmission System
(g) Consenting to issue of "permit to work", "sanction for tests" and "limitation of access"
(h) Analyzing all Transmission System failures and preparing reports with recommendations for performance improvement

4.17.1 ECONOMIC DISPATCHING OF GENERATION

Procedures and requirements for economic dispatching of generation have been laid down in the Generation Dispatch Code (Section 5).

4.17.2 COMMUNICATIONS AND SCADA SYSTEMS

Communications and SCADA systems shall have the capability for SCC to carry out switching operations in its Transmission System, acquisition of data from the identified locations of the Transmission System, and to exchange information with the Users and vice versa.

Voice and Data communication facilities for SCADA shall be secured against unauthorized access in accordance with the standards specified by the Transmission Licensee.

4.17.3 FREQUENCY CONTROL

Frequency Control shall be achieved with the aid of automatic action of the speed governing systems of Generating Units combined with manual control.

The Governing system which has the capability to act on frequency changes within the specified levels will respond to frequency fluctuations, attempting to initiate the corrective measures. If the frequency fluctuations are substantial and exceed the limits specified, then manual interaction will be necessary. The Transmission Licensee shall instruct the Generation Licensees to ensure that automatic speed governing systems are activated all the time, unless it has very valid reasons not to do so.

4.17.4 VOLTAGE CONTROL

The Transmission Licensee shall ensure that the Transmission System voltage is maintained within the specified levels under normal operating conditions. Under normal operations, the Transmission

System shall have sufficient dynamic and static reactive power capability to provide reactive power requirements of the system.

The Transmission Licensee shall consider the possible alternative methods to provide such reactive power capabilities, taking into consideration the benefits that could be achieved in lowering the cost of system operation with no harmful effects on system reliability.

Accordingly, the Transmission Licensee shall monitor the system voltage at suitable locations and shall provide dynamic or static reactive power injection equipment as appropriate, to ensure that at all connection points, voltages are within the specified levels. Voltage monitoring shall be carried out on a regular basis.

All Generating Unit excitation systems shall be operated under the control of Automatic Voltage Regulators, and as far as possible, it shall be set to maintain a constant terminal voltage. Generation Licensees shall provide reactive power outputs, be it reactive power absorption or production, as directed by the Transmission Licensee. The Transmission Licensee may also adopt other means of reactive power control, such as switching off of unloaded Transmission lines or changing the tap on transformers, as appropriate.

4.17.5 SWITCHING OPERATIONS

The Transmission Licensee shall ensure that switching operations are carried out only by Authorized Persons, under the direction of SCC. Switching programs for planned switching operations shall be prepared at least two weeks in advance by the Authorized Persons who are responsible for carrying out the switching, and forward the same to SCC for study and approval.

SCC shall play the coordinator's role in the execution of the switching operations and outages. Where facilities are available and when necessities arise, SCC themselves may carry out the switching operations.

These include the switching operations

(a) for the implementation of the Transmission Outage program
(b) for the implementation of the Generation Outage program,
(c) in normal day to day operations of the Transmission System
(d) in responding to emergency and fault situations of the Transmission System
(e) in responding to User requirements

In extreme emergencies where there is a threat to human life or to system equipment, switching operations may be carried out without being directed by SCC. Immediately after carrying out any switching operations, all related information shall be reported to the SCC by the relevant officers.

SCC shall not direct or undertake any switching operations/outages outside the programs as listed above, unless the removal of any circuit or equipment becomes necessary under emergency situations or if there is any violation in the agreements entered into with Users.

Switching operations in the Transmission System will also take place owing to the operation of protection relays in clearing the Transmission System faults.

4.17.6 SCC RECORDS

SCC shall record events and incidents that take place or may affect the Transmission System. These shall include, but not be limited to, the following:

(a) All switching operations.
(b) Outages, restorations, and demand control activities.
(c) Issue and cancellation of Permit to Work, Sanction for Tests and Limitation of Access.
(d) Commissioning and decommissioning of Transmission System plant and equipment, Generating Units.
(e) Failure of any Generating Units, Transmission System plant and equipment.
(f) Any dangerous or abnormal occurrences with implications on the Transmission System operations, including any occurrences in User Systems that have an effect on the Transmission System.
(g) All messages received or transmitted in connection with Transmission System operations.
(h) Accidents and fatalities

4.17.7 SCC REPORTS

Information so collected shall be made available in the following formats.

(a) Daily report
(b) Outage report
(c) Monthly report

(a) Daily Report

The daily report will include a summary of system operations, incidents, events such as system loadings at night peak, day peak and off peak, generation by plant, system failures, customer complaints, demand control activities, planned outages, etc. for the preceding 24 hour period ending at 0600 Hrs on each day. This shall be made available by 0900 Hrs on the following business day.

(b) Outage Report

Whenever a total system outage or a partial outage occurs, SCC shall submit a detailed report with a copy to the PUCSL.

The detailed report shall include the following:

(a) Executive summary
(b) Description of the outage
(c) System conditions prior to failure
(d) Analysis of the relay operations
(e) The cause/s of failure, establishing whether the failure is owing to a system deficiency, protection system deficiency/failure or other equipment failure
(f) Proposals for avoidance of recurrence of a similar failure and the work plan proposed.
(g) Event records, Disturbance records, Log book entries and any other information.

The report shall be discussed at a meeting attended by the representative of the departments responsible for Transmission System maintenance, Transmission Planning, Protection development and the SCC, within four weeks from the date such failure has taken place. Convener of the meeting shall be the SCC and shall have the right to invite any other Licensees or a Transmission System User for the meeting, subject to majority of the other participants agreeing.

Objectives of the meeting shall be to identify the lapses on the part of the operational personnel as well as the system deficiencies that gave rise to the system contingencies, and corrective action needed to remedy such shortcomings.

Transmission Licensee shall ensure that corrective action be completed in accordance with the Work Plan agreed at such meetings.

(c) Monthly Report

SCC shall carry out a statistical analysis of the system performance on a monthly basis, which will include data relating to system outages, demand control measures, quality of supply indicators, etc. a copy of which shall be submitted to PUCSL.

4.18 CONTINGENCY PLANNING

A contingency in the Transmission System may arise owing to generation deficiencies, inadvertent tripping of Transmission System components, and failure of Transmission System equipment or operational errors.

These may result in partial or total blackouts and the Transmission Licensee is required to develop contingency plans to manage such situations and bring back normalcy to the Transmission System safely, and as fast as possible.

4.18.1 RESTORATION PLANS

It is the responsibility of the Transmission Licensees to develop and maintain restoration plans to manage contingencies that arise.

These shall include the following, but not limited to,

(a) Issuing instructions to Generators with Black start capability to start, energizing the system and synchronize where possible
(b) Standing instructions to Grid Users
(c) Creation of small independent systems (islands) with identified generation and loads.
(d) Listing the synchronizing points for the islands
(e) step-by-step process of integration of the islanded parts forming larger islands
(f) Completing the restoration

Recovery from a partial or a total blackout is often associated with uncertainties and unexpected complexities, and hence the restoration plans cover many possible scenarios and also need to be flexible.

The restoration plans shall be consistent with the accepted best international practices and shall be formulated in consultation with Transmission System Users, especially the Generation Licensees and Distribution Licensees. It is essential that these plans are subjected to periodical review.

All Transmission Licensee personnel and all Users shall be aware of the restoration plans and shall be well versed with the role each has to play in such eventualities. All Users shall cooperate with the Transmission Licensee by following SCC instructions.

4.18.2 VOLTAGE AND FREQUENCY

Under contingency situations normal standards of voltage and frequency shall not be applicable.

4.18.3 SYSTEM STUDIES

The Transmission Licensee shall carry out system studies to determine the effect of various Transmission System component failures, on the system reliability and security, and strengthen such weak links in the Transmission System.

4.18.4 DEMAND CONTROL

Power system behaviour during a restoration process depends on its characteristics as related to its active and reactive power balance. Therefore, Demand control measures shall be adopted to secure a demand reduction in situations where Transmission System operational difficulties pose a threat to the Transmission System stability or where available generation capacity becomes insufficient to meet the system demand.

Demand control methods to be implemented will be as follows:

(a) Automatic load shedding
(b) Manual load shedding
(c) Demand Side Management agreements
(d) Demand control through other measures

4.18.5 AUTOMATIC LOAD SHEDDING

An automatic under-frequency load shedding program will be implemented by the Transmission Licensee to control the system demand in order to limit the consequences of transmission or generation failures. The load shedding program shall be executed in a number of stages, and the selection of the loads to be shed shall be based on the information provided by the Distribution Licensees.

Accordingly, each Distribution Licensee shall be required to submit a schedule annually to the Transmission Licensee, identifying feeders at each grid substation as essential and non essential loads with feeders having non-essential loads being further categorized in the order of priority. The schedule shall also include the range of loading on the feeders during the Day, Peak and Off-peak periods. The Transmission Licensee shall finalize the load shedding program in consultation with the Distribution Licensees.

Distribution Licensees shall ensure that permanent load transfers from one feeder to another are not done without the Transmission Licensee being informed. Once a feeder is disconnected on under-frequency load shedding, it shall not be reconnected to the system without permission from the SCC.

4.18.6 MANUAL LOAD SHEDDING

Manual load shedding may become necessary in situations where operational difficulties or insufficient generation capacity pose threats in meeting the forecasted system demand.

Such operational difficulties be known beforehand on most occasions, and where possible, the Transmission Licensee shall issue warnings on Manual Load shedding to the appropriate Distribution Licensees and Transmission Customers, at least by 1600 hrs a day ahead.

At times, when demand reduction is required due to Transmission System deficiencies and if such forewarnings become impractical, then the Distribution Licensees shall be in readiness to carry out load shedding at short notice.

These load shedding programs will be based on the schedules agreed between the Distribution Licensees and the Transmission Licensee as required by the Distribution Code, with both parties being aware of the percentage of load shed, depending on the time period.

Electronic media may be used by the Transmission Licensee to convey the information and the Distribution Licensee shall confirm the operations within 24 hours, giving the times at which the load was shed, the scheme followed and the times of restoration.

4.18.7 DEMAND SIDE MANAGEMENT ARRANGEMENTS

The Transmission Licensee may enter into agreements with Transmission Customers to act on warnings issued by the Transmission Licensee a day ahead or at short notice.

4.18.8 DEMAND CONTROL THROUGH OTHER MEASURES

The Transmission Licensee may resort to control the demand through voltage reduction and instruct the Distribution Licensees also to act in the same manner.

In extreme emergencies, as the last resort, the Transmission Licensee may lower the system frequency as a demand control measure.

4.19 TRANSMISSION SYSTEM PROTECTION

The Transmission Licensee shall ensure that the protection system of the Transmission System is well coordinated with those of the Distribution Systems, Transmission Customer systems and Generators, and that the individual protection schemes are capable of speedily, selectively and reliably disconnecting a faulty section from the rest of the system. The Transmission Licensee shall convene meetings with the Users to discuss any issues related to protection relaying, as and when necessary. All literature relating to protective relaying, associated wiring/schematic diagrams, relay settings, relay testing data and operational records etc, shall be kept securely and safely preferably in a data base, to enable ready access by Transmission Licensee to such information.

All protection relays shall be tested according to a pre planned program, and protection schemes shall be upgraded as and when required according to the declared Protection Policy. Protection relay settings shall be reviewed, whenever significant changes effected to the Transmission System or when Generation resource changes necessitate such action.

All relay operations shall be carefully analyzed and the cause for every operation shall be established, and corrective action shall be taken to ensure that protective schemes are in proper working order.

4.20 COMMUNICATIONS

Transmission Licensee shall establish communication channels with the other Licensees, Transmission Customers, PUCSL and the Users for effective exchange of information related to, but not limited to:

(a) Operational and system data.
(b) Operating instructions between Licensees, and between Licensees and Users.
(c) Significant incidents/events that have taken place in the Transmission system or a User's System that may affect the operation of the Transmission System.
(d) Significant incidents/events that are being planned in a Licensee's System or User's System that may affect the operation of the Transmission System.

The main objective of the exchange of the above information is to ensure that the Transmission Licensee and Users become aware of the operations, events or incidents that will take place or has taken place in the Transmission System or User Systems, which will enable them to assess the risks arising from the same and prepare themselves to take appropriate action to maintain integrity, security and reliability of the Transmission System as well as the User's system. Such information shall be exchanged on reasonable requests of either party or in accordance with prior agreements.

The Transmission Licensee shall also establish an enquiry service for dealing with incidents on the system and interruption of supply.

4.20.1 OPERATIONAL AND SYSTEM DATA

All Generators shall provide hourly generation (MW and MVAr) to SCC on real time basis. Hydro power generators, in addition, shall forward the reservoir level information on daily basis. Other renewable energy-based generators would report information about their resource level, as appropriate.

The Transmission Licensee shall submit operational data to PUCSL through LISS, and also to the other Licensees and Users, as and when required or as agreed.

4.21 SAFETY

4.21.1 SAFETY MANUAL

The Transmission Licensee shall prepare a Safety Manual incorporating all safety rules and safety precautions applicable to the Transmission System. Distribution Licensees will also prepare their Safety Manuals and so will be all Users. The objective of the Safety Manual will be to lay down the requirements to ensure safety of persons working at or across the operational and ownership boundaries between the Transmission System and those of its Users and other Licensees.

The manual will specify the procedures to be applied to ensure the health and safety of all who are liable to be working on or testing the Transmission System or on plant and equipment connected to it. Transmission Licensee shall submit a copy of the Safety Manual, and any modifications thereto, to PUCSL for the purpose of record, and shall make the same available to all authorized persons, competent persons and all Users for compliance.

The Transmission Licensee shall furnish a copy of its Safety Manual to all parties with an electrical interface with the Transmission System. The said parties shall also furnish a copy of their Safety Manuals to the Transmission Licensee. Any party who wants to revise any provision of its Safety Manual shall inform all other parties who have an electrical interface with them, of the intended revisions and agree upon.

4.21.2 SAFETY MANAGEMENT SYSTEM

The Transmission Licensee shall establish a safety management system that maintain and improve electrical safety standards by a systematic and continuous approach. This system shall set, implement and modify benchmarks related to electrical safety and use their feedback for continuous improvement. The system shall address,

(a) Identifying comprehensive details of the hazards and risks associated with the design, construction, operation and maintenance of Transmission Licensees works;
(b) Ways of mitigating these hazards and risks to ensure safety; and
(c) Ensuring that users will comply with the requirements of the system.

For all work on systems operated at medium voltage or above,

(a) the nomination of safety coordinators, and
(b) a suitable system of documentation to record all operational events

are required. The Transmission Licensee's safety coordinator will be the SCC control person and when tests are carried out at site, the Transmission Licensee's authorized person at site will be the safety coordinator. All oral communications in respect of all operational events shall be recorded. Relevant records and documentation shall be kept in safe custody for a period of at least six months after such communication.

4.21.3 SAFETY PRECAUTIONS

All Grid substations and Connection point substations shall be kept under lock and key. Only authorized persons who are provided with a master key shall have access to them. Following are the most important safety precautions that need to be taken, when working on apparatus/equipment connected to a high voltage system, considered as dead:

(a) Isolation of the system/plant/apparatus on which work is to be carried out from the remainder of the system and also from all in-feeds such as embedded generators, self generating plants/equipment, using visible isolation devices that have to be kept locked in the isolated position

(b) Discharging and earthing the system/plant/apparatus on which work is to be carried out, by way of providing a connection with an approved earthing device, where practicable keeping the same locked and immobilized.

4.22 OPERATING INSTRUCTIONS AMONG TRANSMISSION LICENSEE AND OTHER LICENSEES & USERS

Operations in the Transmission System, Users' Systems or the Distribution System could have an operational effect on each other's systems. It shall be the responsibility of each party to bring such information to the notice of all relevant parties whose systems may be affected as a result of such operations.

4.23 SIGNIFICANT EVENTS/INCIDENTS

Licensees may be confronted by situations that will require the system operations to be carried out with known weaknesses that will have an operational effect on the system, and it shall be the duty of the Transmission Licensee to notify the Users to keep them informed of such risks. These notifications shall be of sufficient detail to enable the Users to take appropriate action to mitigate the effect of lowering of quality or facing outages. Examples for such situations are listed below:

(a) Operating the system or part of the system with system security, reliability and power quality levels lower than specified
(b) Certain plant or equipment being operated above their rated capacities (capabilities)
(c) Operating the system with alarms being actuated, indicating abnormal operating conditions
(d) Adverse weather conditions
(e) Breakdowns, faults and temporary changes in the capabilities of plant/equipment
(f) Increased risks of inadvertent or non-discriminatory protection relay operations
(g) Planned outages
(h) Maintenance work that may increase the risks of causing electricity supply failures
(i) Shortcomings in communications and metering equipment

All reportable incidents occurring in Grid substations and Generators shall promptly be reported by the operators of the stations to SCC. SCC may ask for a written report on any incident and also call for a report from any other Users affected by a reportable incident.

5. GENERATION DISPATCH CODE (GDC)

5.1 INTRODUCTION

This Generation Dispatch Code (GDC) specifies,

(a) rules and procedures the System Operator should follow to optimize the system operation,
(b) the role of Transmission Licensee and other Licensees in this optimization,
(c) mechanisms to coordinate the real time operation of the system, and
(d) reporting requirements.

5.2 APPLICABILITY

This Code applies to the Transmission Licensee, Generation Licensees, Distribution Licensees, Transmission Customers and Embedded generators.

5.3 OBJECTIVES

The objectives of the GDC are the following:

(a) Enable the Transmission Licensee to dispatch adequate generation resources to meet the electricity demand at all times, guaranteeing the transparency and predictability in the dispatch of generation, whilst ensuring the integrity of the Grid and the levels of supply quality and reliability as required by this Code.

(b) Establish the rules and procedures the System Operator shall follow in order to optimize the electricity generation by minimizing the energy purchasing costs through the optimization of the allocated water resources, and thereby, minimizing the thermal generation purchases in the medium and long run

(c) Define the role of the Transmission Licensees (in relation to both the Transmission Business and the Bulk Supply) and other Licensees in this optimization, and the mechanisms to coordinate the real time operation of the system and the reporting requirements.

5.4 ECONOMIC DISPATCH AND SCHEDULING

This section establishes the rules the System Operator shall follow to dispatch the system and schedule generation, either the day ahead or in real time.

5.5 DISPATCH PROCEDURES

The dispatch procedures shall be based on the following principles:

(a) Licensees to submit the information required for day ahead dispatch and real time dispatch, according to the System Operator requirements.
(b) The System Operator to validate data, confirm or reject data, to communicate (notify) the Day Ahead Schedule, the Ancillary Services schedule and other results of the dispatch process, and
(c) The System Operator to issue Dispatch Instructions, including request for load disconnection, during real time operation.

5.6 DAY AHEAD ECONOMIC DISPATCH

For each day the System Operator shall produce a day-ahead security constrained economic dispatch plan based on the results of the Week Ahead Plan, with the aim of supplying the demand at the

optimum total production cost, whilst ensuring the levels of supply quality and reliability as required by this Code, to:

(a) plan and schedule sufficient generation and transmission capacity to meet expected load and reserve requirements, within the Grid performance standards criteria established by the Grid Code,
(b) coordinate maintenance requested by the Licensees,
(c) plan, when necessary, load shedding, and
(d) inform the results to each Licensee about their expected operation for the next day, for them to take all required measures to be able to comply with it.

In case of holidays and weekends, the System Operator shall produce the Economic Dispatch on the last working day.

The System Operator shall perform an economic dispatch to determine the optimal use of available generation resources and transmission capacity to supply the forecast load, within the required security and quality of service requirements and taking into account operational constraints (including spinning and load following reserves).

To produce such a day-ahead dispatch, the System Operator shall use a security constrained dispatch model which minimizes the total operational cost, able to consider:

(a) Load forecast at each connection node.
(b) Generation availability and or operating restrictions.
(c) Generation Prices (energy prices), reflected in the Contracts registered by the Single Buyer, for thermal generators.
(d) Fuel and environmental constraints.
(e) Daily water requirements as coordinated with the Water management Secretariat and/or other water users.
(f) Required reserve margins and voltage control resources as required to meet the minimum performance standards established in the Grid Code.
(g) The characteristics, losses and constraints of the transmission system.

All generators must be dispatched with the spinning reserve required to meet the performance standards established in the Grid Code, except in conditions of supply deficit or operational restrictions. In such emergencies, the System Operator may choose to operate with a lower reserve margin. This situation needs to be immediately informed to PUCSL and the Licensees in the most practicable manner.

5.6.1 RESULTS

The Day Ahead Economic Dispatch shall produce the following results:

(a) For each Generation Licensee, per plant and/or machine, generation schedule and participation in the spinning reserve, frequency regulation and voltage and reactive power control.
(b) Transmission restrictions that may occur in the system.
(c) For each Distribution Licensee, supply restrictions (if any).
(d) The hourly cost of energy, if needed, by time intervals as PUCSL may instruct the System Operator (consistently with the Time of Use tariff system).
(e) Total transmission losses.
(f) Must run generators forced by performance standard requirements or other requirements in the system (such as tests), accompanied by an estimation of the cost differential compared with an optional dispatch without must run generation.

5.6.2 DAY AHEAD SECURITY CONSTRAINED ECONOMIC DISPATCH MODEL

The Day Ahead Economic Dispatch Model shall be a security constrained dispatch model that must meet the following minimal conditions:

(a) Allow to represent hourly load curves in all nodes of the transmission network.
(b) Represent the configuration of the network to the level of detail necessary to take into account the constraints that affect the daily dispatch, ensuring that the schedule is feasible with the potentially exiting transmission restrictions and within the performance standards.
(c) Represent hourly load flows in the network and determination of losses.

(d) Represent thermal plants in detail, indicating availability by type of fuels, energy costs, the specific fuel consumption per MWh, restrictions on the maximum hourly load variation, and the possibilities of contributing to primary and secondary frequency regulation.
(e) Represent the minimum time that must elapse between a stop and the following start-up, and the start-up and stop costs.
(f) Represent the power reserve requirements for regulation.
(g) Represent the spinning reserve requirements to maintain the system operation within the performance and the required response times during contingencies.
(h) Allow detailed modeling of non-conventional renewable energy-based generation and their restrictions.
(i) Allow detailed modeling of restrictions imposed by safety and quality of service standards, including must run generation of forced machines, and requirements arising from frequency regulation and voltage control.

For the particular case of hydro power plants, the model has to be able to represent:

(a) Different types of basins and hydro power (run-of-river, storage capacity, cascades and links between components of it, compensating or regulating dams, pumped-storage stations, etc.), and downstream restrictions affecting the hourly dispatch of hydro power;
(b) Restrictions on weekly and daily peaking ability of power plants, including maximum allowable ramp;
(c) Forced generation owing to base or minimum downstream flow volume requirements.
(d) Limitations to their daily maximum generation and/or weekly, not to exceed the maximum allowable downstream flows or other water management requirements.
(e) Any restrictions or rules of operation, represented as its effects on energy and capacity delivery.
(f) Maximum zero-generation time without the need for operating spillway gates.
(g) Maximum hourly admissible generation variation due to water flow control requirements.

The Day Ahead Economic Dispatch Model must be approved by PUCSL and its characteristics be informed to all the Licensees. The System Operator cannot introduce modifications to the model without previous authorization of PUCSL.

The model, as well as its manuals will be available for Licensees and Transmission Customers upon request. In case there is any software license costs, the same shall be borne by the requesting Party.

5.6.3 DAY AHEAD NOTIFICATION AND PUBLICATION

Before 1500 each day, the System Operator shall notify each Generator for the next day:

(a) Transmission restrictions in the system
(b) Hourly generating schedule (by fuel type if applies) for each unit
(c) Hourly spinning reserve, frequency regulation and reactive power control commitments for each plant;

Before 1500 each day, the System Operator notifies each Distribution Licensee:

(a) Transmission restrictions in the System;
(b) Hourly discriminated foreseen supply restrictions (if any) for each Distribution Licensee

The Day Ahead Plan shall be accompanied by the input information provided by the Water Management Secretariat or such other Authority and the Licensees. In case the System Operator had used different information, this decision needs to be justified and reflected in the Plan.

Before the end of the day, the System Operator shall post the updated Day Ahead Dispatch on its website for public access[8].

[8] Posting for public information shall be only after the initial preparations are completed, according to the Roadmap for Implementation. See the Appendix to this Generation Dispatch Code.

5.7 ADMINISTRATION OF SHORTAGES

The System Operator may plan and instruct a Licensee to shed load if the Day Ahead Dispatch or Real Time Dispatch show shortage of energy in the system as a whole or in one or more specific regions in the system, owing to insufficient generation or insufficient transmission capacity. All Licensees are obliged to comply with the curtailment schedules, load shedding plans and instructions of the System Operator.

In case of expected prolonged shortages, the criteria to be applied to determine the load shedding each Licensees has to execute will be determined by PUCSL. The System Operator will be responsible for implementing such criteria, determining the amount and timing of load shedding to be produced by Licensees.

During real time operations, the System Operator may instruct curtailments that were not planned for the day ahead, to solve emergencies or unanticipated conditions in order to maintain the security and integrity of the system. These curtailments may be instructed without previous request for authorization from PUCSL if the circumstances do not allow it. In such cases, the System Operator must inform PUCSL at the earliest possible moment of such events.

5.8 REAL TIME OPERATION AND DISPATCH INSTRUCTIONS

The System Operator has the responsibility of monitoring and coordinating in real time, the operation of the system, reliability, security and quality of service. To be able to fulfil these functions, each Licensee is obliged to inform immediately any modification to the day ahead expected conditions that may affect generation schedules, loads, reserve, ancillary services, reliability or security in the system (procedures to communicate such incidences is included in the Grid Code).

Each Licensee is obliged to follow dispatch and operation instructions received from the System Operator, unless when by doing so it could endanger the security of its equipment or its staff. Penalties may be imposed on a Licensee if this Licensee fails to use its best endeavour to act in accordance with dispatch instructions issued by the System Operator.

The System Operator shall follow the generation and reserve scheduled on the Day Ahead Economic Dispatch, except when conditions require an update of the economic dispatch and re scheduling of generation and/or reserves. Normal deviations of the load will be covered using spinning reserve Ancillary Services.

During the operation of the system, the System Operator shall:

(a) Review forecast and actual system conditions, including load, generation availability and constraints, and update the expected conditions for the rest of the day;
(b) Modify the schedule of generation when a Generation Licensee informs a modification in the availability

In case of significant deviations between expected day-ahead conditions and updated conditions for the rest of the day, the System Operator shall re-schedule generation to restore the economic dispatch of generation resources and ensure the balance between actual load and actual generation. This rescheduling will be done using the same model used for the day-ahead dispatch adjusting the relevant input data. The System Operator shall issue the required dispatch instructions based on the re-scheduling results for the rest of the day and, when necessary, the foreseen load curtailments.

In case of emergencies or unexpected conditions that endanger the security of the system, the System Operator has the right to issue generation instructions that differ from the generation schedules informed with the Day Ahead Economic Dispatch, to maintain the security of the system and the quality of service within the standards.

In case of emergencies or any other unexpected condition that endangers the security of the system, the System Operator shall give priority to system reliability over economic operation. In these conditions, the System Operator shall issue the instructions and follow the emergency procedures to restore the system to normal operation as soon as possible, independent of economic dispatch. Once the emergency or disturbance or unexpected condition has been solved or, if it not solved, the system

has been adjusted to the new conditions within security and reliability standards, the System Operator shall again accord the due priority to economic efficiency.

5.8.1 OBLIGATIONS OF GENERATION AND DISTRIBUTION LICENSEES

Generators must meet operating schedules as directed by the System Operator within a tolerance band defined by PUCSL in regard to power generation, spinning reserve, participation in the regulation of frequency, and other requirements to maintain the Grid supply in accordance with the Planning and Operating Standards (Section 7). Deviations from the programmed values beyond the defined tolerance are considered a breach of the Generator's obligations and subject to penalties as decided by PUCSL.

Distribution Licensees and Transmission Customers must meet the restrictions indicated by the System Operator within a tolerance defined by PUCSL, and meet other requirements to maintain the operation of the electrical system within the established performance standards. Deviations from the programmed values beyond the defined tolerance is considered a breach of the Distribution Licensee's obligations and subject to penalties as decided by PUCSL.

Embedded generation on standardised Power Purchase Agreements will have to be duly considered, when Distribution Licensee obligations are agreed between the System Operator and each Distribution Licensee.

5.9 OPERATIONS REPORT AND EX POST DISPATCH ANALYSIS

Every day before 1000, the System Operator shall produce and post in the System Operator website, and simultaneously provide to PUCSL, an Operations Report containing an evaluation of deviations between actual conditions and conditions that were expected in the day ahead dispatch, and how such deviations affected generation scheduling, operational economics, reserve and the quality of service.

After holidays and weekends, the Operations Report shall contain the same information for each one of these days.

PUCSL may request the System Operator to include other data in the Operations Report.

Appendix: GDC 1

Road map for Implementation of the Generation Dispatch Code

Note: This appendix contains specific dates for certain activities. It would be required update this appendix when PUCSL is ready to approve the Grid Code, to ensure that the dates given here are realistic.

The proposed Operational Rules imply changes to the way the operations are being planned and carried out in Sri Lanka. Thus, the implementation will require a significant amount of effort and time, thus together with the proposed Operational Procedures, a roadmap is proposed for their implementation, considering that some of their outputs are essential inputs for the extraordinary tariff filing and review process that will take place by mid of 2011.

While many of the aspects related to how operations planning and system operation are done today, are adequately done mostly from the technical point of view, there are some other aspects that still need to be improved, essentially related to:

- Allocation of roles according to the Electricity Act and Licenses
- Hydrothermal generation and transmission optimization function
- Transparency and access to information
- Connection with other regulations

In order to accomplish the objectives and take benefit of improvements, it is necessary to implement a number of tools, such us dispatch models for optimization, communication procedures including web-based information systems, and capacity building, to train the System Control Centre staff in the new procedure and in the use of the tools and communication procedures.

This proposal considers too the new full scale SCADA system and an Energy Management System (EMS) for the Sri Lankan Power Sector, currently (December 2010) at an early stage in the tender document preparation. While this new system will be able to provide proper solutions for all the objectives and improvements aforementioned, its implementation will still demand a fairly long time, longer than what the new regulatory regime requires at present.

The proposed Operational Procedures and how to implement them already consider this future system in such a way that what is implemented now, if fully compatible with the future system and ensure that at the proper time, all tools implemented now provide the necessary features for a smooth transition towards the full scale SCADA and EMS systems.

In consideration of all the above mentioned, this Roadmap for Implementation is presented, which includes special provisions towards their gradual implementation considering the needs for developing the tools, communication procedures and capacity building required for a quick response to the actual needs while taking into account the future integration with the full scale SCADA and EMS systems.

1. Immediate Needs

The following activities are required to be undertaken at the earliest possible, in order to facilitate the implementation of the Operational Procedures

- Dispatch model(s): procurement, implementation and training
- Templates for exchanging information between System Operator, Licensees and PUCSL
- Web based systems for exchange of information and posting information required to be made public
- Revise the System Operator's internal organization to carry out the functions assigned to it by the Operational Procedures

1.1 Dispatch Models: Procurement, Implementation and Training

Based on the model specifications described in the Operational Rules in the foregoing chapters, the System Operator shall procure the required software. Software responding to those specs are commercially available in the market, thus no special programming needs are required.

Normally available models require implementation and fine tuning, in order to make them represent properly the power system electrical behaviour. Thus, implementation and fine tuning should be included in the procurement process to have assistance from the software provider in these regards.

Adequate participation of the System Operator's personnel in the implementation and fine tuning must be granted in order to ensure adequate knowledge transfer and develop the require capacity for running these tools and update them when needed. Training needs to be part of the scope of services required from the software provider.

1.1.1 Timing

The dispatch models should be operational and ready to produce the required information for the upcoming tariff filing review, foreseen for June 2011. Therefore the models need to be fully implemented and the personnel properly trained, no later than 30th April 2011.

1.2 Templates for Exchanging Information between System Operator, Licensees and PUCSL

Information requirements to Licensees need to be systematized through standard templates to facilitate the initial data gathering and subsequent updates.

These templates normally can be developed in MS Excel spreadsheets. Existing forms used to receive information from licensees are a good basis for this, and based on the dispatch models selected, the supplier should advice on how to adapt them to the specific software requirements.

1.2.1 Timing

The templates design and development should start simultaneously with the dispatch model implementation.

1.3 Web Based Systems for Exchange of Information and Publication

Based on the existing facilities, the System Operator shall define what functions need to be additionally implemented.

1.3.1 Timing

The publication requirements established in the Operational Procedures shall to be put in force not earlier than the moment when the dispatch models are fully operational and the output properly tested.

However the design of the required system needs to be started in advance in order to have them ready for the moment when publication can start. The start of the works should be no later than 1st February 2011.

1.4 System Operator Internal Organization

The adequacy of the System Operator's internal organization to carry out the functions assigned to it by the Operational Procedures needs to be revised and if considered necessary properly adjusted to have the human resources required for that.

1.4.1 Timing

This activity has to be initiated as early as possible during 2011, mostly considering that the personnel deployed to carry out the required functions needs to be fully accomplished by the time the dispatch models and template design commence.

6. GRID METERING CODE

6.1 INTRODUCTION

The Grid Metering Code (GMC) of the Grid Code,

(a) defines the responsibilities of the Transmission Licensee and Users with respect to metering of energy and demand,
(b) specifies the minimum requirements for energy/demand metering, and
(c) lays down the procedures Licensees have to adopt on maintenance, validation, collection, processing and verification of metering data.

6.2 APPLICABILITY

GMC applies to the Transmission Licensee, Distribution Licensees, Generation Licensees, Transmission Customers, all Grid Users and all Parties who are authorized to carry out distribution/supply activities, and are connected to the Grid.

6.3 OBJECTIVES

Objectives of the GMC are to ensure that,

(a) the energy/demand metering function is done in a just, fair and an unbiased manner,
(b) measuring active and reactive power and the energy flow at the interface transfer points of the Grid/Generators and Grid/Distribution Licensees, and also the Grid/Transmission Customers,
(c) Transmission Licensee as well as all the Grid Users are aware of their responsibilities in respect of the metering services,
(d) appropriate procedures are followed in providing metering data for billing and settlement, and
(e) a dispute settlement process is in operation for resolving any disputes quickly and satisfactorily.

6.4 RESPONSIBILITIES

6.4.1 TRANSMISSION LICENSEE

The Transmission Licensee, shall be responsible for the following:

(a) Installing, commissioning, maintaining, repairing, replacing, testing and inspecting all meters and associated equipment at all Connection Points in accordance with the provisions and the standards specified in this Code.
(b) Collection, storage and communication of metered data.
(c) Ensuring that meters or any associated equipment which do not meet the minimum requirements stipulated by the standards specified in this Code are removed and replaced with the least possible delay, thus guaranteeing the integrity and Overall Accuracy of the metering function.
(d) Keeping the test certificates/records for a period stipulated by PUCSL.
(e) Providing all necessary information on the preparation needed at the User end for the installation of the metering equipment.
(f) Informing the User of the meter reading dates, cumulative active and reactive energy usage where applicable, and demand for the billing period.

6.4.2 USERS

Users shall be responsible for the following:

(a) Supply meters and associated equipment in accordance with the Connection Agreement or as specified in this Code.
(b) Ensure safety of the meters and associated equipment installed in their premises.

(c) Provide unrestricted access to authorized representatives of the Transmission Licensee at all times, and where metering equipment has been installed in a restricted area, the two parties shall agree on a procedure for the Licensee to gain access to the same.
(d) Notify the Transmission Licensee of any suspected malfunctioning, defects, damages or any potential dangers to the equipment within five working days from the User becoming aware of such situations.
(e) Refrain from tampering and not to permit tampering by others, of any meters or related equipment.

6.5 METERING- GENERAL REQUIREMENTS

6.5.1 GENERATION/TRANSMISSION BOUNDARY

Energy and demand metering at Generation/Transmission boundaries shall be designed and installed in such a manner that the net output from each Generating unit and the total amount of energy exported to the Transmission Licensee's System can be accurately measured.

As far as possible, energy and demand metering shall be at the Connection Point i.e., for energy exported from the Generating unit to the Grid at the HV side of the unit transformer (step-up transformer), and for energy imported from the Grid for station consumption, on the HV side of the station auxiliary transformer.

At both Connection points, one main meter and one check meter, of static energy and demand metering type, shall be installed.

6.5.2 TRANSMISSION/DISTRIBUTION BOUNDARY

Two static energy and demand meters shall be installed at the LV (33 kV or 11kV, as relevant) side of the Power Transformers at Grid Substations, one the main meter and the other the check meter, for measuring demand and energy flow from the Grid to the relevant Distribution Licensee Systems or Transmission Customers.

In the alternative, at the request of a Distribution Licensee or if the situation demands, revenue meters may be installed on each 33kV or 11kV feeder serving the Distribution Licensee.

Energy and demand meters of acceptable accuracy, shall be installed to measure internal consumption of the Grid Substations including substation auxiliaries, lighting, fans and cooling equipment.

6.5.3 TRANSMISSION/DISTRIBUTION BOUNDARY (FOR TRANSMISSION CUSTOMERS)

Two static energy/demand meters shall be installed at the connection point one the main meter and the other the check meter, for measuring demand and energy flow from the Grid to the relevant Transmission Customer.

6.5.4 INSTALLATION OF METERING SYSTEMS AND OWNERSHIP

Generation Licensees, Distribution Licensees and Transmission customers shall provide the meters and the associated equipment, which shall include the equipment given below:

(a) Energy/demand meters
(b) Instrument transformers
(c) Communication equipment
(d) Cabling
(e) Protective devices
(f) Test terminals

The Transmission Licensee shall install the metering system in accordance with the Connection Agreement. The meters shall be installed as close as reasonably practical to the Connection Point, taking into consideration the physical location, costs and relevant technical issues.

Prior to installation, parties who provide meters and associated equipment shall submit the necessary certificates and demonstrate that all meters and equipment meet the requirements as specified in this Code. Also, they shall be responsible for testing the meters and equipment at a laboratory accredited by PUCSL.

Once installed, the Transmission Licensee shall own the metering system and will be responsible for its maintenance.

6.5.5 METERING POINT AND INTERIM REQUIREMENTS

The Metering Point shall always be at the Connection Point, as specified in the Connection Agreement.

However, in the existing system, owing to practical difficulties, some Metering Points will not coincide with the Connection Points and in such situations, compensation shall be applied for the energy and demand required for any plant and equipment that lie between the Connecting Point and the Metering Point.

The preferred method of applying compensation to enable a Virtual Metering Point will be to install meters, which have the capability of being configured for on-line dynamic loss compensation. In the alternative, compensation may be applied to the recorded meter readings. In both cases, the User and the Transmission Licensee shall reach agreement on the compensation and adjustment factors to be applied off-line.

The Transmission Licensee shall test each type of meter and equipment in accordance with the accepted standard international practice. The Transmission Licensee shall publish such information on its website and shall make the details available to Users on request.

6.6 DESIGN REQUIREMENTS

Transmission Licensee shall ensure that the design of all meters and the related equipment are in compliance with the requirements of the applicable standards including the following:

(a) Full four quadrant metering where active and reactive energy flow, or is likely to flow, in both directions .
(b) Measuring and recording the appropriate electrical quantities in accordance with the applicable tariff or other charging arrangements between the Licensee and the User.
(c) Burden requirements of the current and voltage transformers are correctly determined and used in a manner to enhance accuracy.
(d) Capable of electronic data transfer and compatible with the Transmission Licensee interrogation and data collection systems.

6.6.1 ACCURACY OF METERS AND ASSOCIATED EQUIPMENT

(a) Energy and demand meters used at the Connection Points shall be static and of Class 0.2 accuracy or higher accuracy.
(b) Current transformer and voltage transformer accuracies have to be compatible with the accuracy of the meters used.
(c) Where possible, voltage transformers shall be made to operate at the point at which maximum accuracy can be achieved.
(d) Energy and demand meters used for auxiliary energy consumption at the connection point shall be static and of Class 0.5 accuracy or of higher accuracy, and instrument transformer accuracies have to be compatible with the accuracy of the meters used.

6.6.2 PROGRAMMING REQUIREMENTS OF METERS

All meters shall be programmed to comply with the criteria listed below, in accordance with the relevant values stipulated in the applicable Tariff Decision issued by PUCSL or the Power Purchase Agreement, as relevant.

(a) MAXIMUM DEMAND

The average demand over each averaging period, commencing at 00:00 each day shall be recorded and the highest value of such recorded demand over the billing cycle, shall be recorded as the maximum demand. Unless otherwise stated in the Tariff Decision issued by PUCSL, (i) the

averaging period shall be 15 minutes, and (ii) demand shall be measured and recorded in kilovolt ampere (kVA) and kilowatt (kW).

(b) TIME OF USE

The Transmission Licensee shall ensure that all meters except those at the Generator/Transmission interfaces are programmed to comply with the time intervals of the Time of Use (TOU) tariff regime, specified in the applicable Tariff Decision issued by PUCSL for the purpose of measuring active and reactive energy, or any other quantity. The accuracy of the boundaries of each time interval shall be within ±5 minutes.

6.7 DATA COLLECTION

The Transmission Licensee shall have the right to collect, import/export data relating to Active Power, Reactive Power, Active Energy and Reactive Energy from the respective metering installations. Information may be collected by remote interrogation or manual on-site interrogation in accordance with the terms of this Code.

6.7.1 DATA STORAGE

The Transmission License shall establish a database for metering data, and for each meter installation it shall store the following:

(a) Name of the Licensee/Customer/Account number
(b) Unique identification number for the installation
(c) Site-specific adjustment factors to be applied
(d) All metering data such as Demand, Energy, MVAr, MVArh at specified intervals as required by the Transmission Licensee and the relevant Tariff Decisions of PUCSL.
(e) All information related to meters and instrument transformers.
(f) Test certificates of the metering equipment.
(g) Communication details.
(h) Date of Commissioning and Commissioning documents.
(i) Testing, calibration history and the persons who carried out the work.
(j) Fault, repair, and maintenance history of the installation.
(k) Contact details of the User representatives.

6.7.2 OWNERSHIP AND SECURITY OF THE DATABASE

The Transmission Licensee shall be the owner of the metering database and be responsible for the security of data. Database information shall be considered as strictly confidential and shall not be disclosed to any Party other than to the metered entity or to PUCSL as required by the License conditions or for law enforcement purposes.

The Transmission Licensee shall ensure the all relevant data in the database are made available on schedule to the relevant parties for billing and settlement purposes.

The Transmission Licensee may provide direct access facility for any User to the database and it shall only be limited to viewing of his own data.

6.7.3 METER READINGS AND MONITORING

All metering data shall be directly downloaded to the metering database from the respective metering installations. However, during the transition period, manual meter reading and reporting may be needed and in such instances, manual meter readings shall be taken, witnessed and certified by authorized representatives of all concerned parties.

For the purposes of remote interrogation, the Transmission Licensee may use its own data communication network. In the alternative, it shall enter into, manage and monitor contracts to provide for the maintenance of all data-links by which data is passed from metering systems of Generation Licensees, Distribution Licensees, Transmission Customers and any other Grid Users. In the event of any fault or failure of such communication lines or any error or omission in such data, the Transmission Licensee shall retrieve such data by manual on-site interrogation, duly certified by authorized representatives of all concerned parties.

6.7.4 DATA VALIDATION

The Transmission Licensee shall be responsible for data validation and substitution of metering data.

When the main metering system becomes non functional, erroneous or operating outside the prescribed limits, the Transmission Licensee shall use the check meter readings, wherever such meters are available.

Within a month from the day this Code being approved, the Transmission Licensee shall propose data estimation procedures for Generation Licensees, Distribution Licensees and Transmission Customers, to estimate the demand and energy flow, in situations when both the main meters and check meters are not available or not functioning. PUCSL shall examine the same and accept, reject or approve the same subject to modifications within two weeks from the date of submission.

Such approved procedures shall be adopted to calculate the energy and demand when metering systems are faulty.

6.8 MAINTENANCE OF METERING SYSTEMS

6.8.1 MAINTENANCE, TESTING AND AUDITING PROGRAM

The Transmission Licensee shall maintain all metering systems according to a planned program and shall keep all test results, maintenance records and sealing records in respect of all items tested/inspected. On request, relevant information shall be made available to the User.

When carrying out maintenance, testing or auditing, prior notice shall be given to Users in accordance with SLEA 2009. User's or his authorized representative's signature shall be obtained to certify the meter readings before and after testing.

The Transmission Licensee shall develop procedures on the removal or replacement of meters, and for surcharges and fines where applicable, and make such information available to Users.

6.8.2 TESTING OF METERING SYSTEMS

Metering systems shall be tested adopting the best international practices. Any testing activity shall be in one of the two categories: (i) routine testing and (ii) testing upon a request raised either by the Transmission Licensee or a User.

(a) Routine Testing

Routine testing shall be conducted according to a pre-planned schedule. The Transmission Licensee shall test all meters at least once in twelve months, and the instrument transformers at least once in five years.

(b) Testing Upon a Request

The Transmission Licensee or a User may raise a request for testing.

(i) If and when the Transmission Licensee has any doubts about the accuracy of the metering systems, a written notification shall be issued to the User. Results of the most recent routine test, which shall not be more than 12 months old (five years in case of instrument transformers) in accordance with the routine testing procedure, shall be attached to the notification. If no routine test has not been conducted within the last 12 months (five years in case of instrument transformers) or if a routine test is due within the next 30 days, the Transmission Licensee shall conduct a routine test.

(ii) A User may make a written request to the Transmission Licensee, and upon payment of the necessary charges[9], the test shall be conducted.

[9] These charges are fixed in the procedure for setting Allowed Charges.

Testing shall be arranged by the Transmission Licensee.

Sufficient notice shall be given by the Transmission Licensee announcing the test date and time, and agreement shall be reached with the User, to ensure that all relevant parties are notified of the tests, and are invited to witness them. As soon as practicable, the Transmission Licensee shall make the test results available to the relevant User.

6.8.3 METER SYSTEMS OPERATING OUTSIDE THE PRESCRIBED LIMITS

During a test, if a metering system is found to be operating outside the prescribed limits of accuracy, the Transmission Licensee shall implement the following without any delay:

(a) If the Test was Routine, as required in section 6.8.2 (a)

Restore the metering systems to operate within the prescribed limits of accuracy as soon as is reasonably practicable. No compensation shall be payable to the Transmission Licensee or the User, as the case may be.

(b) If the test was conducted upon notification by the Transmission Licensee to User, as required in section 6.8.2 (b)(i)

(i) Restore the metering systems to operate within the prescribed limits of accuracy as soon as is reasonably practicable.
(ii) Revise all charges on the basis of test results. The period for revision shall be from the date the Transmission Licensee has informed the User in writing of the suspected malfunctioning up to the date of testing.

(c) If the test was conducted upon notification by a User to the Transmission Licensee, as required in section 6.8.2 (b)(ii)

(iii) Restore the metering systems to operate within the prescribed limits of accuracy as soon as is reasonably practicable.
(iv) Refund all payments by the User as testing charges.
(v) Revise all charges on the basis of test results. The period for revision shall be from the date the User has made his written complaint up to the Transmission Licensee to the time of testing.

6.9 DISPUTES

The Transmission Licensee shall make all efforts to resolve disputes on matters related to metering and reach agreement with the User. However, if the User is not satisfied with the solution offered, the matter shall be placed before PUCSL for resolution.

7. PLANNING AND OPERATING STANDARDS

7.1 INTRODUCTION

Grid Planning and Operating Standards (GPOS) specify the technical standards, criteria and parameters used for resource planning and for planning and operation of the Transmission System.

7.2 APPLICABILITY

This GPOSC applies to the Transmission Licensee, all Transmission Customers, Transmission system Users including the Generators and all parties who are connected to the Transmission System.

7.3 OBJECTIVE

The objective of the GPOSC is to ensure that the Transmission Licensee will plan, develop and operate a coordinated and a secure Transmission System that will provide a safe, economical and a reliable electricity supply.

7.4 RESPONSIBILITIES

It is the responsibility of the Transmission Licensee to plan, develop and operate the Grid in accordance with the standards specified in this Code. The Users also have to ensure that their systems are operated, where applicable, within the limits specified in this Code.

7.5 SYSTEM PLANNING STANDARDS

7.5.1 DECLARED FREQUENCY AND VOLTAGES OF SUPPLY

The declared frequency of supply shall be 50 Hz.

The declared Transmission voltages shall be 132,000 V and 220,000 V between any two phases.

7.5.2 VOLTAGE REGULATION

The voltage (RMS) profile shall be planned within the following limits under normal operating conditions;

Table GPOS-1: Declared Transmission Voltages and Tolerance under Normal Operating Conditions

Voltage	Tolerance
220,000 Volt	± 10% from the Declared Voltage
132,000 Volt	± 5% from the Declared Voltage
33,000 Volt and 11,000 Volt	± 2% from the Declared Voltage

Supply voltage levels (RMS) under all three categories above shall be maintained within the following under emergency conditions.

Table GPOS-2: **Declared Transmission Voltages and Tolerance under Emergency Operating Conditions**

Voltage	Tolerance
220,000 Volts	± 5% to ±10% from the Declared Voltage
132,000 Volts	± 10% from the Declared Voltage
33,000 Volts 11,000 Volts	± 2% from the Declared Voltage

7.5.3 RELIABILITY CRITERIA

The system shall be planned to maintain voltages and thermal loading to provide performance of the network to satisfy the N-1 criterion. For this purpose, the Transmission System shall be considered to comprise N components, made up of Generating Units, step-up transformers in each generating unit, and transmission circuits. A Grid Substation components included in the N components are step-down transformers, switchgear and measuring equipment, tap-changing equipment and reactive power compensation equipment.

7.5.4 THERMAL LOAD LIMITS

(a) Normal Operating Condition

Under normal operating conditions, overloading of conductors and transformers shall be avoided.

The Transmission Licensee shall develop at least two thermal ratings in terms of load carrying capacities for all relevant individual circuit element of the Transmission system. These are Normal Cyclic Capacity (NCC) and Short Term Emergency Capacity (STER).

NCC becomes applicable under normal operating conditions, whereas STER is used under contingency situations. (IEC 60853, 60826, 60949)

(b) Unbalanced Loading

Unbalanced loading on the system shall be in accordance with the IEEE Standard C37.102-1995: IEEE Guide for AC Generator Protection or other relevant standards specified by the Transmission Licensee. The above information shall be submitted to the PUCSL for record purposes.

7.5.5 SHORT CIRCUIT LIMITS

Maximum design fault levels of the grid are shown in the Table GPOS-3.

Table GPOS-3: Design Fault Levels

Bus bar voltage	Transmission or Distribution System	Maximum 3-phase fault level (kA)	Maximum 1-phase fault level (kA)
132 kV and above	Overhead	40.0	xxx
	UG cable	40.0	xxx
33 kV	Overhead	13.1	xxx
	UG cable	16.0	xxx
11 kV	UG cable	20.0	xxx
11 kV	Overhead	xxx	xxx

7.5.6 ECONOMIC CRITERIA

The following economic criteria shall be used:

- Establishment of cost of losses
- Reliability: loss of sales and economic cost of unserved energy
- Economic selection of conductors and cables

7.6 OPERATING STANDARDS

7.6.1 RELIABILITY GUIDELINES

The reliability levels shall be assessed using internationally accepted standard reliability indices, given below

(i) System Average Interruption Duration Index (SAIDI)

(ii) System Average Interruption Frequency Index (SAIFI)

7.6.2 POWER QUALITY GUIDELINES

(a) Voltage Imbalance

The degree of voltage unbalance, which is defined as the ratio between the rms values of the negative sequence component and the positive sequence component of the voltage unbalance shall be kept within 1%. IEEE Standard C37.102-1995: IEEE Guide for AC Generator Protection.

(b) Voltage Fluctuation

Voltage fluctuation shall not exceed x provided it does not exceed a risk to the Grid or to any User Systems. P28 Engineering recommendations of UK may be used for guidance.

(c) Harmonics

Voltage fluctuation for harmonics IEEE 519 shall be used as the applicable standard.

7.6.3 GUIDELINES FOR SYSTEM LOSSES

For each Tariff Period[10], PUCSL shall impose a cap on technical and non-technical losses for the Transmission System.

7.6.4 GUIDELINES FOR CUSTOMER & SYSTEM POWER FACTOR

Power factor at customer points and in general within the system shall be monitored using the energy and demand meters. It is necessary to maintain the power factor close to unity to improve the effective utilization of the network, reduce power losses and improve the supply voltages. PUCSL may issue guidelines on power factor from time to time, if the need arises.

7.6.5 SYSTEM SECURITY GUIDELINES

In addition to the planning criteria stated above, the future transmission developments plans shall be developed conforming to the load security criteria given in the Table GPOS-4.

Table POS-4: Load Security Criteria

Class of supply	Range of group demand	Minimum demand to be met after	
		1st Circuit Outage	*Supply Implication*
A	up to 6 MW	In repair time Group demand	No Requirement
B	over 6 MW to 12 MW	a. Within time to switch in standby transformer Group demand minus 6MW b. In over head line repair time Group demand	Requirement for standby transformer and associated switch gear, etc., but a single circuit over head line is acceptable.

[10] Please see the current version of the "Methodology for Tariffs", PUCSL.

C	over 12 MW to 24 MW	c. Within time to switch in standby transformer Group demand minus 12MW d. Within three hours Group demand	Requirement for standby or (firm) transformer capacity and for duplicate over head line or cable supply route
D	over 24 MW to 60 MW	e. Within 15 Minutes for group demand from 36 MW to 60MW **:** 2/3 of Group demand f. Within three hours Group demand	No requirements. Alternative supply as per Class C
E	over 60 MW to 300 MW	g. Within 60 Seconds Group demand minus 20MW (Automatically disconnected) h. Within 3 hours Group demand	i. Within 3 hours For group demand from 100MW to 150MW**:** Group demand-100MW For group demand from 150MW to 300MW**: ½** group demand j. Within time to restore arranged outage Group demand
F	over 300 MW	k. Immediately Group demand	l. Immediately ½ group demand m. Within time to restore arranged outage Group demand

Note:

A circuit is the part of an electricity supply system between two or more circuit breakers switches and/or fuses inclusive. Bus bars are not considered as circuits.

8. INFORMATION AND DATA EXCHANGE

8.1 INTRODUCTION

Grid Code Information and Data Exchange, provides a summary of information and data requirements to be exchanged between the Transmission Licensee, Users and those who are seeking connection to the Grid, as required by the Transmission Licensee.

The Grid Code requires the Licensees, Customers, Consumers, Users and PUCSL to exchange and update information/data from time to time. The purpose of this part of the Grid Code is to summarize such information/data requirements, and to recommend the appropriate formats for the submission of the same.

8.2 APPLICABILITY

This part of the Grid Code applies to the Transmission Licensee, Generators, all Distribution Licensees, Transmission Customers and all system Users including embedded generators.

8.3 OBJECTIVES

The objective of this part of the Grid Code is to establish a mechanism and a series of forms and formats to collate and list all data/information to be submitted by the Transmission Licensee, System Users, PUCSL and vice versa.

8.4 RESPONSIBILITIES

Generators, Distribution Licensees, all system Users and all who seek connection to the Grid shall be responsible for submitting all necessary data/information as required by this Code. Accuracy of the data/information submitted will be the responsibility of the system Users who submit the data.

The Transmission Licensee shall provide all information and data as required by this Code to the Grid Users, prospective Users, other Licensees and PUCSL.

Any data, which Users fail to provide as required by the Grid Code, may be estimated by the Transmission Licensee, based on data previously supplied. Responsibility for the accuracy of such data rests with the relevant system Users, and the Transmission Licensee will in no way be held responsible for whatever decisions taken on results of studies carried out using such data.

8.5 DATA AND INFORMATION TO BE SUBMITTED TO THE TRANSMISSION LICENSEE UNDER GRID PLANNING CODE AND GRID CONNECTION CODE

8.5.1 GENERATORS

- **General Information**

Applicants requesting for a new grid connection of generators or a modification of existing connection shall submit the following data at the preliminary stage.

Information Description	Value or description	Grid Code Reference
Name of the proposed generation facility and location (as decided by the Transmission Licensee)		3.12.1 (GCC) 2.9 (GPC)
Description of the project		
-Total generation capacity (MW and MVA)		
-Total power required for auxiliaries		

Information Description	Value or description	Grid Code Reference
Type of generator (hydro, wind, gas turbines, steam) and capacity of each unit		
Single line diagram, which shall include the following: Bus bar arrangements Electric circuit configurations (overhead lines, under ground cables, Transformers) Switchgear Current transformers, voltage transformers Operating voltages Earthing arrangements Numbering and nomenclature		
Location maps, site plans		
Transmission line route for the connection to the grid		
Scheduled date of commissioning		

- **Performance Information**

i. Generator

The information shall be provided for each unit where applicable.

Information Description	Value or description	Grid Code Reference
Unit number		3.12.5
Manufacturer		
Rated generation voltage		
Rated MVA capacity		
Power factor: over excited and under excited		
Short circuit ratio		
Direct axis short-circuit time constants • Transient (T_d') seconds • Sub-transient (T_d") seconds		
Direct axis open-circuit time constants • Transient (T_{do}') seconds • Sub-transient (T_{do}") seconds		
Quadrature axis open-circuit time constants • Transient (T_{qo}') seconds • Sub-transient (Tqo") seconds		
Direct axis synchronous reactance (X_d) • Unsaturated %		
Direct axis transient reactance (X_d') • Unsaturated % • Saturated %		
Direct axis sub-transient reactance (X_d") • Unsaturated % • Saturated %		
Quadrature axis unsaturated reactance • Synchronous (X_q) % • Transient (X_q') % • Sub-transient (X_q") %		
Potier reactance (X_p) %		
Leakage reactance (X_l) %		
Negative phase sequence reactance (X_2) %		
Zero phase sequence reactance (X_0) %		
Armature winding short-circuit Time constant (T_a) seconds		
Main field current at no load and at rated voltage (Ampere)		
Main field current at full load, rated voltage and rated power factor overexcited (Ampere)		
Resistance of main field windings at operating temperature of ___ ^{o}C ___Ohm		

Information Description	Value or description	Grid Code Reference
Machine damping factor (K_D)		
"Turbine + *Generat*ing *Unit*" Inertia Constant (H) = MW x seconds/MVA		
Saturation curves • To indicate the corresponding field current values at 1.0 pu and 1.2 pu of terminal voltage on the air-gap and open circuit curves. (a) V-curve (b) Reactive capability curve Factory test reports and field test result, if any		

ii. Excitation System

Item	Value or description	Applicable Article in the Grid Code
Voltage regulator model		3.12.5
Functional description and block diagram of the excitation system and the Automatic Voltage Regulator showing transfer functions of individual elements		3.9.6
The setting and block diagram of the minimum and maximum excitation limiters showing transfer functions of individual elements to be provided on IEEE formats. (IEEE421.5)		
Generator reactive power limits (generator PQ capability curve) addressing effects of all control, protection, and operating/ equipment limits that can restrict reactive power output		

iii. Power System Stabilizer

Information Description	Value or description	Grid Code Reference
Functional description and block diagram of the Power System Stabilizer (PSS) (if installed) showing transfer functions of individual elements to be provided on IEEE formats. (IEEE Vol PWRS–1 No.3 pp 95-100) or PSSE format		3.12.5
Report on methodology in deriving the PSS setting, including simulation results and tuning procedures.		3.9.6

iv. Governors

Information Description	Value or description	Grid Code Reference
Functional description and Governor Block Diagram showing transfer function of individual elements		3.12.5,
Governor time constant		3.9.7
Governor speed droop setting range		
Governor Dead band • Maximum Setting ±Hz • Normal Setting ±Hz • Minimum Setting ±Hz		

v. Generator Transformer

Information Description	Value or description	Grid Code Reference
Rated capacity MVA		
Rated voltage • Primary (kV) • Secondary (kV)		3.12.5
Nominal voltage ratio, primary/secondary		
Positive sequence impedance at • Maximum tap (%)		

Information Description	Value or description	Grid Code Reference
• Minimum tap (%) • Nominal tap (%)		
Zero phase sequence impedance (%)		
Tap changer range + % to - %		
Tap changer step size %		
Tap changer type on load / off load		
Earthing • Primary • Secondary		
Vector Group		
Magnetizing curve		

vi. Prime Movers

Hydro Turbines

Information Description	Value or description	Grid Code Reference
Rated capacity (MW)		3.12.5
Water Time Constant (in seconds)		
Inertia constant (H, in seconds)		

Steam Turbines

Information Description	Value or description	Grid Code Reference
Rated capacity (MW)		3.12.5
Power fraction for High Pressure (HP), Intermediate Pressure (IP) and Low Pressure (LP) turbines.		
Functional description and block diagram showing transfer function of individual element of the governor, turbine and boiler		
HP steam extraction range (expressed in terms of the boiler rated output)		
Details of HP steam extraction valves		
General boiler control strategy		
Test data/reports • Load rejection tests • Load step response tests • Frequency response tests Control and intercept valve curves: • position vs. signal • valve opening vs. signal • Closing/opening speed tests		

Gas turbines: Open Cycle and Combined Cycle

Information Description	Value or description	Grid Code Reference
Rated capacity (MW)		
Performance data and curves • Power vs fuel consumption • Exhaust temperature vs. fuel consumption • Power vs. ambient temperature • Power vs. speed • Inlet guide vane effects		3.12.5
Functional description and block diagram of gas turbines units showing transfer function of individual elements (including effect of ambient temperature) in PSSE format		

Test data/report: • Load rejection tests • Frequency response tests		
Steam turbines for closed cycles shall provide the data required under 8.4.2 - Steam Turbines		

Wind Turbines

Information Description	Value or description	Grid Code Reference
A detailed simulation model of the wind turbine(s) to be used in PSS/E format		3.12.5
Rated capacity (MW)		
Generator type: cage rotor, doubly fed induction generator or synchronous, constant speed or variable speed		
Inertia constant (H, in seconds)		
Power converter rating where applicable		
Frequency tolerances • Frequency range within which continuous operation is guaranteed. • Time based capabilities for frequencies lower and above the limits where continuous operation is guaranteed		
Voltage tolerance • Continuous operation • Time based capabilities for voltages lower and above the limits where continuous operation is guaranteed		
Low voltage ride through (LVRT/FRT) • Curve showing the tolerable drop in voltage, settling time to resume normal output.		
Unbalanced loading • Negative phase sequence withstand		
Active power regulation • Ramp rate (% of rated output per minute)		
Frequency Control • Frequency response (regulate the output above a certain defined frequency, say 50.2 Hz)		
Reactive power capability • Limits on lagging and leading power factors within which the rated output can be guaranteed. • P-Q capability curve		

vii. Generator Protection

Information Description	Value or description	Grid Code Reference
Current transformer and voltage transformer details, such as ratios, burdens and class		3.12.5
Generator protection relay settings and calculations with the grading curves/characteristics		3.9.10
Relay settings for all other devices		

viii. Other Information

Information Description	Value or description	Grid Code Reference
Safety Manual and schemes at the User facilities and for the		3.12.5

Information Description	Value or description	Grid Code Reference
Connection Point		
All requested technical diagrams of the Connection		
List of names and telephone numbers of the Applicant's authorized representatives		
Proposed maintenance program for the Connection Point equipment		
Protection schemes and relay settings		
All calculations related to relay settings		

8.5.2 DC CONVERTER STATIONS

Information Description	Value or description	Grid Code Reference
Rated MW per pole for transfer in each direction		3.12.5
DC Converter type (i.e. current or voltage source)		
Number of poles and pole arrangement		
Rated dc voltage/pole (kV)		
Return path arrangement		
mentioned above in the 4th row		
Rated dc current per pole		
Single line diagram of the complete dc Network		
Details of the complete dc Network including resistance, inductance and capacitance of all dc cables and/or dc lines		
Details of any dc reactors (including dc reactor resistance)		
DC capacitors and/or dc-side filters that form part of the dc Network		
AC filter reactive compensation equipment parameters		
DC Converter control system models		
Nominal and maximum (emergency) loading rate with the dc Converter in rectifier mode.		
Nominal and maximum (emergency) loading rate with the dc Converter in inverter mode		
Maximum recovery time, to 90% of pre-fault loading, following an AC system fault or severe voltage depression. Maximum recovery time, to 90% of pre-fault loading, following a transient dc Network fault.		
Harmonic Assessment Information		

(a) DC Converter Transformers

Information Description	Value or description	Grid Code Reference
Rated MVA		3.12.5
Nominal primary voltage (kV		
Nominal secondary (converter-side) voltage(s) (kV);		
Winding and earthing arrangement		
Positive phase sequence reactance at minimum, maximum and nominal tap		
Positive phase sequence resistance at minimum, maximum and nominal tap		
Zero phase sequence reactance		
Tap-changer range in %		
number of tap-changer steps		

8.6 TRANSMISSION CUSTOMERS

(a) General Information

Information Description	Value or description	Grid Code Reference
Customer Name		*2.6.4.1*
Contact Address		
Reference no/Account no:		

Information Description	Value or description	Grid Code Reference
Telephone		
Email Address		
Authorized Officer's Name		
Connection Point Coordinates		
Equipment Specifications		

(b)Performance Information

(i) Transformer

Information Description	Value or description	Grid Code Reference
Rated capacity MVA		3.12.5 , 2.9.7
Rated voltage • Primary (kV) • Secondary (kV)		
Winding arrangement and vector group		
Nominal voltage ratio		
Positive sequence impedance (%)		
Zero sequence impedance (%)		
Tap changer range + % - %		
Tap changer step size %		
Tap changer type: on-load or off-load		
Earthing • Primary • Secondary		
Tap changer type on load/off load		
Vector Group		

(ii) User Substation Arrangements

Information Description	Value or description	Grid Code Reference
Single line diagram, which shall include the following: Busbar arrangements Electric circuit configurations (overhead lines/underground cables, transformers) Switchgear Current transformers, voltage transformers Operating voltages, Earthing arrangements Numbering and nomenclature		3.12.5,2.9.7

(iii) User Load Information

Motors

Information Description	Value or description	Grid Code Reference
Motors • MW rating • Power factor • Rated current at full load • Voltage • starting method and starting current; • inertia constant for the motor and the driven load		3.12.5,2.9.7

Load Details

Information Description	Value or description	Grid Code Reference
Estimated details on the types of its loads and the estimated profile of each major load (e.g. air conditioning, combined heat and Power, motors, drives, etc.) Connected Load		3.12.5,2.9.7

(iv) Other Information

Information Description	Value or description	Grid Code Reference
Safety Manual and safety schemes at the User facilities and for the Connection Point		3.12.5, 3.12.8, 2.9.7
All requested technical diagrams of the Connection		
List of names and telephone numbers of the Applicant's authorized representatives		
Proposed maintenance program for the Connection Point equipment		
Protection schemes and relay settings		
All calculations related to relay settings		

8.7 DATA AND INFORMATION TO BE SUBMITTED TO THE TRANSMISSION LICENSEE UNDER GRID OPERATIONS CODE AND GRID DISPATCH CODE

8.7.1 DISTRIBUTION LICENSEES

(a) Load Forecast for the Operational Area

Year	Energy (GWh)			Demand (MW)		
	Day	Peak	Off peak	Day	Peak	Off peak
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Note: Day, Peak and Off-peak refer to time intervals in the time-of-use regime. For a description and the time intervals so defined, please see the current Tariff Decision.

(b) Grid Substation wise Load Forecast

Year	Minimum Demand (MW)			Maximum Demand (MW)		
	Day	Peak	Off peak	Day	Peak	Off peak
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Note: Day, Peak and Off-peak refer to time intervals in the time-of-use regime. For a description and the time intervals so defined, please see the current Tariff Decision.

(c) Embedded Generator Information

Each Distribution Licensee shall submit all data in respect of embedded generator operation and all technical information related to such generators/transformers etc.

8.7.2 TRANSMISSION CUSTOMERS

(a) Load Forecast

Year	Energy			Maximum Demand		
	Day	Peak	Off peak	Day	Peak	Off peak
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

8.8 DATA AND INFORMATION TO BE SUBMITTED TO PUCSL BY THE TRANSMISSION LICENSEE

(a) In accordance with the Grid Planning Code

Information Description	Value or description	Grid Code Reference
Long term Transmission Development Plan		
Least-cost Generation Expansion Plan		

(b) In accordance with the grid Operations Code and Grid Dispatch Code

Information Description	Value or description	Grid Code Reference
Hourly Generator unit loadings (MW and MVAr)		
Reservoir levels at 0000 daily		

8.9 DATA AND INFORMATION TO BE SUBMITTED BY PUCSL TO THE TRANSMSSION LICENSEE

Information Description	Grid Code Reference
Planning and Operating Standards	*Section 8*

APPENDIX 1: RULES AND PROCEDURES FOR GRID CODE ENFORCEMENT AND REVIEW PANEL

Reference in the code: section 1.1.5.1

1. Functions

Functions of the GCERP shall be as follows:

(a) Positively contribute to the effective enforcement of the Grid Code
(b) Monitor and evaluate the working of the Grid Code and make recommendations to PUCSL for effective implementation.
(c) Review all suggestions and amendments proposed by any party and make suitable recommendations to PUCSL.
(d) Initiate and coordinate revisions and regular reviews to the Grid Code and make suitable recommendations to PUCSL for incorporation.
(e) Facilitate the publishing of the proposed amendments and the reasons for the recommendations.
(f) Facilitate the resolution of issues brought up by the members of the GCERP or by the PUCSL and submit its recommendations to PUCSL.
(g) Produce an annual report on the activities of the Panel.

2. Membership

2.1 The GCERP shall consist of nine members as follows:

(a) Two members representing the Transmission Business and Bulk Supply Operation Business of the Transmission Licensee, respectively.
(b) One member representing the Distribution Licensees who shall also be a member of the Distribution Code Enforcement and Review Panel (DCERP) as well.
(c) Two members representing the state-owned generators.
(d) One member representing privately owned generators of installed capacities exceeding 100 MW
(e) One member representing privately owned generators of installed capacities less than 100 MW
(f) One member representing the bulk supply customers served by the Transmission System.
(g) Director (Licensing) of PUCSL shall function as the Secretary to the panel.

2.2 All members representing Licensees shall be electrical engineers serving in senior positions.

3. Chairperson

(a) GCERP shall elect one of its members as the Chairperson of the GCERP.
(b) Term of office for a Chairperson shall be for one year.
(c) Chairperson, on completion of his term may be appointed for a maximum of one more term.

4. Secretary to GCERP

(a) Director - Licensing of PUCSL shall function as the Secretary of the GCERP (Secretary).
(b) The Secretary shall not be a member of the GCERP and shall not have voting rights.
(c) The Secretary shall be responsible for all administrative work of the GCERP and also for keeping PUCSL informed of GCERP activities and progress, as directed by GCERP.
(d) The Secretary may delegate his duties to another officer of the PUCSL, with the approval of the GCERP.
(e) The Secretary may use the facilities and human resources available in PUCSL to carry out the duties entrusted to him/her with regard to the GCERP.

5. Appointment of Members to GCERP

(a) The Secretary shall request the organizations listed in Section 2 to nominate suitable officers having requisite qualifications and experience to be appointed as members of GCERP, within 14 days from the date PUCSL approves the Grid Code.
(b) All organizations from which such requests have been made shall be required to nominate suitable officers within two weeks from the receipt of the request under 5(a).
(c) Within seven days from the receipt of the said nominations, the Secretary shall seek approval of the PUCSL to appoint them as the members of the GCERP.
(d) Unless PUCSL has valid reasons to refuse acceptance of the nominations, PUCSL shall approve the same.
(e) If PUCSL decides against any of the nominations, the Secretary shall inform the relevant Licensee or organization accordingly and request for new nominations.
(f) Within a week from the date PUCSL grants approvals to the nominations, the Secretary shall inform the member and the relevant organization accordingly.
(g) Whenever a vacancy occurs in the GCERP, the above procedure shall be followed and vacancies shall be filled within 30 days from the day vacancy/vacancies occurred.

6. Period of Membership

(a) The term of office of a member of GCERP shall be for two years from the date of appointment.
(b) Of the first members of the GCERP, four members representing Licensees shall hold office for 6 months, 9 months, 12 months, 18 months respectively.
(c) GCERP shall decide on the members whose terms will be limited as stated in (b).
(d) No member shall hold office continuously for a period exceeding four years.

7. Cessation of Membership of GCERP

A person who is a member of GCERP shall cease to be a member if

(a) he ceases to be an employee of the Licensee which nominated him/her
(b) he ceases to be holding the position in the organization that nominated him/her to the GCERP in the case of nominees of organizations other than Licensees
(c) he does not attend more than three consecutive meetings, or more than four meetings in a year, without the approval of the GCERP
(d) if he resigns from the GCERP on his own accord.

8. Meetings of GCERP

(a) The Chairperson shall summon all meetings of the GCERP and at least one meeting shall be convened every month.
(b) Any member of GCERP may request the Chairperson to call a meeting, and the Chairperson shall not turn down such requests, unless he/she has good reason to do so.
(c) The Chairperson shall preside at all meetings, and in his absence, GCERP shall elect one of its members as Chairperson pro tem.
(d) At least five days' notice of the date, time and place for the holding of normal meetings shall be given.
(e) An agenda shall be provided with the Notice of Meeting.
(f) A quorum shall consist of not less than five members, and the Chairperson shall be considered as a member in a quorum count.
(g) In the event that all the business contained on the agenda cannot be dealt with judiciously within the time allocated for the meeting an adjournment shall occur.
(h) The Chairperson with the consent of GCERP may invite guests with relevant expertise to specific meetings.

9. GCERP Decisions

Decisions shall normally be by consensus, except at the request for a vote on specific requests by any member.

10. Reimbursements

All members shall be paid an allowance and reimbursement of traveling expenditure for every meeting a member participates.

11. Expenses, Accounts and the Budget

PUCSL shall bear all expenses of the GCERP and the Secretary shall be responsible for maintaining its accounts.

(a) Secretary shall prepare the annual budget for the GCERP's consideration.
(b) Annual budget for the ensuing year must be adopted by the GCERP on or before 30th July of the current year.
(c) The adopted budget shall be forwarded to the PUCSL with the recommendation that it be incorporated in its "statement setting out expenditure" for the next financial year.
(d) PUCSL may l accept the budget. In the event any revisions/amendments, are required , PUCSL and GCERP will resolve the issues through discussions.