ELECTRICITY GRID CODE
OF
LIBERIA

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Foreword

The Liberia Electricity Grid Code (LEGC) specifies the framework for connection and usage of the grid, system services, grid expansion and procedures for the planning and operation of the transmission system during normal and exceptional conditions. It is a live working document which will be continuously subjected to revisions and amendments to comply always with existing policy, legislation, and good industry practices.

The LEGC is prepared using a functional rather than an organisational approach , so that it will remain robust and require minimal changes as the Liberia electricity industry evolves and the reforms proceed. It identifies and defines the responsibilities of two key independent functional entities in the Liberia electricity market, the Transmission Network Asset Owner (NGC) and the Transmission System Operator (TSO). These functional entities, together with other GCPs connected to the transmission network, and including electricity traders operating within the Electricity Market must comply with the provisions of the LEGC and the Market Operation Rules (MOR) which is yet to be developed by the TSO for approval by the LERC. The LEGC development approach further allows for a consistent improvement of the quality of electricity supply levels and the associated performance standards and benchmarks for the TSO and the transmission network service provider or the NGC (referred to as the TGCP in the LEGC) as their expertise develops.

Proposals for changes to the LEGC will be received by a Grid Code Advisory Committee (GCAC). The GCAC is a stakeholder representative committee, and its composition is laid out in the LEGC. The roles and responsibilities of the GCAC are prescribed in the LEGC among which includes proposition of recommendations to the LERC for changes to the Code.

This LEGC provides a general framework for the revision of existing Technical Standards and Procedures thereby ensuring harmonization for the safe, secure, and reliable operation of the Liberia Interconnected Transmission System (LITS). It will work in conjunction with other legal and regulatory documents, including but not limited to the 2015 Electricity Law of Liberia (ELL), the Liberia National Energy Policy as of May 2009 (or any other policy thereafter approved), the Liberia Distribution Code and other codes, rules and regulatory guidelines issued by the LERC.

Part A: General Provisions

Part A, General Provisions, establishes the guiding principles and purpose of the Liberia Electricity Grid Code (LEGC); defines the scope of the principal actors involved under the LEGC; provides the definition of roles and responsibilities, derogations, and transitional measures to assist actors in meeting their obligations under the Code; and elaborates arrangements for the governance and management of the LEGC. This Part also establishes the hierarchy of the LEGC relative to the Law, the Regulations, other codes, and rules, and contains a Section that provides meaning of acronyms (or terminology) used in the LEGC.

Section 1: Preamble

1.1 Purpose and Scope of the Liberia Electricity Grid Code (LEGC)

1.1.1 The Liberia Electricity Grid Code (LEGC) is formulated to ensure efficient coordinated operation and maintenance of the Liberia Interconnected Transmission System (LITS). The LEGC is a dynamic document that is revised periodically in accordance with laid down procedures, considering the reasonable interests and views as expressed by the stake holding entities in the light of new developments and the experience gained in the actual implementation of the Code.

1.1.2 This LEGC is approved by the Liberia Electricity Regulatory Commission (LERC) following extensive deliberations by stakeholders and it is based on the provisions of Sections 3.3: A. 5, 6, 8, 9, B.4 and 3.4 of the 2015 Electricity Law of Liberia (ELL) that together mandate the LERC to establish the LEGC to ensure the coordinated technical operation, maintenance, and performance monitoring of the high voltage transmission system within Liberia.

1.2 Objectives of the LEGC

1.2.1 The objective of the LEGC is to provide fair, transparent, non-discriminatory, safe, reliable, secure and cost-efficient delivery of electrical energy through establishment of requirements, procedures, practices and standards that govern the planning, development, connection, operation, maintenance and use of the LITS.

1.2.2 The LEGC describes the responsibilities and obligations associated with all the functions involved in the generation, transmission and supply of bulk electric power and energy over the LITS including the functions of the TSO, NGC (or the Transmission Service Provider), a Wholesale supplier (Generation Company or Trader), a Distribution Company and a Large Consumer. The Code also defines the boundaries of operation and interactions with international power pool operations, as part of West Africa Power Pool (WAPP).

1.3 Application of the LEGC

1.3.1 The following are the parties bound by the LEGC:

(a) The Transmission System Operator (TSO);
(b) The National Grid Company (NGC) or Transmission Services Provider;
(c) Generation companies with assets directly connected to the transmission network;
(d) Licensed electricity Import or Export Traders;
(e) The WAPP Operator, to the extent that their operation impacts the Liberia electricity network;
(f) Distribution Companies with equipment connected to the transmission network;
(g) Large Consumers with assets directly connected to the transmission network(s);
(h) Significant embedded generators (embedded in the distribution network);

(i) Ancillary service provider; and
(j) The Market Operator (MO) [regulation 50 of the Electricity Licensing Regulations (ELR) mandates the TSO to assume this role in the interim].

1.3.2 Except for the TSO and the MO, all the parties listed under sub-section 1.3.1 shall be referred to in this LEGC as "Grid Code Participants" or "GCPs".

1.3.3 A GCP shall be a legal entity either:
(a) with an Asset Vesting Agreement with the TSO granting the TSO operational control of all Connection points in the LITS – in the case of a Transmission GCP, or
(b) having a valid Connection Agreement with the TSO for the purposes of:
(i) constructing, owning and providing LITS infrastructure or ancillary services;
(ii) injecting, wheeling, or off-taking power for its own use or for retail; or,
(iii) exchanging power either with the electricity networks of neighboring countries or within the WAPP.

1.3.4 The TSO and all GCPs shall comply with the provisions of the ELL, the terms and conditions of the ELR and issued licenses (where applicable) as well as the approved LEGC and any other applicable regulations, rules and legislation.

1.3.5 A breach of any of the instruments mentioned in sub-section 1.3.4 could result in the sanctioning, suspension, or withdrawal of the applicable License.

1.4 Hierarchy

1.4.1 For guidance of the parties to this Code, it is noted that the hierarchy of documents related to the Code is as follows, from the highest to the lowest:
(a) The ELL;
(b) The ELR issued by the LERC;
(c) The Electricity Tariff Regulations and Methodology issued by the LERC;
(d) The Customer Service and Quality of Supply Regulations as issued from time to time by LERC;
(e) The Operating License of the connected entity;
(f) This LEGC and any other codes, rules, regulations, or procedures issued by the LERC; and
(g) Any codes, rules, procedures, and protocols issued by the WAPP.

1.4.2 In the event of conflict, the document highest in the hierarchy takes precedence. Where a GCP encounters conflict between any of the documents listed in sub-section 1.4.1, the GCP should seek advice from the TSO, the Grid Code Advisory Committee (GCAC) and ultimately the LERC.

Section 2: Abbreviations

In this Liberia Electricity Grid Code, the following abbreviations mean:

AC	Alternating Current
AFLC	Automatic Frequency Load Control
AFLS	Automatic Frequency Load Shedding
AGC	Automatic Generation Control
AVR	Automatic Voltage Regulation
BST	Bulk Supply Tariff
BIL	Basic Insulation Level
CLSG	Cote d'Ivoire - Liberia - Sierra Leone – Guinea Transco
CO_2	Carbon dioxide
CS & QoS	Customer Service and Quality of Supply Regulations
CT	Current Transformer
DC	Direct Current
ECOWAS	Economic Community of West African States
EHV	Extra High Voltage
ELL	2015 Electricity Law of Liberia
EMS	Energy Management System
EMT	Electromagnetic Transient
ELR	Electricity Licensing Regulations
EPA	Environmental Protection Agency
EPSRP	Emergency Power System Restoration Plan
ERERA	Ecowas Regional Electricity Regulatory Authority
GCAC	Grid Code Advisory Committee
GCP	Grid Code Participant
GDP	Grid Development Plan
GoL	Government of Liberia
GPS	Global Positioning System
GWh	Gigawatt-hour or one billion watt-hours of energy
HV	High Voltage
HVRT	High Voltage Ride Through

IEC	International Electro-technical Committee
IEEE	Institute of Electrical & Electronic Engineers
IHD	Individual Harmonic Distortion
ITU	International Telecommunication Union
kVar	Kilovar, or one thousand volt-amperes of reactive power
kW	Kilowatt or one thousand watts of active electric power
kWh	Kilowatt-hour or one thousand watt-hours of electrical energy
LCTDMP	Least Cost Transmission Development Master Plan
LEC	Liberia Electricity Corporation
LERC	Liberia Electricity Regulatory Commission
LEGC	Liberia Electricity Grid Code
LITS	Liberia Interconnected Transmission System
LV	Low Voltage
LVRT	Low Voltage Ride Through
MD	Maximum Demand
MDF	Main Distribution Frame
MO	Market Operator
MOR	Market Operation Rules
MOU	Memorandum of Understanding
MVar	Megavar, one million volt-amperes of reactive electric power
MW	Megawatt, one million watts of active electric power
NGC	National Grid Company
NOx	Nitric oxide gases
PLC	Power Line Carrier
PPA	Power Purchase Agreement
PoC	Point of Connection
PSA	Power Supply Agreement
PSS	Power System Stabilizer (or stabilization)
PV	Photo Voltaic
Plt	Long term flicker Perceptibility
Pst	Short term flicker Perceptibility
RAS	Remedial Action Schemes
RETs	Renewable Energy Technologies

RMR	Reliability Must-Run
RMS	Root Mean Square
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
SFRS	Secondary Frequency Regulation System
SO_2	Sulphur dioxide
SPS	Special Protection Scheme
TGCP	Transmission Grid Code Participant
THD	Total Harmonic Distortion
TLR	Transmission Loss Ratio
TSO	Transmission System Operator
TSP	Transmission Service Provider
UTC	Coordinated Universal Time
VAR	Volt Amperes Reactive
VRPP	Variable Renewable Power Plant
VT	Voltage Transformer
WAPP	West Africa Power Pool

Section 3: Roles And Responsibilities Of Main Actors

3.1 Background

The open-access transmission service that is envisaged for the LITS requires extensive coordination of the roles and responsibilities of the several actors *(listed in Section 1.3 of the LEGC)* to successfully deliver the required service.

3.2 Roles of Main Actors

3.2.1 The TSO is the exclusive and independent operator of all transmission assets irrespective of ownership and shall play the central role in respect of activities related to the LITS. The TSO shall operate the system and render the services in a fair, transparent and non-discriminatory manner in line with the prescribed standards and quality to all qualified entities *(or GCPs)*.

3.2.2 The Grid Code Advisory Committee (GCAC) of the LERC established under Section 5 of the LEGC shall have the mandate to oversee the activities and decisions of the TSO towards ensuring the attainment of the objectives of the LITS.

3.2.3 The National Grid Company (NGC) is the transmission asset owner *(or Transmission GCP)* and shall have responsibility for the design, construction, and maintenance of the transmission assets which will be used in providing the transmission services.

3.2.4 A Generation GCP is a wholesale supplier who shall construct, maintain, and operate power plants in accordance with the instructions of the TSO to provide wholesale electricity supply through the LITS to distribution companies and consumers.

3.2.5 A Distribution GCP (or Distribution Company) or Large Consumer GCP who wishes to off-take power from the LITS shall design, construct, and operate its network that is connected to the LITS in accordance with the prescribed standards and instructions of the TSO.

3.2.6 An Import/Export Trader GCP is a Wholesale supplier that uses the LITS facilities interconnected with the electricity networks of a neighboring country in the WAPP for electric power and energy transactions and shall do so in accordance with the provisions of this LEGC, the ECOWAS Energy Protocol and the WAPP Operations Manual.

3.2.7 The TSO, in performing the functions as Market Operator (MO), is responsible for the procurement and settlement aspects of the electric power and energy transactions over the LITS in accordance with Market Operation Rules (MOR) developed and established with the approval of the LERC.

3.3 Responsibilities of the TSO

3.3.1 The TSO shall operate the LITS to provide services in accordance with the Performance and Reliability Standards of the LEGC. The TSO's responsibilities in this regard shall include:

(a) the operation of all vested LITS equipment, installations and facilities in accordance with the operation instructions and guidelines for the respective equipment or in accordance with Prudent Utility Practice;

(b) the provision of open, fair and non-discriminatory access and connection to the LITS for all licensed or permitted GCPs, in accordance with the Regulations and provisions of the LEGC;
(c) the performance of all the planning functions related to the LITS;
(d) making recommendations as required for transmission expansion projects to adequately meet the forecast requirements for demand growth, potential generation additions and customer reliability standards;
(e) the scheduling of sufficient generation capacity to meet forecast demand in accordance with merit order principles and carrying out real-time operations, dispatching and controlling the output of generating units to ensure reliable and economic operation of the LITS;
(f) the control and operation of the LITS to ensure security of the network within its technical limits and in accordance with the provisions of the LEGC;
(g) undertaking outage planning and coordinating maintenance activities of all equipment and facilities that will or are likely to impact on the reliability of the LITS;
(h) the planning, development, supply, installation, commissioning and maintenance of adequate central SCADA/EMS system together with any necessary associated backup systems, telecommunication systems and the coordination of their expansion and upgrade;
(i) the planning, development and supervision of installation and maintenance of Remote Terminal Units (RTUs) at transmission substations and generating stations and the coordination of their upgrade;
(j) investigation and review of each major power system operational incident and the issuance of the relevant reports;
(k) the real-time monitoring and recording of electric power and energy balance;
(l) provision, installation, operation and maintenance of the main revenue metering system of the LITS in collaboration with the MO;
(m) the coordination of operations and liaising with WAPP System and Market Operator to carry out studies and analyses to ensure reliable operation of the WAPP;
(n) the development and establishment of the System Operations Manual and Safety Rules for coordinated and safe operation of the LITS; and
(o) supervising and ensuring adherence to Safety Rules by all GCPs.

3.3.2 The TSO shall collect information and statistics, publish reports, and disseminate information relating to the performance of the LITS.

3.3.3 The TSO shall operate the LITS efficiently in accordance with the LEGC.

3.3.4 The TSO shall liaise with the LERC in order to ensure consistent and effective development and application of the LEGC.

Market Operator/TSO

3.3.5 Despite sub-section 3.3.1, the TSO is required under the Regulations to perform additional functions as the Market Operator with responsibilities for the procurement and settlement of electricity market transactions under the oversight of a committee established by the LERC.

3.3.6 Until the Market Operation Rules are established and the market operation functions (of the TSO) are clearly delineated, the TSO is mandated under this LEGC to perform the critical functions of the MO as provided for particularly under the Metering Sub-code including the following:

(a) administering of power supply and power purchase agreements;
(b) determination of Generation GCP and power pool energy and ancillary service offers; and
(c) the performance of accounting, billing, and settlement functions for LITS supply services or transactions.

3.4 Responsibilities of a Transmission GCP

3.4.1 A Transmission GCP shall conclude an Asset Vesting Agreement with the TSO delegating all authority to the TSO for the granting and control of connections to the transmission asset facilities in the interest of facilitating open, fair, and non-discriminatory access to the LITS by all other GCPs.

3.4.2 Despite sub-section 3.4.1, each Transmission GCP shall be responsible for:

(a) the design, installation and maintenance of its transmission equipment to meet system performance and reliability requirements;
(b) the design, installation and maintenance of its protection system to ensure timely disconnection of faulted facilities and equipment;
(c) execution of the operating instructions of the TSO with respect to system operational limits and performance standards;
(d) ensuring cooperation with the TSO and other GCPs in the discharge of system security responsibilities;
(e) ensuring cooperation with the TSO and other GCPs in the coordination of system planning responsibilities towards the development and expansion of the LITS; and
(f) the provision of accurate and timely data and information to the TSO.

3.5 Responsibilities of a Generation GCP

3.5.1 Each Generation GCP including a VRPP GCP shall carry out its responsibilities in accordance with the provisions of the LEGC.

3.5.2 A Generation GCP shall be responsible for:

(a) the design, installation, commissioning and maintenance of its plant and equipment to meet the requirements of the Connection Sub-code and other relevant regulations;
(b) compliance at all times with applicable requirements and conditions of connection for generating units in accordance with the Connection Agreement with the TSO and in consultation with any relevant transmission asset owner, where necessary;
(c) providing the TSO with information on available capacities and operating constraints of its generating units to facilitate dispatch under all power system operating states;
(d) developing maintenance plans for its equipment and providing all information required to the TSO for outage planning and maintenance coordination;

(e) operating its plant and equipment in accordance with dispatch instructions of the TSO to meet system performance and reliability requirements and in a manner that is consistent with the reliable operation of the LITS; and
(f) providing accurate and timely data, information, and reports to the TSO.

3.6 Responsibilities of a Distribution GCP or Large Consumer GCP (Demand GCPs)

A Distribution GCP or Large Consumer GCP shall be responsible for:

(a) operating its distribution network or facilities connected to the LITS in a safe and reliable manner and in accordance with the requisite performance and reliability standards;
(b) executing the operating instructions and directives of the TSO in a manner that is consistent with the reliable operation of the LITS;
(c) ensuring that its network and operations do not degrade the performance of the LITS and take the necessary measures to promptly remedy any degradation; and
(d) procuring and deploying adequate reactive power compensation and all other devices to meet its obligations under the LEGC.

3.7 Responsibilities of the GCAC

The responsibilities of the GCAC are to:

(a) assist the LERC to supervise the TSO in the implementation of all its functions and oversee all operations, activities and transactions on the LITS with the goal of ascertaining compliance with the LEGC;
(b) ensure the effective and consistent application of the rules and standards in the LEGC;
(c) coordinate the approval (by the LERC) of the "Non-compliance Listing" and associated Compliance Plans compiled by the TSO in accordance with Section 4 of the LEGC;
(d) issue guidance on the interpretation and implementation of the LEGC;
(e) assist with administering dispute resolution procedures established by LERC concerning the provisions of the LEGC and the use of the LITS;
(f) review and recommend updates to the LEGC to achieve sector objectives and goals; and
(g) perform any other function conferred on it by the LEGC.

3.8 Other Responsibilities of a GCP

3.8.1 Every GCP that intends to establish and connect to the LITS any new or modified equipment or network that it owns, operates or controls shall liaise with the TSO and the Transmission GCP, and obtain the required approval from the LERC.

Compliance with Laws And Industry Standards

3.8.2 The TSO and all GCPs shall comply with all relevant laws, the Regulations, the requirements of the LEGC, and other codes, Licenses & Permit, applicable international standards, and Prudent Utility Practice.

3.8.3 Despite the separation, the different Parts of the LEGC are intended to be consistent and complementary for the satisfactory and efficient delivery of transmission operational services and nothing in this Code precludes the application of evolving technologies and processes as they become available.

Section 4: Transitional Provisions And Derogations

4.1 Purpose and Scope

Section 4 provides:

(a) the rationale for derogations,
(b) how derogations are to be made, and
(c) the duration of these exemptions.

4.2 Configuration of Equipment and Installations

4.2.1 The TSO and each GCP shall within three months of the coming into force of the LEGC prepare a "Non-compliance Listing" of all assets and connected facilities indicating the specific technical characteristics which do not comply with the LEGC. All GCPs shall submit their non-compliance listings to the TSO and the TSO shall compile them including its own list for submission to the LERC through the GCAC.

4.2.2 The LERC shall approve a transitional period for the coming into compliance of all assets and connected facilities on the "Non-compliance Listings" compiled by the TSO.

4.2.3 All generating equipment and facilities, transmission network facilities, distribution network facilities, and other Demand GCP facilities that are in operation and connected to the LITS at the time of coming into force of this LEGC shall, despite any non-compliance with the LEGC, continue to operate for a period not exceeding thirty-six months following the Effective Date of the LEGC, provided that the non-compliance has been identified and included in the "Non-compliance Listing". Each equipment and facility not included in the Non-compliance Listing shall be deemed to be fully compliant.

4.2.4 All GCPs, in consultation with the TSO, shall prepare "Compliance Plans" for the upgrade of their respective affected connected facilities, and the TSO shall prepare "Compliance Plans" for the upgrade of each affected LITS node or facility to make them fully compliant within a reasonable period and, in any case, not exceeding the transitional period allowed.

4.2.5 The TSO shall present all such Compliance Plans to LERC for acceptance and approval within a period of nine months after the coming into force of the LEGC and thereupon confirm to each GCP its obligations and accepted timeframe to remedy the identified non-compliance and/or deficiencies.

4.2.6 The non-compliance or deficiencies identified for each listed asset or node shall for all other purposes of the LEGC be deemed to be compliant during the transitional period.

4.2.7 During such part of the transitional period as has been accepted by LERC for implementation of remedial action on that non-compliant asset or node, a GCP may not be disconnected or denied service based on that deficiency or non-

compliance which has been identified and included in the "Non-compliance Listing".

4.2.8 A request for derogation made by a GCP or the TSO from any provision of the LEGC shall contain the following:

(a) the version number of the LEGC;
(b) identification of the Plant and/or Apparatus in respect of which a derogation is sought;
(c) identification of the provision which the GCP or TSO is, or will be, unable to comply with;
(d) the extent of the non-compliance;
(e) the reason for the non-compliance; and
(f) the date by which compliance will be achieved (if remedy of the noncompliance is possible)

4.3 Service Performance Standard During Transition Period

Prior to the completion of the upgrade of any LITS node or facility that was declared to be non-compliant, the performance benchmarks for only those services affected by the recorded deficiency shall not be applicable.

4.4 Management Systems

4.4.1 The application of the procedures prescribed in this LEGC for generation dispatch may be deferred with the consent of LERC until the associated commercial arrangements and corresponding energy accounting, billing and settlement instruments of the Wholesale Electricity Market are finalized including the establishment of the MOR.

4.4.2 Enforcement of the procedures for maintenance and outage planning may be deferred by up to nine months with the consent of LERC to enable the GCPs and the TSO complete administrative arrangements for introduction of the procedures.

4.5 Capacity Building (Human Resource Development)

The TSO shall employ, train, suitably equip and maintain an adequate workforce that is qualified and competent in transmission planning, dispatch economics, maintenance scheduling and performance monitoring as well as commissioning and testing of grid components to enable it to perform its functions.

4.6 Existing Contracts

4.6.1 Unless revoked or amended by agreement each contract in respect of transmission services and operations consummated by the Transmission GCP and the TSO and existing at the Effective Date of this LEGC shall continue in force.

4.6.2 The LEGC shall apply to all such existing contracts in so far as the LEGC does not impair the obligations arising from the existing contract.

4.6.3 The TSO in consultation with the Transmission GCP shall endeavor to negotiate for new contracts or amend existing contracts which shall conform to all the provisions of the LEGC within **one year** from Effective Date of coming into force of this LEGC.

4.6.4 Neither a GCP nor the TSO shall enter a new contract or extend any existing contract that is not in accordance with the LEGC.

4.7 LERC Right to Review Scope of Derogations

4.7.1 The LERC and the GCAC shall keep a register of the Non-compliant Listings identifying derogations that have been approved for the TSO and the GCPs and the relevant provision(s) of this LEGC involved.

4.7.2 The LERC may initiate on its own initiative, or at the request of the TSO or the GCAC, or in view of a GCP complaint, review of any existing derogations or any derogations under consideration under this Section of the LEGC, where a relevant and material change in circumstance has occurred.

Section 5: Governance Of The Grid Code

5.1 Purpose and Objectives

This Section 5 of the Code defines the arrangements for the management and governance of the implementation of the LEGC for the provision of transmission services for the benefit of the electricity supply industry.

5.2 Conduct of the TSO

5.2.1 Guided at all times by generally accepted best practices for an Independent System Operator (ISO), the TSO has the exclusive mandate to operate the LITS and shall be responsible for the good governance and management of the LITS in accordance with the LEGC.

5.2.2 Subject to provisions under Section 6 of the LEGC, the TSO shall not take or issue any advice, directions or instructions that may contravene the fundamental principles of fairness, transparency, non-discrimination and open access in the governance and management of the LITS.

5.2.3 The TSO, as the ISO of the LITS, shall neither act nor be considered as a GCP.

5.2.4 The activities of the TSO shall be open for review by any interested GCP.

5.2.5 The TSO shall be accountable to the GCAC established by the LERC for managing and enforcing compliance with the letter, spirit, and intent of the LEGC.

5.3 Establishment of the GCAC

5.3.1 In accordance with regulation 51 of the ELR, the LERC hereby establishes the Grid Code Advisory Committee (GCAC) to:

(a) assist with LERC's oversight role in ensuring compliance with the LEGC by the TSO and the GCPs; and

(b) manage the periodical review of the LEGC.

5.3.2 The GCAC shall comprise the following persons knowledgeable in the electricity supply industry:

(a) One member of the LERC's Electricity Technical Committee who shall serve as Chairperson

(b) Head of Technical Regulation, LERC;

(c) Chief Executive Officer of the TSO;

(d) A representative each of the following:

(i) the Transmission GCP (Transmission Licensee);

(ii) the national generation GCP (LEC-Generation);
(iii) other generation GCPs connected to the LITS;
(iv) WAPP operator/suppliers connected to the LITS;
(v) Distribution GCPs connected to the LITS;
(vi) Large Consumers (Demand GCPs)
(vii) the Ministry of Mines and Energy;
(viii) the Electrical Engineering Academia;
(ix) the Engineering Society of Liberia; and

(e) One independent and unaffiliated person with technical expertise in generation, transmission and distribution operations

5.3.3 LERC shall appoint the members of the committee upon their nomination by the relevant entity or institution, where applicable.

5.3.4 A member of the GCAC, except a representative from the LERC, shall hold office for a three-year term subject to re-nomination and re-appointment.

5.3.5 Any changes of representation by entity or institution shall be communicated in writing to LERC which shall confirm the appointment within thirty (30) days.

5.3.6 The representative of the LERC shall be the Secretary to the GCAC and shall publish the latest list of members of the GCAC within 14 days of any change.

5.3.7 The LERC shall house the GCAC Secretariat and provide all administrative and secretarial personnel, logistics and support for the Committees' work and meetings.

5.3.8 All members shall have a designated backup replacement to serve on the GCAC in case of unforeseen circumstances. Such nominations shall be made in writing to the GCAC Secretariat and shall be approved by LERC. The constituency of representatives may replace members at any given time, provided they give 14 days' written notice to the GCAC and the LERC.

5.3.9 The LERC may request the replacement of members by their constituency upon recommendation of the GCAC, if they have not attended three consecutive meetings.

5.4 Mandates of GCAC

The GCAC is established to:

(a) regularly ensure a consultative stakeholder review and discussion on the implementation of the LEGC;

(b) issue guidance on the interpretations and implementation of the LEGC;

(c) probe into problems raised by GCPs pertaining to implementation of the LEGC;

(d) review and make recommendations to LERC regarding proposals for derogations in relation to compliance with the LEGC;

(e) analyze any major grid disturbances within fourteen (14) calendar days after occurrence and evolve any consequent revision to the LEGC;

(f) review and make recommendations regarding proposals for amending the LEGC; and

(g) recommend to LERC, changes to the LEGC together with the reasons for the changes and any objections, if applicable.

5.5 Meetings of GCAC

5.5.1 The GCAC shall meet at least once every quarter.

5.5.2 The chairperson shall preside over all meetings of the GCAC and in the absence of the chairperson a member of the GCAC elected by the members present from among their number shall preside.

5.5.3 The chairperson shall at the request of not less than one third of the membership of the GCAC convene an extraordinary meeting of the GCAC at the place and time determined by the chairperson.

5.5.4 The Secretary shall prepare the agenda for each meeting in consultation with the Chairperson and inform members of meetings on the dates and the times agreed with the Chairperson. Such notices for convening meetings shall be transmitted at least two (2) weeks prior to the scheduled date. The Secretary shall be responsible for preparing and keeping accurate records of all meetings.

5.5.5 The quorum at a meeting of the GCAC is seven members or a greater number determined by the GCAC in respect of an important matter.

5.5.6 Matters before the GCAC for determination shall be decided by a simple majority of members present and voting and in the event of an equality of votes, the person presiding shall have a casting vote.

5.5.7 The GCAC shall establish and adopt its own rules and procedures relating to the conduct of its business.

5.5.8 The TSO shall prepare the performance report of the LITS every quarter and submit it for review by the GCAC and the LERC. The quarterly performance report shall be submitted to the GCAC and the LERC within fourteen (14) days after the end of the quarter.

5.5.9 The LERC shall fund the administrative activities of the GCAC but GCAC members are responsible for their own travel and subsistence expenditure.

5.5.10 The Chairperson of the GCAC shall submit to the LERC semi-annually, reports on the activities of the GCAC within six weeks after the end of the period.

5.5.11 The GCAC, at its discretion, may invite experts or any other organization such as Government Departments, Local Authorities, or academic/ technical institutions, to attend the GCAC meeting depending on the agenda. Such invited members can express or offer advice on the matter under consideration but shall act as observers only in the final determination.

5.6 Grid Code Review and Revision Procedures

5.6.1 The LEGC will evolve as the electricity supply industry (ESI) in Liberia evolves. No revision or modification of the LEGC shall be made without the knowledge of the GCAC and LERC approval.

5.6.2 Proposals for revision of any provision of the LEGC may be made by a GCP or the TSO, the "Proposer".

5.6.3 A proposal for LEGC revision shall be in writing and shall be sent to the TSO with a copy to the LERC.

5.6.4 The TSO shall receive, register and acknowledge all submissions and pass on the proposals (including its own proposals, if any) to the Secretariat of the GCAC.

5.6.5 The Secretariat of the GCAC shall notify all GCPs and the TSO of all revision proposals received and shall make copies accessible to them either over the internet or through other appropriate means.

5.6.6 The TSO shall within **three months** of receipt of a revision proposal, provide the GCAC and the "Proposer" with its views, comments, and advice on each proposal. A GCP may also provide the GCAC with its comments on a revision proposal within the stipulated period.

5.6.7 The GCAC shall consider each revision proposal at the next regular meeting and make recommendations which shall be forwarded to the LERC.

5.6.8 The LERC shall consider the submissions of the "Proposer", the TSO and the recommendations of the GCAC and advise all the parties of its decision with full and written justifications.

5.6.9 The LERC shall approve the LEGC and all its amendments and shall publish the approved latest revision of the LEGC on its website for compliance.

5.6.10 Every amendment from the previous Version shall be clearly marked in the margin. In addition, a revision sheet shall be placed at the front of the Revised Version noting the number of every changed section or sub-section, together with a brief statement of the change.

5.6.11 The GCAC Secretariat shall be responsible for version control of the LEGC and shall make the latest version of the LEGC available electronically and notify all GCPs of the approved amendments or exemptions within **one week** of receipt of the LERC approval.

5.6.12 The GCAC Secretariat shall make hard copies of the latest version of the LEGC available to requesting entities, for which a nominal fee may be charged to recover reproduction costs.

5.7 Complaints and Disputes

5.7.1 The GCAC shall handle disputes regarding interpretation of the LEGC.

5.7.2 A GCP may lodge a complaint in writing with the GCAC Secretariat where it believes that:

(a) the rules, regulations, or procedures of the LEGC are not operating fairly; or

(b) the TSO or a GCP is not acting in accordance with the LEGC.

5.7.3 The GCAC Secretariat shall:

(a) receive, register and acknowledge all complaints;

(b) promptly notify the TSO, the GCAC and the affected parties to the complaint of receipt of such a complaint; and

(c) make copies of the complaint accessible to all the stakeholders mentioned in sub-section 5.7.3(b) either over the internet or through other appropriate means.

5.7.4 All the affected parties shall, within thirty (30) days of their receipt of a complaint, provide the complainant, the TSO and the GCAC with their views, comments, and responses to the complaint.

5.7.5 The GCAC shall consider each complaint at the next regular meeting and, in accordance with its procedures for dispute resolution , make recommendations to the parties for amicable resolution of the complaint or dispute.

5.7.6 If an aggrieved GCP is not satisfied with the ruling of the GCAC the matter shall be referred to the LERC whose decision is final.

5.8 Unforeseen Circumstances

5.8.1 Any technically relevant issues not covered by the LEGC shall be referred to the GCAC for further consideration and recommendation for inclusion in the LEGC.

5.8.2 Where any unforeseen situations occur, the TSO shall convene an emergency meeting with all affected GCPs to formulate a solution and the actions to be taken in the circumstance by the GCPs. If no agreement can be reached, the TSO shall provisionally determine the action to be taken after considering the views expressed by the GCPs.

5.8.3 The TSO shall, within 14 days after taking the provisional action, refer the matter to the GCAC whose decision shall prevail over the provisional determination of the TSO.

5.8.4 If a GCP appeals to LERC over the decision of the GCAC, the decision of LERC on the matter shall supersede the decision of the GCAC.

5.8.5 The normal operations of a GCP should never be disrupted by any situation or dispute. The majority decision of the meeting of GCPs or the considered determination of the TSO shall be implemented unless and until the GCAC issues a different ruling; and the ruling of the GCAC shall be in force unless and until a different decision is issued by LERC (if the issue is referred to LERC).

5.8.6 The decision of LERC is ultimate and shall be implemented by all GCPs.

5.9 Grid Code Violations and Sanctions

If a GCP is in breach of any provisions of the LEGC, the LERC shall impose administrative and financial penalties as provided in the applicable laws, Regulations, rules, and provisions of a License, where applicable.

Part B: Transmission License Conditions

This Part of the LEGC defines the Conditions of the licenses for the transmission segment of the electricity supply industry comprising the TSO License and the Transmission License. It contains the sub-codes that deal with the requirements, processes and procedures for planning and development of the Grid, the technical requirements, processes and procedures for connection to the LITS and the rights and requirements for transparency and nondiscrimination in the provision of services from the LITS.

Section 6: Transparency And Non-Discrimination Requirements

6.1 Background, Purpose, and Scope

Section 6 of the LEGC defines the requirements and actions which will inter alia provide fair, transparent, and non-discriminatory access to the LITS for use by GCPs and any other duly licensed or permitted entity for whom open access is to be provided.

6.2 Publication of Procedures

6.2.1 The TSO shall develop and publish in detail all the requirements, qualifications and administrative procedures to be fulfilled or followed by those seeking to be provided services from the LITS by the TSO.

6.2.2 The requirements shall include all technical standards for connection equipment, operating parameters, communication requirements and performance benchmarks for service provision.

6.2.3 The qualifications shall include all legal, financial, and technical qualifications to be fulfilled by applicants seeking services from the LITS.

6.2.4 The administrative procedures shall include all administrative, financial, technical and any other procedures or processes to be followed prior to the commissioning of a connection as well as the obligations of the GCP for the continued operation of the connection.

6.2.5 The TSO and LERC shall publish the LEGC on their respective websites and make copies readily available to the public and any other related publications upon the payment of applicable fees.

6.3 Equal Application of the Grid Code

The LEGC shall be applied equally and uniformly to all entities. All conditions and situations that are similar shall receive consistent and equitable treatment without discrimination.

6.4 Transparency Criteria

6.4.1 The TSO shall conduct all its affairs as an ISO that follows well publicized rules, regulations and procedures that are known to all interested parties such that all its actions are predictable and in accordance with the LEGC.

6.4.2 There shall be transparency in all TSO decisions, procedures, application of rules, regulations, and charges of the TSO regarding participation in the development of the LITS, connections to the LITS, utilization of LITS' services, and the allocation of resources and costs of services.

6.4.3 To ensure transparency regarding access, use and operation of the LITS, only fees and charges that have previously been published by the TSO may be levied on

applicants or GCPs and the dispatch of generating plants shall follow strictly the procedures prescribed in the Scheduling and Dispatch Sub-Code.

6.4.4 Subject to Section 5.4 the primary function of the GCAC is ensuring transparency, consistency, and fairness for all GCPs, in which regard, the GCAC may demand and consider justifications and explanations for TSO's actions and decisions and may direct the review or revision of any TSO action or decision.

6.4.5 Despite provisions under Section 5.5 and in furtherance of the transparency objective, the following rules shall apply to the performance of the functions of the GCAC relating to meetings:

(a) the agenda for meetings of the GCAC shall reflect the priorities of all the stakeholders and shall be announced and made public well in advance;
(b) the dates and places of meetings shall be announced;
(c) any interested GCP shall be allowed to be physically present at any meeting (except when discussing individuals or appointments) to observe the proceedings where decisions are taken; and
(d) the minutes of meetings and documentation shall be published within 10 working days.

6.5 Delegation and Outsourcing of Functions

6.5.1 The TSO may delegate or contract the functions associated with performance monitoring and merit order dispatch to independent companies or persons, provided they are not likely to have a "conflict of interest" towards entrenching a non-discriminatory, fair, and competitive environment.

6.5.2 The TSO shall delegate or contract only **independent** parties for the performance of any of those other functions that could influence the nature of open access and competition within the LITS.

6.5.3 The TSO may contract or delegate to a GCP any technical function that does not influence the outcome of the competitive environment.

6.5.4 **"*Independent*"** under this section means – *having no connection with and under no influence of any actors in the determination of any competitive issue under this LEGC*.

6.6 Exercise of Discretion by the TSO and Other Officials

6.6.1 The TSO or any other person shall not make a decision that is inconsistent with the LEGC in respect of the usage or provision of services from the LITS.

6.6.2 The TSO may use its discretion and good judgment in making decisions on any matter on which the LEGC does not contain complete or adequate stipulations.

6.6.3 The exercise of a discretionary power by the TSO shall however be justified in writing to the GCAC and the affected party while such decision is taken.

6.6.4 The principles and rationale for any discretion exercised or decision taken by the TSO shall be published and made available to any person upon request.

6.6.5 A person aggrieved by a discretionary decision taken by the TSO may request for a review by the GCAC, as necessary.

6.6.6 The GCAC shall consider the complaint and uphold or recommend a reconsideration of the TSO decision.

6.6.7 A discretionary decision once approved by the GCAC shall be considered as a precedent which shall be applied uniformly and equally to all similar situations unless explicitly reversed or revised in writing.

6.7 Charges for LITS Services

6.7.1 LERC shall determine the charges payable to the TSO and the Transmission GCP for their respective operational and transmission services rendered in accordance with the Tariff Regulations

6.7.2 The charges mentioned in sub-section 6.7.1. for the use of LITS services shall not exceed those approved by the LERC and shall be published in the Gazette.

Section 7: Planning Sub-Code

7.1 Background, Purpose, and Scope

7.1.1 The Planning Sub-code specifies the planning responsibility for grid developments and the policy, standards or criteria and organizational procedures to be applied. Grid development includes the construction or refurbishment of power lines, transformers, substation equipment, reactive compensating devices, auxiliaries, and control systems.

7.1.2 Transmission system planning accounts for new connection requirements, development of existing transmission system and apparatus due to changes in factors such as demand, generation, reliability, and environmental requirements.

7.1.3 The primary aim of transmission planning is the maintenance of the integrity of the bulk transmission system. The adequacy and security of supply to any particular load or area is secondary to this primary aim.

7.1.4 The objective of the Planning Sub-code is to define processes and standards to ensure that:

(a) the configuration of new transmission infrastructure is optimized and in accordance with projected long-term needs;

(b) the development of infrastructure facilities and apparatus is well coordinated in terms of technical arrangement and characteristics;

(c) system congestion of existing facilities and apparatus is adequately anticipated, and reinforcement schemes are designed to overcome constraints to electrical power transfer and overall power system performance; and

(d) all GCPs provide from time to time, the planning data that is required.

7.1.5 The Planning Sub-code therefore specifies the information to be supplied by GCPs to facilitate the evaluation of the impact of the connection of new facilities, identification of congestion and the planning of expansion, reconfiguration, reinforcement, or development of the transmission network regarding its adequacy to meet the needs of all existing and prospective GCPs.

7.2 Grid Planning Responsibility

7.2.1 The TSO shall collaborate with the Transmission GCP to discharge all functions relating to the planning and coordination of Grid developments. The Transmission GCP shall arrange and liaise with all GCPs through the TSO for the performance of studies and all other activities needed to formulate and present a **five-year** Least Cost Transmission Development Master Plan hereafter referred to as the Grid Development Plan (GDP).

7.2.2 The planning activities leading to the GDP shall be undertaken sufficiently in advance so that all prudent and required steps for coordination, design, construction, and commissioning of the needed facilities are performed without disturbing the delivery of power over the LITS and so that all stakeholders have an opportunity to contribute to all the steps.

7.2.3 The planning process shall also provide sufficient time for the preparation of designs and proposals so that all interested persons have an adequate non-discriminatory opportunity to participate in any invitation to build or supply the facilities.

7.3 Grid Development Plan (GDP)

7.3.1 The GDP shall be a document describing the future modifications, expansion and development of the LITS. It shall indicate the new components that have to be built, their main technical characteristics, their location within the LITS as well as the terms and conditions for their commissioning. It shall also indicate the expected technical performance of the LITS.

7.3.2 Subject to the planning process requirements established under section 7.2, the TSO shall within 18 months of coming into force of this Grid Code develop the initial 5-year GDP for approval by LERC.

7.3.3 The TSO and the Transmission GCP shall keep the plan updated and annually publish a 5-year ahead network expansion plan indicating the major investments planned and considering possible revisions in actual and forecast demand, sources of supply and transmission transfer capacity.

7.3.4 The GDP and any subsequent revisions or updates shall be submitted to the GCAC for review and then to the LERC for approval prior to any commitments being made for its implementation.

7.3.5 Subject to sub-section 7.3.1, the GDP shall include, as a minimum, the following main contents, for the planned period:

(a) a transmission network expansion planning methodology;
(b) an evaluation of the current technical situation of the transmission network;
(c) forecast of demand (minimum of up to 5 succeeding years) and impact on existing transmission capacity;
(d) list of generation projects to be connected, and details of the connection point, and connection contract for each such generation project;
(e) a list of newly proposed demand connections with details of the connection point and the corresponding connection contract for each such new demand connection;
(f) a list of any new connections proposed, that are not included in the annual list, and details of the connection point and connection contract for such new connections;

(g) calculation of the system's power distribution load profile, the expected peak and average power flows at steady state in the dry and wet seasons;
(h) analysis of the LITS' steady state and dynamic stability;
(i) calculation of the short circuit current at all 225kV, 66kV buses and those 33kV (or 22kV) buses that are directly connected to high voltage buses;
(j) an analysis defining the transmission network's reactive power compensative requirements during the planned period;
(k) analysis of the areas that the TSO or the Transmission GCP considers that black start capability will be required;
(l) analysis of whether the transmission network can continue to meet network performance criteria as provided under Section 12, and Technical Schedules TS – K and TS – L of the LEGC;
(m) analysis of the least cost investment required to:
    (i) support the current approved GDP, regional power development plan, and any current connection contracts; and
    (ii) meet the network performance criteria as provided under Section 12 and Technical Schedules TS – K and TS – L of the LEGC;
(n) a proposed development plan to meet the above requirements over the planning period; and
(o) a proposed expenditure plan for the next financial year consistent with the proposed development plan.

7.4 Grid Planning Criteria

7.4.1 The planning criteria for the grid shall be based on a network security philosophy that has been agreed with the LERC in accordance with the guidelines in this section 7.4.

7.4.2 The transmission system shall be designed to ensure adequate, secure, and acceptable reliability levels, that should meet the (N-1) reliability criteria.

7.4.3 Following from sub-section 7.4.2, the LITS shall be capable of withstanding the following contingency outages without contravening the LITS Performance Standards prescribed under Section 12 and Technical Schedules TS – K and TS – L:

(a) outage of any single transmission network equipment or line segment; and

(b) outage of any one generating unit or power in-feed from any cross-border or regional interconnection such as the WAPP/CLSG tie-line.

7.4.4 Any of the events defined in sub-section 7.4.3 shall not cause:

(a) loss of supply;

(b) unacceptable high or low voltage outside the specified limits (i.e., Voltage limits to be maintained;

(c) unacceptable overloading of transmission elements - (i.e., Line loading limits not to be exceeded);

(d) prolonged operation with system frequency outside the specified performance and reliability limits; and

(e) system instability.

7.5 Grid Planning Studies

7.5.1 Grid planning studies shall be conducted by the TSO to ensure the safety, reliability, security, and stability during operation of the LITS, as provided in Part C of the LEGC and in accordance with performance standards stipulated in Section 12.

7.5.2 Grid planning studies shall be conducted whenever necessary to assess the impact of any proposed addition or change of equipment in the LITS or in a GCP's facility that is connected or is to be connected to the LITS.

7.5.3 The purpose of such studies shall be to identify the technical specifications *(of changes or additions)* or corrective measures needed to eliminate any potential non-compliance with the LEGC that may result from such changes or additions.

7.5.4 The standard studies to be performed shall include the following:

(a) Load Flow studies to evaluate the behavior of the LITS under forecast minimum and maximum load conditions for existing and proposed new connections;

(b) Short Circuit studies to evaluate the effect on equipment of the LITS due to the connection of new generating plants, lines and other facilities which are likely to result in increased fault duties on the equipment and consider the least total cost method of addressing any such issues;

(c) Voltage Stability Analysis to determine if the grid is vulnerable to voltage collapse; and

(d) Steady State Stability Analysis to determine if the LITS is vulnerable to any disturbance or dynamic stability problems.

7.5.5 The following additional analyses may be performed when determined by the TSO to be necessary:

(a) reliability analysis - for assessment of the probability of loss of load and unserved energy;

(b) transient stability analyses – to assess the ability of system to regain stable operating point after transient disturbance*;* or

(c) electromagnetic transient (EMT) studies - to assess the effect of very short duration current and voltage transients (e.g., lightning and switching effects) on equipment.

7.6 Grid Planning Data

7.6.1 All GCPs shall provide the TSO with Standard Planning Data as specified in Technical Schedule TS–S by the **1st day of July** each year.

7.6.2 The Standard Planning Data generally shall include the prime technical characteristics of generation and transmission facilities as well as historic and forecast data on energy and capacity demand for each connection point or LITS node.

7.6.3 In addition to Standard Planning Data, Detailed Planning Data as specified in Technical Schedule TS–D or other specific details shall be provided by a GCP within **thirty (30) days** of being requested by the TSO.

Section 8: Connection Sub-Code

8.1 Background, Purpose, and Scope

8.1.1 To maintain stable and secure operation of the LITS to provide the expected standard of service for the benefit of all GCPs, certain minimum technical, design and operational criteria are to be met by all applicants seeking connection of plant and equipment to the LITS.

8.1.2 This Section 8, the Connection Sub-code, provides protection for the transmission system and all connected plant and equipment with an assurance of secure and reliable operation of the LITS for efficient service delivery.

8.1.3 The purpose of the Connection Sub-code is to:

(a) provide the framework, rules and guidelines for connection to the transmission network to facilitate the harmonious and coordinated access to the LITS by GCPs in a fair, transparent and non-discriminatory manner;

(b) specify the minimum technical, design and operational criteria at the connection point of a GCP and to ensure maintenance of acceptable reliability and quality service;

(c) establish the process to be followed to set up a new connection or modify an existing connection to the transmission network without adverse effects to the LITS; and

(d) define the data exchange requirements between the TSO and GCPs.

8.1.4 The scope for this Sub-code covers the responsibilities and grid connection requirements for the following:

(a) the TSO;

(b) the Transmission GCP,

(c) other transmission network operators (either within or outside Liberia) that are connected or intending to be connected to the TSO system (LITS);

(d) Distribution GCPs connected (or intending to be connected) directly to the LITS;

(e) Generation GCPs connected or intending to be connected to the LITS;

(f) Large Consumers connected to (or intending to be connected) directly to the LITS; and

(g) Ancillary services providers to the LITS.

8.2 Connection Principles

8.2.1 The Connection Sub-code is based on the following principles relating to connection to the LITS:

(a) Provided they satisfy all requirements in this Sub-code, all Generation GCPs including VRPPs, Distribution GCPs and Large Consumers that seek to connect directly to the network of the Transmission GCP shall have the opportunity to connect to the LITS and have fair and equitable access to the services provided by the TSO;

(b) The terms and conditions under which connection to the LITS and provision of service is to be granted shall be set out in a commercial agreement designated as the Connection Agreement entered between the TSO and the GCP;

(c) The processes and operations under this Sub-code should result in the achievement of

I) long term benefits to GCPs in terms of costs and reliability of the LITS, and

ii) open communication and information flows between the TSO and GCPs while ensuring the security of confidential information belonging to GCPs; and

(d) No facilities shall be connected without a minimum arrangement for communications, metering and protective relaying being in place.

8.2.2 The TSO shall not assume any responsibility for the protection of a GCP's plant or equipment or any other portion of the GCP's electrical equipment. A GCP shall be responsible for protecting its equipment in such a manner that faults or other disturbances within the LITS do not cause damage to the GCP's equipment.

Obligations and Responsibilities

8.3 General

A GCP shall construct, operate, and maintain all equipment that are part of its facility in accordance with:

(a) the requirements of the LEGC;
(b) Prudent Utility Practice; and
(c) applicable national and international laws, protocols, and standards.

8.4 Obligations of the TSO

The TSO has an obligation to:

(a) coordinate the design aspects of equipment proposed to be connected to the LITS with those of other GCPs to achieve the performance and reliability requirements of the Grid;
(b) evaluate in collaboration with the Transmission GCP requests for connections or amended connections to the LITS;

(c) enter into a Connection Agreement for a connection to the LITS with any applicant that seeks to connect to the grid and meets the specified requirements;
(d) advise a GCP or any other person who may be affected about any expected service interruption so that the GCP may make alternative arrangements during such interruption;
(e) make recommendations to the Transmission GCP and the other GCPs regarding the reinforcement or expansion of their facilities to meet reliability requirements; and.
(f) coordinate the planning and development of the LITS in accordance with the terms and conditions of the TSO License and the LEGC.

8.5 Obligation of Transmission GCP

A Transmission GCP has an obligation to:

(a) enter into an Asset Vesting Agreement (with the TSO) granting the TSO operational control of all Connection Points relating to the LITS including the coordination of the design, installation, maintenance and implementation of system expansion plans relating to any part of the LITS;
(b) process requests forwarded to it by the TSO for either connections to its equipment or to modify a connection to its equipment;
(c) execute TSO operational instructions to ensure compliance with the power system performance and quality of supply standards as described in Technical Schedules TS – K and TS – L and the Connection Agreement between a GCP and the TSO;
(d) ensure that to the extent that a Connection Point relates to its part of the LITS, every arrangement for connection with a GCP or any other arrangement involved with a Connection Agreement complies with all the relevant sections of the LEGC;
(e) arrange for and participate in the planning and development of the LITS;
(f) permit and participate in the inspection and testing of facilities in accordance with the provisions of the LEGC;
(g) permit and participate in commissioning of facilities and equipment that are to be connected to its network, in accordance with the LEGC;
(h) ensure that modelling data in respect of its (transmission system) assets and which are provided for planning, design and operational purposes are current, complete, consistent and accurate, and that whenever and wherever warranted by the TSO, the Transmission GCP shall perform tests to verify data accuracy;
(i) provide to the TSO and other relevant GCPs in respect of its assets all technical characteristics, drawings, specifications and other details available to it and reasonably required for diagnosing problems or modelling the performance of the LITS;
(j) provide to the TSO drawings and other technical details of each Connection Point with other GCPs;
(k) organize and perform under the coordination of the TSO all maintenance activities for all its assets which form part of the LITS for optimum service

availability and reliability such that electricity may be transmitted efficiently and continuously to the agreed capability;

(l) employ its best efforts to restore equipment and service as soon as practicable following any interruption at a Connection Point; and

(m) comply with applicable regulatory provisions and all relevant provisions of the LEGC.

8.6 Obligations of Generation GCP

A Generation GCP that seeks connection of its generating facility to the LITS has an obligation to:

(a) submit to the TSO an application in respect of a new or an altered equipment owned, operated or controlled by it and which it desires to connect to the LITS;

(b) have in force a valid Connection Agreement with the TSO prior to the facility being connected to the LITS;

(c) comply with the requirements of the TSO and the relevant Transmission GCP in respect of design requirements of equipment proposed to be connected to the LITS;

(d) at all times, comply with applicable requirements and conditions of connection for generating units as stipulated in the LEGC and in accordance with its Connection Agreement with the TSO;

(e) provide generating unit technical characteristics, data and Availability Declaration information to the TSO in accordance with the relevant provisions of the LEGC;

(f) permit and participate in the inspection and testing or commissioning of facilities and equipment to be connected to the LITS;

(g) permit and arrange for the witnessing and participation of the TSO and the relevant Transmission GCP in the commissioning or re-commissioning of facilities and equipment to be connected to the LITS;

(h) commit to operate its facilities and equipment in accordance with the instructions of the TSO, so long as it remains connected to the LITS; and

(i) give prior notice of any intended voluntary disconnection in accordance with the provisions of this Sub-code.

8.7 Obligations of Demand GCP (Distribution or Large Consumer GCP)

A Demand GCP that seeks connection to the LITS has an obligation to:

(a) submit to the TSO an application in respect of any new or altered equipment or network that it owns, operates or controls and which he desires to connect to the LITS;

(b) have in force a valid Connection Agreement with the TSO prior to its equipment or network being connected or re-connected to the LITS;

(c) comply with the requirements of the TSO and the relevant Transmission GCP in respect of the design and technical standards of equipment or networks proposed to be connected to the LITS;
(d) ensure that all facilities which are owned, operated or controlled by it and associated with a Connection Point at all times comply with applicable requirements and conditions of connection for GCPs as stipulated in the LEGC and in accordance with the Connection Agreement with the TSO;
(e) provide to the TSO information on energy and power demand forecasts as specified in the relevant sections of the LEGC;
(f) permit and participate in inspection and testing of facilities and equipment in accordance with the provisions of the LEGC;
(g) permit and arrange for the witnessing and participation of the TSO and the relevant Transmission GCP in the commissioning or re-commissioning of facilities and equipment which are to be connected to the LITS;
(h) commit to operate its facilities and equipment in accordance with the instructions of the TSO, so long as it remains connected to the LITS; and
(i) provide prior notice of any intended voluntary disconnection in accordance with the provisions of this Sub-code.

8.8 Investment Responsibilities

8.8.1 Unless otherwise agreed prior to coming into force of this LEGC, or in a connection contract, the following principles shall apply:
(a) For connections to a generation facility, the Transmission GCP is responsible for investment up to and including the point at which the generating unit connects to a bus bar designed to operate at a voltage of 66kV or higher. Such investment shall be of a technical standard to ensure the connection meets the network performance criteria in Technical Schedule TS – L.
(b) For connections to other GCPs, the Transmission GCP is responsible for investment up to and including the point at which a supply transformer connects to a bus bar designed to operate at a voltage of 66kV or higher.

8.8.2 The details of the investment boundary shall be as agreed between the GCP and the Transmission GCP, in accordance with the principles stated in sub-section 8.8.1, and recorded in detailed drawings, diagrams and documentation as part of the Connection Agreement.

8.8.3 For clarity, it is noted that the investment boundary may not necessarily be the Connection Point.

8.9 Connection Point

8.9.1 The Connection Point is the point which connects the GCP's equipment, network or generating unit(s) to the transmission network.

8.9.2 The Connection Point shall be described with detailed drawings, diagrams and documentation in the Connection Agreement.

8.10 Ownership Boundary

8.10.1 The Connection Point shall be the ownership boundary between the Transmission GCP and any other GCP.

8.10.2 The assets for each party at the ownership boundary shall be listed with detailed drawings, diagrams and documentation provided in the Connection Agreement.

8.11 Operating and Maintenance Boundary

Unless otherwise agreed, the party that owns an asset shall be responsible for investing, constructing, testing, operating, and maintaining all the assets that it owns in accordance with the applicable Law, the Regulations and this LEGC.

8.12 Requirement for Connection Agreement

8.12.1 A prospective GCP seeking to establish a new connection to the LITS shall negotiate and execute a Connection Agreement with the TSO for connection of its plant and equipment to the LITS in accordance with procedures prescribed under Sections 8.14 and 8.15 of the LEGC.

8.12.2 The Connection Agreement shall define the commercial and technical terms for connection, including but not limited to:

(a) the technical description of the connection;
(b) provisions for submission of information, reports, safety rules, test and commissioning programs and electrical diagrams;
(c) the commercial terms for such connection, which terms must comply with the LERC's Tariff Regulations & Methodology and associated approved transmission tariffs; and
(d) an agreed time for completion of the connection.

8.12.3 A GCP seeking to establish a modification to an existing connection to the transmission system shall negotiate and execute an Amended Connection Agreement with the TSO in accordance with procedures established under Sections 8.14 and 8.15 of this Sub-code.

8.12.4 A Connection Agreement or Amended Connection Agreement may contain provisions for reasonable financial penalties where the TSO or relevant Transmission GCP fails to provide the connection within the agreed time, provided such penalties represent a reasonable pre-estimate of actual losses that the (prospective) GCP is likely to incur due to such a delay.

8.13 Grid Impact Studies

8.13.1 The TSO shall develop and maintain a set of required technical impact studies for evaluating the impact of any proposed connection or modification to an existing connection on the LITS.

8.13.2 The TSO shall specify which of the planning studies described in Section 7 of the LEGC will be carried out to evaluate the impact on the Grid for a proposed development.

8.13.3 A prospective GCP may request additional technical studies to be undertaken by the TSO as part of the Grid Impact Studies and shall bear the cost of the additional studies requested.

8.13.4 An applicant for a new connection or a modification of an existing connection to the LITS shall take all the necessary steps to ensure that the proposed development will not result in the degradation of the LITS.

8.13.5 The TSO may disapprove an application for connection or a modification to an existing connection if the Grid Impact Studies show that the proposed development will result in unacceptable degradation of the LITS.

8.13.6 To enable the TSO carry out the necessary detailed Grid Impact Studies, a GCP may be required to provide data as specified in the relevant sections of the Planning Sub-code, the Connection Sub-code and any additional data that may be specified by the TSO.

8.13.7 The TSO shall maintain an up-to-date fault level database that should be made available to a GCP on request. The TSO shall inform the GCP, if fault levels at a Connection Point are likely to impact adversely on a GCP's equipment that is connected to the Grid. The TSO shall also provide information and recommendations on mitigation measures (e.g., a special protection system) as may be needed.

8.14 Application for New Connection or Modification

8.14.1 The TSO, in consultation with the Transmission GCP, shall publish the procedures for submission and processing of applications for a new connection or a modification of an existing connection to the LITS. The Transmission GCP, TSO and the applicant shall adhere to the published procedures.

8.14.2 A prospective GCP seeking a new connection or a GCP seeking a modification of an existing connection to the LITS *(i.e., an Applicant)* may for the purposes of preparing an adequate relevant proposal, obtain from the TSO,

(a) the appropriate application form (refer to Appendix A),

(b) the Grid Development Plan (GDP), and

(c) the layout and/or block schematic diagrams of the relevant LITS Node.

8.14.3 The Applicant shall submit to the TSO the completed application form for a new connection or a modification of an existing connection to the LITS and pay the published application fee to the TSO.

8.14.4 A completed application shall include the following information:

(a) a description of the proposed new connection (or the modification to an existing connection), which shall comprise the Connection Proposal (or Connection Modification Proposal) for the pertinent Connection Point;

(b) the relevant Standard Planning Data in accordance with the requirements of section 7.6 of the Planning Sub-code; and

(c) the expected completion date of the proposed connection.

8.15 Processing of Application for a New Connection or Modification

8.15.1 A Transmission GCP must connect the power network/apparatus or power plant of an applicant seeking connection to the transmission network provided the request is:

(a) compliant with the approved GDP; and
(b) approved by the TSO.

8.15.2 The TSO, in consultation with the Transmission GCP, shall evaluate the application and inform the applicant whether the proposed development is acceptable or not within **sixty (60) days** from the date of submission of the completed application.

8.15.3 If the application is acceptable the TSO shall, in consultation with the Transmission GCP, approve the Connection Proposal or the Connection Modification Proposal and sign a Connection MOU or a Connection Modification MOU, (as the case may be,) with the applicant.

8.15.4 If the application is not acceptable, the TSO shall notify the applicant stating why the application is not acceptable. The TSO shall include in its notification, suggestions on how the application could be improved and made acceptable.

8.15.5 Where an applicant's connection requirement is rejected because it is not covered by the existing approved GDP, the applicant may request for a modification of the approved GDP through the TSO or Transmission GCP for consideration and approval by the LERC.

8.15.6 When the appropriate modification of the GDP has been approved in accordance with the procedures as issued from time to time by the LERC, then the TSO and the relevant Transmission GCP may arrange to connect the applicant, provided the applicant agrees to pay for costs arising directly from the proposed connection.

8.15.7 The applicant may revise and resubmit the application as it deems appropriate, and the TSO and Transmission GCP shall consider the resubmission.

8.15.8 If the TSO/Transmission GCP and the applicant cannot reach agreement on the proposed connection or the modification to an existing connection, either party may bring the matter to the attention of the LERC for resolution.

8.15.9 If a Connection MOU or Connection Modification MOU is signed, the applicant shall, within **thirty (30) days** from signing (or a mutually agreed longer period), submit to the TSO the Detailed Planning Data pertaining to the Connection Proposal or the Connection Modification Proposal in accordance with the requirements stated in Section 7.6 of the Planning Sub-code.

8.15.10 The applicant seeking connection shall undertake to build and operate its network or installed equipment in compliance with the LEGC and other existing regulations, rules, standards and procedures.

8.15.11 The applicant may at any time thereafter commence construction of the facility subject to having deposited copies of the Connection MOU or the Connection Modification MOU with the LERC and any other relevant regulatory authority *(as may be required).*

8.15.12 In consultation with the Transmission GCP, the TSO and the applicant shall negotiate and execute a Connection Agreement or Amended Connection Agreement, (as the case may be,) before the construction is completed after making any relevant corrections and amendments to the MOU to reflect what has been constructed and/or installed at the Connection Point.

8.15.13 The Connection Agreement or the Amended Connection Agreement shall only come into force after the satisfactory construction and commissioning of the facility and the issuance of a ***Certificate of Approval to Connect*** by the TSO.

8.15.14 The TSO shall lodge copies of a *Connection Agreement* or *Amended Connection Agreement* with the LERC within **fourteen (14) days** after its execution.

Technical Requirements for Connected Equipment

8.16 General Requirements for GCP's Equipment

8.16.1 Connected equipment must be equipped with circuit breakers and associated protection and control systems which are able to close/open the maximum short circuit current expected at the connection point.

8.16.2 All other equipment directly connected to the connection point must also be capable of withstanding the maximum short circuit current expected at the connection point.

8.16.3 A Transmission GCP must annually advise the maximum short circuit current that may occur at each connection point. This shall be calculated considering power system development potential consistent with the targets specified in section 8.19 of the LEGC.

8.16.4 For a Generation GCP including VRPPs, the circuit breaker to be used for connection switching must be equipped with a synchro-check system and

disconnectors to ensure safety, unless otherwise agreed with the relevant Transmission GCP and TSO.

Unintended and Unscheduled Back-energization

8.16.5 All GCPs shall take adequate precautions to ensure that no part of the Grid is energized by the GCP's system from another source of supply unless it is requested in writing by the TSO as an exceptional arrangement. The switchgear and controls of a GCP's system shall be so designed as to prevent back-energization and the personnel shall be made aware of the need for this precaution.

8.17 Power System Control

8.17.1 A Generation GCP shall install technical facilities on its generating units or facility to provide the following information to the TSO's Control Center:

(a) Status indications of circuit breaker, isolator switches, and earth switches insofar as they are required for operation of the network;
(b) Measurement of active and reactive power flow in both the import and export directions, as well as voltages and frequency;
(c) Where applicable, reference values for control (activation/deactivation of primary/secondary control) and instantaneous demand value of the secondary control;
(d) Reference value of the reactive power in the form of the schedule or as an instantaneous value (e.g., for voltage and reactive power control); and
(e) Selected protection information.

8.17.2 Subject to technical requirements specified under Part E – Renewables Sub-code, a VRPP GCP shall equip its plant or modules with suitable equipment to provide appropriate control signals to the TSO relating the following where appropriate:

(a) Wind speed (m/s) for VRPPs comprised of wind turbines;
(b) Wind direction (shown in degrees relative to North=0^{o}) for VRPPs comprised of wind turbines;
(c) Solar irradiation (W/m^2) for VRPPs comprised of solar PV modules;
(d) Percent of plant in operation (%); and
(e) Available power estimation (MW).

8.17.3 Each Generation GCP (including the VRPP GCPs) shall have its own control center facility well equipped to effectively schedule the power interchange with the TSO's LITS Control Centre.

8.18 Protection Requirements

General Principles

8.18.1 Protection schemes are generally classified into two groups as follows:

(a) Equipment protection and
(b) System protection.

8.18.2 Equipment protection relates to the selective and rapid detection of a fault and disconnection of the faulty equipment or circuit.

8.18.3 System protection schemes respond to a system condition (as opposed to a system fault), such as under frequency, voltage slide, out of step or sub-synchronous resonance, and appropriate automatic actions are undertaken to maintain integrity of the power system.

8.18.4 Protection schemes are considered adequate when the protection relays perform correctly in terms of:

(a) Dependability,
(b) Security,
(c) Speed of operation,
(d) Selectivity, and
(e) Sensitivity.

Minimum Requirements/Protection Philosophy

8.18.5 The minimum protection requirements for any new or existing connection will vary depending on many factors such as load type, earthing methods, and others. However, the minimum requirements shall encompass

(a) three-phase over-current,
(b) earth fault (to suite earthing requirements), and
(c) inter-tripping.

8.18.6 The TSO and each GCP shall implement the prevailing protection philosophy, standards and preventive maintenance procedures that shall improve the reliability performance of their respective systems and result in the least adverse effects on the LITS.

8.18.7 The Transmission GCP and other GCPs are responsible for designing, installing, and testing protection system in their networks so that they comply with the protection adequacy requirements in sub-section 8.18.4 as determined by the TSO and specified in relevant Connection Agreements. Protection schemes shall be secured against unwanted operation for out-of-zone faults, brief overloads, transient surges, or power swings etc.

8.18.8 Electrical lines connecting a GCP's network to the transmission network, and the transmission network itself, must be equipped with protection system in accordance with the latest version of standards published by the Transmission GCP periodically.

8.18.9 The coordination of protections at connection points must be agreed between the TSO, Transmission GCP and other GCPs and the protection system settings must be technically coordinated and graded in accordance with values approved and issued by the TSO.

8.18.10 All Generation GCPs with facilities connected to the transmission network shall provide protection against

(a) loss of excitation on the generating unit, and

(b) pole slipping on the generating unit.

8.18.11 All GCPs shall ensure correct and appropriate settings of protection to achieve effective removal of faulty equipment within the clearance time specified in section 8.19 of this LEGC.

Back-up Protection

8.18.12 Backup protection facilities shall be provided in accordance with the prevailing protection standards in case of failure of the main protection to operate.

8.18.13 All circuit breakers connecting to a Connection Point must be equipped with breaker failure protection. If the protection system fails to interrupt fault current within fault current interruption time, the circuit breaker failure protection shall be capable of initiating tripping of all the necessary electrically adjacent circuit breakers to interrupt the fault current as provided under section 8.19.

8.18.14 In the circumstances cited in sub-section 8.18.13 that involve faults on the GCP's network, the GCP's protection may be allowed to trip necessary circuit breakers on Transmission GCP's network *(inter-tripping of protection equipment)*, subject to consensus of the Transmission GCP and the TSO, and this must be described in the Connection Agreement.

Protection Bypass/Disconnection

8.18.15 Protection settings at the connection point shall not be altered, or protection bypassed and/or disconnected without consultation and agreement of the TSO and the GCP.

8.18.16 Where protection is bypassed and/or disconnected, by agreement, then the cause must be rectified, and the protection restored to normal condition within **one (1) day**.

8.18.17 If an agreement as required under sub-section 8.18.16 has not been reached the electrical equipment should be removed from service forthwith.

Additional Protection Requirements

8.18.18 Where a GCP's protection equipment is required to communicate with the Transmission GCP's protection equipment it must meet the communications interface requirements specified by the TSO.

8.18.19 Additional protection functions required for a VRPP are specified in section 15.7 under the Renewable Energy Sub-code of the LEGC.

Network Stability and Integrity

8.18.20 High speed relays, high speed circuit breakers and automatic re-closing facilities shall be used where studies show that their application will enhance network stability. Automatic re-closing under out-of-step conditions shall be prevented by blocking relays.

8.18.21 Under-Frequency Load Shedding relays shall be coordinated to ensure system stability and integrity.

8.18.22 The target performance for the protection system of a GCP measured in terms of Dependability Index shall be as specified in sub-section 12.6.3 of the LEGC.

8.19 Short Circuit Current and Fault Clearance Time

8.19.1 Fault clearance times at a Connection Point and the method of system earthing including, where relevant, the recommended generating unit neutral earthing configuration, will be provided by the TSO on request.

8.19.2 The maximum allowable short circuit current and maximum fault clearance time at a Connection Point by main protections in the transmission system shall be as determined according to relevant studies and specified by the TSO in the System Operations Manual.

8.19.3 Total fault clearance time as provided in the System Operations Manual shall be from fault inception until the time to arc extinction, which therefore shall include relay operation, circuit breaker operation and telecommunications signaling times.

8.19.4 GCPs will be expected to coordinate their protection schemes according to the clearance times specified by the TSO. Prospective GCPs whose proposed protection schemes cannot achieve the times specified, or whose power station cannot continue operations whilst line faults on the LITS are cleared, may be required to resubmit their proposals for final approval by the TSO.

8.19.5 A Transmission GCP may propose to LERC a maximum fault level or fault clearance time different from that specified in the TSO's System Operations Manual for specific substations where it reasonably considers such alternative fault level or clearance time would result in a lower overall cost of supply to consumers. Such a proposal should demonstrate the overall cost benefit to consumers of such a different fault level or clearance time.

8.19.6 LERC shall duly consider any such proposal (stated in sub-section 8.19.5) in consultation with the GCAC, the TSO and all affected GCPs.

8.19.7 Where the LERC considers that such a proposal would result in a lower overall cost to consumers without compromising on system integrity, a fault level or

clearance time different from the specified default fault level or clearance time for a specific substation may be approved.

8.20 Telecommunications Requirements for Monitoring and Control

8.20.1 A telecommunication system shall be established so that the TSO and GCPs can communicate with one another, as well as exchange data signals for monitoring and control of LITS equipment at all times.

8.20.2 The TSO shall provide the Transmission GCP and other GCPs with the requirements for the complete telecommunication equipment that is required for monitoring and control within the LITS, and a description of the requirement contained in the relevant Connection Agreement.

8.20.3 A Transmission GCP and each GCP shall provide the complete set of telecommunication equipment prescribed by the TSO for monitoring and control of all the Connection Points within the LITS and in accordance with the executed Connection Agreement.

8.20.4 The TSO is responsible for coordinating with GCPs the commissioning, checking and integration of a GCP's data/information system into the TSO's data/information system.

8.21 SCADA System for Monitoring and Control

8.21.1 The Transmission GCP shall procure, install and setup RTUs and other telemetry equipment for monitoring real-time information and controlling equipment which form part of the LITS or at a Connection Point.

8.21.2 The RTUs shall be compatible with the Master Station protocol and in accordance with the defined requirements, specifications, planning and development as provided by the TSO.

8.21.3 All other GCPs shall provide any other related telecontrol/SCADA equipment and interfaces for interconnection with the TSO's SCADA system to perform agreed monitoring and control functions.

8.21.4 The integration process of a GCP's data acquisition and transmitting equipment to the TSO's SCADA/EMS system shall be such that each party shall carry out the necessary works in its own system, but the GCP shall bear full responsibility for a successful integration.

8.21.5 The list of data to be transmitted to the SCADA/EMS system as provided in Technical Schedule TS – M shall be agreed between the GCP and the TSO and shall be specified in the Connection Agreement.

Process Signals Interface to RTU

8.21.6 The interface of the process signals to RTU shall be as specified by the TSO. The provision and maintenance of the wiring and signaling from the GCP's plant and

equipment to the interface cable to the Main Distribution Frame (MDF) shall be the responsibility of the GCP.

8.21.7 Measured quantities/values and indications to be supplied by GCPs to the TSO shall be in the formats as specified by the TSO or as agreed between TSO and GCP. Where the required signals become unavailable or do not comply with applicable standards for reasons within the control of the provider of the information, the GCP shall report the deficiencies to the TSO and restore or correct the signals and/or indications to what was agreed.

8.21.8 The TSO shall notify a GCP of additional measured quantities and/or indications in relation to a GCP plant and equipment that are needed to meet a Transmission GCP's system requirement. The costs related to the GCP's modifications for the additional measured quantities and/or indications shall be for the account of the providing GCP.

8.21.9 Within **seven (7) days** of receipt of TSO's notification specified in sub-section 8.21.8, the GCP shall ensure that such measured quantities and/or indications are made available at the RTU.

8.21.10 The TSO and the GCP shall agree on the timeous provision of operational data items as per the relevant Power Purchase Agreement (PPA) and/or Power Supply Agreement (PSA) or TSA.

8.21.11 The TSO and a GCP shall jointly verify all measured quantities and/or indications for functionality and accuracy once every **three (3) years**, so as to achieve overall accuracy of operational measured quantities within the limits agreed.

8.21.12 The data formats to be used and the fields of information to be supplied to the TSO by the GCP shall be as per the relevant PPA, PSA or TSA and Connection Agreement.

8.21.13 The TSO shall provide periodic feedback to a GCP regarding the status of equipment and systems installed at the Connection Point. The feedback shall include, but not be limited to, results from tests, condition monitoring, inspections, audits, failure trends and calibration. The frequency of the feedback shall be determined in the operating agreement/service level agreement.

8.22 Data Registration

Data to be Registered

8.22.1 The data relating to a Connection Point and the proposed development that are submitted by the GCP to the TSO, in accordance with the Standard and Detailed Planning Data requirements under Section 7.6 of the Planning Sub-code, shall be registered according to the following data categories:

(a) ***Forecast Data*** - includes demand and active energy, and shall contain the GCP's best estimate of the data being projected for five (5) successive years

(b) ***Estimated Equipment Data*** – contains the GCP's best estimate of the values of parameters and information about the equipment for five (5) successive years; and

(c) ***Registered Equipment Data*** – shall contain validated actual values of parameters and information about the equipment that are submitted by the GCP to the TSO at the Connection Date.

Stages of Data Registration

8.22.2 The data relating to a Connection Point and a GCP development that are submitted by an applicant for a new connection, or an amended connection shall be registered in three stages and classified accordingly as:

(a) Preliminary Project Planning Data;

(b) Committed Project Planning Data; and

(c) Connected Project Planning Data.

8.22.3 The data that are submitted at the time of application shall be considered as Preliminary Project Planning Data. These shall contain the Standard Planning Data and the Detailed Planning Data specified in Section 7.6 of the Planning Sub-code.

8.22.4 Once a Connection MOU or Connection Modification MOU is signed, the Preliminary Project Planning Data as may have been amended during the consideration of the relevant proposal shall become the Committed Project Planning Data and shall be utilized in the evaluation of other similar applications and in preparation of the GDP.

8.22.5 The Committed Project Planning Data shall be updated, confirmed, and replaced with validated actual values of parameters and information about the connected equipment or facility at the time of commissioning and shall be transformed to become the Connected Project Planning Data.

8.22.6 The Connected Project Planning Data shall be registered to replace the Committed Project Planning Data in accordance with the categories specified in sub-section 8.22.1 and shall hitherto be utilized in the evaluation of other applications for a new connection or modification of existing connection and in preparing the GDP.

Data Forms

8.22.7 The applicant, in consultation with the TSO, shall complete and submit the forms for all data requirements in fulfilment of either a Connection MOU or Connection Modification MOU.

8.23 Submittals Prior to the Commissioning Date

Pursuant to the terms, conditions and schedules specified in the Connection Agreement, the following shall be submitted by the applicant prior to the commissioning date:

(a) Specifications for major equipment not included in the Standard Planning Data and Detailed Planning Data;

(b) For distribution network connections and connections for other equipment or networks that will not form part of the LITS, details of switching, protection and control arrangements and equipment settings for connection to the network of a Distribution Company, a Large Consumer or any other Demand GCP system that will be extracting power from the LITS;

(c) For assets that will form part of the LITS, electrical diagrams and drawings of the applicant's equipment at the LITS node;

(d) Information that will enable the TSO to prepare the Connection Point drawings;

(e) Copies of all safety rules and local safety instructions applicable to the applicant's equipment and a list of Safety Coordinators;

(f) A list of the names and telephone numbers of authorized representatives, including confirmation that they are fully authorized to make binding decisions on behalf of the applicant, in relation to operations of the LITS;

(g) Proposed maintenance program; and

(h) Commissioning and test procedures at the Connection Point and for the connected facility.

8.24 Commissioning

Procedure for Commissioning of Equipment and Physical Connection to the LITS

8.24.1 Upon completion of construction, erection or installation of the proposed facility, commissioning of the applicant's development including work at the Connection Point, the equipment at the Connection Point or the GCP development shall be subjected to the required commissioning and test procedures.

8.24.2 The procedure for any tests which may require, result in, or involve a temporary connection to the LITS shall be jointly agreed, scheduled and performed by the applicant or GCP and the TSO in collaboration with the Transmission GCP.

8.24.3 Where the tests are successful and the installation ready for operation, the applicant or GCP shall submit to the TSO, a *statement of readiness to connect*, which shall include the test results and the commissioning report.

8.24.4 The TSO may within **fourteen (14) days** after the receipt of the *statement of readiness to connect*, perform at its sole discretion any tests it deems necessary to accept or decline the *statement of readiness to connect.*

8.24.5 Upon acceptance of the *statement of readiness to connect* received from an applicant or GCP, the TSO shall issue a *Certificate of Approval to Connect* and arrange with the Transmission GCP to connect the facility at the convenience of the applicant or the GCP as may be appropriate.

8.24.6 The physical connection to the LITS shall be made only after the *Certificate of Approval to Connect* has been issued by the TSO.

Requirement to Inspect and Test Equipment During Commissioning

8.24.7 Any new or replacement equipment to form part of or to be connected to the LITS shall be inspected and tested by the TSO to demonstrate that it complies with the relevant standards, the provisions of the LEGC and any relevant Connection Agreement prior to (or within an agreed time after) being connected to the LITS. The Transmission GCP is entitled to witness such inspections and tests.

8.24.8 When the TSO or Transmission GCP notifies the GCP that the status of a Connection Point or any equipment of the GCP does not meet the conditions for energizing, the GCP shall complete the necessary adjustments and modifications required and agree a new inspection schedule with the Transmission GCP and the TSO.

8.24.9 During inspection, the GCP shall prove that equipment in its own system or side of the Connection Point comply with the current technical standards, regulations, and procedures.

8.24.10 Valid test certificates shall be produced upon demand (or within an agreed time thereafter) by any affected GCP, showing that the equipment has passed the tests and complies with the required standards before connection to a network.

Coordination During Commissioning

8.24.11 A GCP seeking to connect a facility to the LITS shall cooperate with other GCPs and the TSO to develop procedures that will ensure that the commissioning of the connection and the connected facility is carried out in a manner that:

(a) does not adversely affect other GCPs or affect power system security or quality of supply; and

(b) minimizes the threat of damage to any other GCP's equipment.

8.24.12 Not less than **four (4) months** prior to the proposed commencement of commissioning of a new or replacement equipment (other than replacement by identical equipment) that could reasonably be expected to alter performance of the power system, the GCP shall submit to the TSO sufficient design information including proposed parameter settings to allow critical assessment and analytical

modelling of the effect of the new or replacement equipment on the performance of the power system.

8.24.13 The TSO shall consult with other relevant GCPs as appropriate and within **twenty (20) days** of receipt of the design information, notify the GCPs for any comments on the proposed parameter settings of the new or replacement equipment.

8.24.14 The TSO and affected GCPs shall consult and agree on the parameter settings.

Commissioning Program

8.24.15 Not less than **three (3) months** prior to the proposed commencement of commissioning by a GCP of any new or replacement equipment that could reasonably be expected to alter performance of the power system, the GCP shall inform the relevant Transmission GCP and the TSO in writing of the commissioning program including test procedures and proposed test equipment to be used in the commissioning.

8.24.16 The relevant Transmission GCP and the TSO shall, within **fifteen (15) days** of receipt of such information notify the GCP that it either agrees with the proposed commissioning program and test procedures or that it requires changes in the interest of power system security, safety or quality of supply.

8.24.17 If the Transmission GCP or the TSO require changes, then the parties shall co-operate to reach agreement and finalize the commissioning program within a reasonable period.

8.24.18 A GCP shall not commence commissioning until the commissioning program has been finalized and agreed with the Transmission GCP and the TSO.

8.24.19 The Transmission GCP and the TSO shall not unreasonably delay finalizing a commissioning program.

Commissioning Tests

8.24.20 The TSO may, at its sole discretion, witness commissioning tests relating to new or replacement equipment that could reasonably be expected to alter performance of the power system or the accurate metering of energy.

8.24.21 The Transmission GCP and the TSO shall, within a reasonable period after receiving advice of commissioning tests, notify the *(requesting)* GCP *[whose new or replacement equipment is to be tested]* whether or not it wishes to witness or observe the commissioning tests and if it finds the proposed commissioning times to be suitable.

8.24.22 A GCP whose new or replacement equipment is tested under this provision shall submit to the Transmission GCP and the TSO the commissioning test results demonstrating that the new or replacement equipment complies with the provisions of the LEGC or the relevant Connection Agreement or both to the satisfaction of the Transmission GCP and the TSO.

8.24.23 If the commissioning tests conducted in relation to a new or replacement item of equipment demonstrates non-compliance with one or more requirements of the LEGC or the relevant Connection Agreement then the GCP whose new or replacement equipment was tested shall promptly meet with the TSO to agree on a process aimed at the achievement of compliance of the relevant equipment with the provisions of the LEGC.

8.24.24 The TSO may independently or at the request of a GCP direct that the commissioning and subsequent connection of the equipment must not proceed if the relevant equipment does not meet the technical requirements and applicable standards.

8.25 Electrical Diagram and Connection Point Drawing Requirements

Responsibilities of TSO and GCPs

8.25.1 The TSO shall specify the format to be followed in the preparation of the Electrical diagrams and Connection Point drawings for any Connection Point and all symbols used in Electrical diagrams and Connection Point drawings shall be in accordance with IEC 60617 Standards as updated.

8.25.2 Each GCP shall prepare and submit to the TSO an Electrical diagram and Connection Point drawing for the equipment on its side of the Connection Point, in accordance with the requirements of the Connection Agreement or Amended Connection Agreement.

8.25.3 The Electrical diagrams and Connection Point drawings shall provide an accurate record of the layout and circuit connections, ratings, identification of equipment and related apparatus and devices on the GCP's side of the Connection Point.

8.25.4 The TSO shall provide each GCP with an electrical diagram and Connection Point drawing for all the equipment on the LITS side of the Connection Point in accordance with the requirements of the Connection Agreement or Amended Connection Agreement.

8.25.5 The TSO shall prepare and distribute the composite Electrical diagram and Connection Point drawing for the entire Connection Point.

Preparation of Electrical Diagram and Connection Point Drawing

8.25.6 All the equipment at the Connection Point shall, wherever possible, be shown in one Electrical diagram and one Connection Point drawing. When more than one Electrical diagram or Connection Point drawing is necessary, duplication of identical information shall be minimized.

8.25.7 The Electrical diagrams and Connection Point drawings shall represent, as closely as possible, an accurate record of the physical arrangement of the equipment, their electrical connections, ratings, identification and the current status of the equipment, related apparatus and other devices at the Connection Point.

8.25.8 The title block of the Electrical diagram and Connection Point drawing shall include the names of authorized persons together with provisions for the details of revisions, dates, and signatures.

Changes to Electrical Diagrams and Connection Point Drawings

8.25.9 The TSO and other affected GCPs shall be provided with a revised Electrical diagram and Connection Point drawing by the Transmission GCP or the relevant GCP, at least **one month** prior to a proposed addition to or change of equipment connected to or forming part of any LITS Node.

8.25.10 If the modification involves the replacement of existing equipment, the revised Electrical diagram and Connection Point Drawing shall be provided to the TSO or other party in accordance with the requirements of the Amended Connection Agreement.

8.25.11 The revised Electrical diagram and Connection Point drawing shall incorporate the new equipment to be added, the existing equipment to be replaced or the change in Equipment Identification.

Validity of Electrical Diagrams and Connection Point Drawings

8.25.12 The composite Electrical diagram and Connection Point drawing prepared by the TSO in accordance with the provisions in sub-section 8.25.5 shall be the Electrical diagram and Connection Point drawing to be used for all operation and planning activities associated with the Connection Point.

8.25.13 If a dispute involving the accuracy of the composite Electrical diagram or Connection Point drawing arises, a meeting between the TSO and the GCP or any other relevant parties shall be held as soon as possible, to resolve the dispute.

8.26 Equipment Identification and Nomenclature

8.26.1 In order to ensure the safe and effective operation of the LITS and to minimize the risk of faults resulting from human error, equipment nomenclature and identification shall be in accordance with a common standard which shall be developed and maintained by the TSO.

8.26.2 All GCPs shall apply the common nomenclature system developed by the TSO to code, number, and otherwise identify all LITS substations, plant and equipment that form part of the LITS or are directly connected to the LITS.

8.26.3 The nomenclature shall be used in all technical drawings, operations, instructions, notices, and other documents.

8.26.4 A GCP shall use reasonable endeavors to ensure that its representatives comply with the nomenclature standards in any operational communications with the TSO.

8.26.5 A GCP shall ensure that nameplates on its equipment at any point within the LITS conform to the nomenclature standards and that the nameplates are maintained to ensure easy and accurate identification of equipment.

8.26.6 The TSO may, by notice in writing, request a GCP to change the existing numbering or nomenclature of transmission equipment and apparatus of the GCP for purposes of uniformity, and the GCP shall comply with such a request provided that if the existing numbering or nomenclature conformed with the previously approved nomenclature standards, the TSO shall pay all reasonable costs incurred by the GCP in complying with the request.

8.27 Compliance with Connection Requirements by Generation GCP

8.27.1 A Generation GCP shall, prior to the commencement date of supply to a GCP with which it has a PPA, provide evidence to the Demand GCP that:

(a) it has a valid Connection Agreement with the TSO, and

(b) each of its generating units complies with the technical requirements of Technical Schedule TS–L, the relevant PPA and the Connection Agreement.

8.27.2 A Generation GCP shall negotiate in good faith with the relevant GCP and the TSO to agree on a compliance monitoring method and program for each of its generating units to confirm ongoing compliance with the applicable requirements of the LEGC and the relevant Connection Agreement.

8.27.3 If a performance test or monitoring of in-service performance demonstrates that a generating unit is not complying with one or more technical requirements then the Generation GCP shall:

(a) promptly notify the relevant GCP and the TSO of that fact;

(b) promptly advise the GCP and the TSO of the remedial steps it proposes to take and the timetable for such remedial work;

(c) diligently undertake such remedial work and report at **monthly** (or other mutually agreed) **intervals** to the GCP and the TSO on progress of implementing the remedial action; and

(d) conduct further tests and monitoring on completion of the remedial work to confirm compliance with the relevant technical requirement.

8.27.4 If a GCP or the TSO reasonably believes that a generating unit is not complying with one or more technical requirements of the LEGC and the relevant Connection Agreement, the TSO may instruct the Generation GCP to conduct tests to demonstrate that the relevant generating unit complies with those technical requirements.

8.27.5 Where the tests provide evidence that the relevant generating unit continues to comply with the technical requirement(s) the GCP or the TSO (as appropriate) shall reimburse the Generation GCP for the reasonable expenses incurred as a direct result of conducting the tests.

8.27.6 If the TSO or a GCP either:

(a) is not satisfied that a generating unit does comply with one or more technical requirements, or

(b) does not have evidence demonstrating that a generating unit complies with the technical requirements, or

(c) holds the reasonable opinion that there is or could be a threat to the power system security,

the TSO may independently or upon the advice of a GCP, direct the relevant Generation GCP to operate the relevant generating unit at a particular generation output or in a particular mode until the Generation GCP submits evidence reasonably satisfactory to the TSO or the GCP that the generating unit is complying with the relevant technical requirement.

8.27.7 A Generation GCP shall maintain records for five years on each of its generating units and power stations setting out details of the results of all technical performance and monitoring tests conducted under the provisions of the LEGC and make these records available to the relevant GCP and the TSO on request.

8.28 Inspection and Testing

Right Of Entry and Inspection

8.28.1 If a GCP who is party to a Connection Agreement reasonably believes that another GCP is not complying with a technical provision of the LEGC and as a consequence, the first GCP is suffering or is likely to suffer an adverse effect, then the first (or aggrieved) GCP may, with the prior consent of the TSO, inform the offending GCP of the intention to enter the relevant facility for the sole purpose of passively observing the situation in order to assess compliance with the technical obligations under the LEGC.

8.28.2 A GCP who wishes to inspect any LITS facility that it does not own shall give the TSO and the Transmission GCP at least **two (2) days'** notice of its intention to carry out an inspection by providing the following information in the notice:

(a) the name of the representative who will be conducting the inspection on behalf of the GCP;

(b) the time that the inspection will commence and the expected time the inspection will be concluded;

(c) the nature of the suspected non-compliance with the LEGC; and

(d) the reasons for desiring an inspection.

8.28.3 A GCP may not carry out an inspection under this section 8.28 on more than two occasions in any month, except for the purpose of verifying the performance of corrective actions claimed to have been carried out in respect of non-conformance observed and documented on a previous inspection or for the purpose of investigating an operating incident that has occurred.

8.28.4 At any time when the representative of a GCP is conducting an inspection, that representative shall:

(a) not interfere with the operation of the facility except to the extent reasonably necessary and approved by the Transmission GCP and the TSO (such approval not to be unreasonably withheld or delayed); and

(b) observe all safety precautions, site access and clearance protocols of the facility, provided that these are not to be used to delay or deny the granting of the access for inspection.

8.28.5 Any representative of a GCP conducting an inspection under this section must be appropriately qualified to perform the relevant inspection.

8.28.6 The cost of inspections under this section shall be borne by the GCP requesting the inspection.

8.28.7 The TSO or any of its authorized representatives may, at any time and without notice, inspect a facility of a GCP and the operation or maintenance of that facility to:

(a) assess compliance by the GCP with its operational obligations under the LEGC or an ancillary service agreement;

(b) investigate any possible past or potential threat to power system security; or

(c) conduct any periodic familiarization or training exercise associated with the operational requirements of the LITS.

8.28.8 A GCP who undertakes an inspection under this section shall within **seven (7) days** of first entry submit to the TSO and the Transmission GCP a report that provides the findings and results of the inspection carried out.

Right of Testing

8.28.9 A GCP who has reasonable grounds to believe that equipment or facilities owned by itself or by others may not comply with the LEGC or the Connection Agreement may request testing of the relevant equipment by giving notice in writing to the TSO.

8.28.10 The TSO shall notify the Transmission GCP and may conduct, either by itself or by contract or otherwise arrange for, the relevant test(s) required at a time suitable to the TSO and the Transmission GCP, if the Transmission GCP's involvement is necessary.

8.28.11 The costs of such tests shall be borne by the GCP that requested for the test, unless the target equipment is determined by the tests to be non-compliant with the relevant Connection Agreement or the LEGC, in which case all reasonable costs of such tests shall be borne by the owner of that facility.

8.28.12 Tests shall be conducted using standard test procedures agreed between the relevant parties, which agreement shall not be unreasonably withheld or delayed.

8.28.13 Tests shall be carried out only by persons with the relevant skills and experience.

8.28.14 A GCP shall give the TSO adequate prior notice of the intention to conduct a test in respect of equipment within the GCP's facility.

8.28.15 The GCP who requests a test under this section may appoint a representative to witness the test and the representative so appointed shall be provided with all the necessary information, schedules, and procedures to enable that representative to follow the stages of the test as it is being conducted.

8.28.16 An accredited testing officer or expert who conducts a test shall submit a report to the GCP who requested the relevant test, the TSO, the Transmission GCP and to any other GCP that is likely to be affected by the results of the test within a reasonable period after the completion of the test, but in any case, not exceeding **two (2) weeks** except for stated reasons.

8.28.17 The TSO may, at the request of a GCP and subject to the other provisions of this Sub-code regarding entry and inspection, instruct a Transmission GCP to arrange and attach a test or monitoring equipment to its plant.

8.28.18 In carrying out a monitoring directive, the performance of the monitored plant or equipment shall not be constrained in any way.

8.28.19 Notwithstanding any provisions in this section, the TSO may undertake equipment testing at any time it deems necessary in accordance with procedures prescribed under section 9.17.

8.29 Routine Testing of Protection Equipment by GCPs

8.29.1 A GCP shall cooperate with the TSO by testing for the proper operation of equipment forming part of a protection system for the Connection.

8.29.2 A GCP shall conduct protection system tests:

(a) prior to the plant being placed in service at the relevant Connection Point; and

(b) at intervals specified in the Connection Agreement or in accordance with a plan agreed between the TSO and the GCP.

8.29.3 A GCP shall bear its own costs of conducting tests under this section.

8.30 Power System Tests

8.30.1 The TSO shall coordinate tests to verify the proper functioning and performance of the LITS and associated equipment. Such tests may be conducted whenever:

(a) an existing facility of the LITS is upgraded or substantially modified;

(b) a new facility of the LITS is commissioned;

(c) a new generating unit of a Generation GCP or equipment of any other GCP is commissioned that is expected to substantially alter the power transfer capability of the transmission network; and

(d) settings or changes are made to any power system stabilizers.

8.30.2 The TSO shall develop a program and coordination arrangements for the tests including criteria for continuation with the tests and operational procedures.

8.30.3 Operational conditions for each test shall be arranged by the TSO and the test procedures shall be coordinated by an officer nominated by the TSO who has the authority to stop the test or any part of it or vary the procedure within pre-approved guidelines if that officer considers any of these actions to be reasonably necessary.

8.30.4 Each GCP shall cooperate with the Transmission GCP and the TSO when required during the planning, preparation and conduct of tests on the LITS to assess the technical performance of the transmission network and, if necessary, conduct coordinated activities to prepare for power system-wide testing or individual on-site tests of a GCP's facility or plant, including the disconnection of a generating unit.

8.30.5 The TSO may direct changes in operation of generating units during power system tests if this is deemed necessary to achieve operational conditions on the LITS which are reasonably required to achieve valid test results.

8.30.6 The TSO shall plan the timing of tests so that the variation from scheduled dispatch that would occur is minimized and the duration of the tests is as short as possible and consistent with test requirements and power system security.

8.31 Disconnection and Reconnection

Voluntary Disconnection

8.31.1 Unless otherwise agreed and specified in a Connection Agreement, a GCP shall give **six months** prior notice in writing to the TSO of its intention to permanently disconnect a facility from a LITS Node.

8.31.2 Subject to the terms of the relevant Connection Agreement, a GCP may request voluntary permanent disconnection or decommissioning of its equipment from the LITS, in which case appropriate operating procedures necessary to ensure that the disconnection will not threaten power system security must be implemented in accordance with the provisions of the LEGC.

8.31.3 The GCP shall pay all costs directly attributable to the voluntary disconnection and decommissioning.

Decommissioning Procedures

8.31.4 If a GCP's facility is to be permanently disconnected from the LITS, the TSO, the relevant Transmission GCP and the GCP shall, prior to such disconnection occurring, coordinate and follow an agreed procedure for the disconnection.

8.31.5 The Transmission GCP shall notify the TSO and any other GCP with whom the TSO has a Connection Agreement, if it believes in its reasonable opinion, that the terms and conditions of such a Connection Agreement will be affected by the procedures for disconnection or the proposed procedures agreed with any other GCP. The parties shall negotiate any amendments to the procedures for disconnection or any amendments to the Connection Agreement that may be required.

Involuntary Disconnection

8.31.6 The TSO or a Transmission GCP may without the prior consent of any affected GCP, disconnect a GCP's facilities from the LITS under any of the following conditions:

(a) during an emergency in accordance with the provisions of the LEGC;

(b) in accordance with applicable laws or order of the law courts; or

(c) in accordance with the provisions of the GCP's Connection Agreement.

8.31.7 In all cases of disconnection by the TSO during an emergency, the TSO shall undertake a review and thereafter provide a report to the GCP and the GCAC advising of the circumstances requiring such action.

8.31.8 In carrying out its obligations under sub-section 8.31.6 (a), where there is more than one GCP involved, the TSO shall, to the extent practicable,

(a) implement an equitable sharing of the reconnection of facilities up to the power transfer capability of the network, and,

(b) in performing these obligations, both the TSO and the relevant Transmission GCP shall, to the extent practicable, give priority to reconnection of sensitive loads.

8.31.9 All disconnections of a GCP's facilities other than those required during an emergency, shall be undertaken in an orderly manner and include a request to the relevant GCP to reduce the power transfer level at the proposed point of disconnection to zero prior to disconnection at the appointed time.

Disconnection to Implement Regulatory Order

8.31.10 The TSO or a Transmission GCP may, pursuant to a directive given by a regulatory or legal authority in accordance with the laws of Liberia or following the withdrawal of the GCP's License or Permit in accordance with the Regulations or permitting guidelines, disconnect a GCP's facilities from the LITS without the GCP's prior consent.

Obligation to Reconnect

8.31.11 The TSO shall reconnect a GCP's facility to the LITS as soon as practicable if:

(a) it is reasonably satisfied that there no longer exists an emergency due to which the GCP's facility was disconnected under sub-section 8.31.6(a) of the LEGC;

(b) it is reasonably satisfied that there no longer exists a reason for the disconnection under applicable laws or the GCP's Connection Agreement as provided in sub-sections 8.31.6(b) and 8.31.6(c) respectively; or

(c) any of the following conditions are met:

(i) a code breach giving rise to disconnection has been remedied,
(ii) where the breach is not capable of remedy, compensation has been agreed and paid by the GCP to the affected parties or, failing agreement, the amount of compensation payable has been determined in accordance with the dispute resolution procedure of the LERC or GCAC and that amount has been paid,
(iii) where the breach is not capable of remedy and the amount of compensation has not been agreed or determined, assurances for the payment of reasonable compensation have been given to the satisfaction of the TSO, the Transmission GCP and the affected parties, or
(iv) the GCP has taken all necessary steps to prevent the re-occurrence of the breach and has delivered binding undertakings to the TSO or the Transmission GCP that the breach will not re-occur.

Part C: Rules Of Practice

Part C, the Rules of Practice, covers the arrangements for system operations, scheduling and dispatch and safety procedure. This Part details the principles, procedures, and processes for secure power system operations; defines the roles and responsibilities of actors in system operation including the planning and coordination of generation and transmission outages and resolution of faults to ensure secure operation of the LITS. It also provides for the ancillary service procurement procedures, the roles and responsibilities of all the actors in producing the demand forecast data used in operational planning, the generation scheduling and dispatch process, and safety coordination procedures.

Section 9: Operations Sub-Code

9.1 Background, Purpose, and Scope

9.1.1 Section 9 of the LEGC contains the provisions and rules governing all the relevant aspects of power system operation. The Operations Sub-code governs the day-to-day control, management and short-term planning functions needed to ensure the satisfactory performance of the LITS.

9.1.2 The LITS is operated in parallel as an interconnected grid with the CSLG transmission system which is part of the regional WAPP interconnected system. In pursuance of harmonized interconnected operations, the WAPP has developed operating guidelines that are subscribed to by all operating members including Liberia represented by the TSO. The TSO and LERC commit to harmonize the LITS operations under the LEGC to the requirements as provided in the WAPP operating guidelines.

Purpose

9.1.3 The purpose of the Operations Sub-code is to define the general arrangements, obligations, policies, criteria and procedures needed to ensure the coordinated provision of system services, network switching, demand /supply balancing, operational planning and events reporting related to the operation of the LITS in a manner consistent with the security of supply and reliability requirements as set out in Technical Schedules TS – K and TS – L, taking into account any expected or real constraints on the generation and transmission systems.

Scope

9.1.4 The Operations Sub-code shall apply to the TSO and all GCPs and their agents and shall deal with issues relating to the following:

(a) Operational planning and management;
(b) Power system operating states and criteria;
(c) Real-time system monitoring and control;
(d) Facilities and procedures for communication during normal and emergency conditions;
(e) Outage and maintenance planning, coordination and execution;
(f) Ancillary services; and
(g) System disturbance monitoring, analysis and reporting.

9.1.5 All entities to whom this Sub-code applies shall always adopt Prudent Utility Practice to ensure reliable and satisfactory operation of the LITS.

9.2 TSO Obligations

9.2.1 The TSO shall have the following responsibilities and obligations in relation to operations of the LITS:

(a) Ensuring overall system reliability and safety of the LITS;
(b) Maintaining stability and security of the LITS; and
(c) Establishment and implementation of LITS operational measures.

System Reliability and Safety

9.2.2 The LITS shall be operated to achieve the highest degree of reliability practicable and appropriate remedial action shall be taken promptly to relieve any abnormal condition that may jeopardize reliable operation.

9.2.3 Pursuant to provisions under Section 10 of the LEGC, energy and other transfers as determined by the scheduling and dispatch arrangements, as far as feasible, shall be adjusted as required to achieve or restore reliable operation of the LITS.

9.2.4 Voltage control, system operations and security monitoring shall be coordinated on a system-wide basis to ensure safe, reliable, and economic operation of the LITS.

9.2.5 During or after a system disturbance, high priority shall be given to keeping all synchronized generating units running and connected to the LITS or islanded on their own auxiliaries and/or local loads, in order to facilitate system restoration.

9.2.6 Black start services shall be provided as available from the generating units.

9.2.7 The TSO shall make all reasonable endeavors to retain international interconnections unless it becomes evident that continued parallel operation of the affected parts of the LITS would jeopardize the remaining system or damage equipment.

9.2.8 If it becomes unsafe to operate generating units in parallel with the LITS due to critical levels of frequency and voltage resulting from a disturbance on the LITS, the separation and/or safe shut down of units shall be accomplished in such a way as to minimize the time required to resynchronize and restore the system to normal operation.

9.2.9 In the event of a system separation, the TSO shall ensure that the part of the LITS with a generation deficit shall automatically remove (or shed) sufficient load to permit early recovery of voltage and frequency so that system integrity may be re-established.

9.2.10 Customer load shall be shed for a reasonable period rather than risking the possibility of a cascading failure or operating at abnormally low frequency or voltage for an extended period.

9.2.11 An interconnected system operator may request that the TSO takes any available action to increase or decrease the active energy transfer into or out of its system by way of emergency assistance. Such requests shall be met by the TSO providing it has the capability to do so.

System Security

9.2.12 The LITS shall be operated as far as practical so that instability, uncontrolled separation, or cascading outages do not occur as a result of the most severe single contingency. Multiple outages of a credible nature shall be examined and, whenever practical, the LITS shall be operated to protect it against instability, uncontrolled separation, and cascading outages.

9.2.13 The TSO is responsible for efficient restoration of the LITS after supply interruptions.

9.2.14 The TSO shall operate and maintain primary and emergency facilities to ensure continuous operation of the LITS.

Operational Measures

9.2.15 The TSO shall establish operating instructions, procedures, standards and guidelines in a *System Operations Manual* to cover the operation of the LITS under all system conditions.

9.2.16 The LITS shall, as far as reasonably possible, be operated within defined technical standards and equipment ratings.

9.2.17 The TSO shall manage constraints on the LITS through the determination of operational limits, and scheduling of sufficient generation required for the demand and ancillary services to relieve constraints.

9.2.18 To achieve a high degree of service reliability, the TSO shall ensure adequate and reliable communications between all control centers, generating units and substations. Communication facilities to be provided and maintained by the various GCPs are specified in *Section 13 – Data & Information Exchange Sub-code.*

9.2.19 The TSO shall be responsible for the determination of the LITS protection philosophy *(as contrasted and supplementary to Equipment Protection philosophy elaborated under section 8.18)* through the conduct of applicable analytical studies.

9.2.20 The TSO shall determine, and review on a regular basis, relay settings for main protection and back-up protection on the LITS.

9.3 Operational Planning and Management

9.3.1 The TSO shall have responsibility for the operational planning and management functions within the LITS comprising:

(a) all tasks concerned with scheduling and controlling of the operation of generating units and transmission equipment to ensure adequate operating margins;

(b) development of procedures for maintaining system integrity during emergencies; and

(c) coordination of maintenance outages with all GCPs including Large consumers.

9.3.2 The purpose of operational planning shall be to ensure that short-term and medium-term events such as maintenance and repair work on equipment and apparatus, constructional activities in the transmission system and schedules registered with the TSO by Generation, Transmission, Distribution and other connected GCPs are handled efficiently by taking them into consideration in the planning of daily operational activities.

Operations Plan

9.3.3 Operations plan for the LITS shall cover at least the following:

(a) **Normal Operations** - where each Generation GCP, Transmission GCP, Distribution GCP or other Demand GCP, working with the TSO, shall plan its future operations so that normal interconnected operation can proceed in an orderly consistent manner with each Demand GCP providing its best estimate of demand to the TSO to develop the total demand forecast.

(b) **Emergency Operations** – where a set of plans shall be developed, maintained, and implemented by each Generation GCP, Transmission GCP and Demand GCP to enable the TSO cope with operating emergencies.

Annual Operations Plan requirements

9.3.4 The annual operations plan shall contain sufficient information in a suitable form to, at the minimum, assess the following:

(a) The adequacy and capability of generating units to meet forecast demand and energy requirements for the next year and up to four (4) years ahead by the end of October in each calendar year;
(b) Verification that generation and transmission outages are planned to maximize resource utilization and optimized placement of generation outages to produce a minimum running cost;
(c) Ensure that operational problems likely to be encountered are highlighted and alternative solutions considered; and
(d) Verification that the actions taken, and emergency procedures issued to deal with possible abnormal system conditions are adequate and satisfactory.

9.3.5 Transmission operations plans shall be coordinated with those of international/regional systems and control areas that are connected to the LITS including coordination of equipment outages, voltage levels, MW and MVAr flow monitoring and switching that affect the interconnected transmission system components.

9.4 Operations Planning Criteria

General Principles

9.4.1 Operational planning for the LITS shall be based on operations criteria that are designed to maintain the security, reliability, safety and continuity of electricity supply within the LITS at least cost.

9.4.2 In performing the operational planning function to provide system services essential for the proper functioning of the LITS, the TSO shall:

(a) take into account the maintenance cycle of plant and equipment and prepare annual, monthly, weekly and daily operational plans to achieve the required objectives;
(b) at all times have a set of current plans, which are based on evaluated options and implement these plans to ensure that supply quality and reliability of the LITS are maintained;
(c) measure, record and account for all power and energy flowing or interchanged over the LITS; and
(d) install and operate devices of acceptable accuracy at each input and output node or feeder of the LITS for the purposes stated in sub-sections 9.4.3 to 9.4.11.

Generation Management

9.4.3 The TSO shall operate sufficient generation capacity under automatic control to meet its obligation to continuously balance power demand and supply in real-time in accordance with the stipulated reliability and quality of supply standards.

Voltage Management

9.4.4 The TSO, in operating the LITS, shall schedule generating unit reactive power outputs and procure reactive compensation as necessary to maintain the voltages at all LITS nodes and substations within established limits as stipulated in Technical Schedules TS–L and TS–V.

9.4.5 Each generating plant shall be capable of continuous operation within the stipulated power factor range to support voltages under normal and contingency conditions.

9.4.6 The TSO shall employ both static and dynamic methods to maintain voltage stability, maintain voltages at the LITS nodes within the prescribed limits and minimize system losses using power system voltage control procedures prescribed in Section 9.11 and methods that include but not limited to the following:

(a) Transformer tap changing;
(b) Reactor and capacitor switching;
(c) Static Var Compensators;
(d) Generating unit reactive power capability;
(e) Demand management; and
(f) Transmission lines charging capacitance.

Time Management and Frequency Control

9.4.7 The TSO shall control and operate all relevant LITS equipment and devices to maintain system frequency within the stipulated performance and reliability limits, as stipulated in Technical Schedule TS – L.

9.4.8 Each Generation GCP shall, to the extent possible, contribute to frequency regulation to achieve the required balance. The TSO shall employ Automatic Generation Control (AGC) and manual actions for secondary frequency control in accordance with procedures prescribed in section 9.10. GCP's generating units that are required to be under AGC shall be specified in the Connection Agreement and those not operating under AGC shall continue to follow dispatch instructions from the TSO. The AGC shall meet the frequency and tie-line standards defined by CLSG/WAPP.

9.4.9 Operating limits for frequency deviation and time error shall be established with LITS reliability as priority. Each Generation GCP shall participate in time error correction procedures and the TSO shall coordinate the time error correction procedures.

Interchange Management

9.4.10 Each Generation GCP shall, through daily schedule verification and the use of reliable metering equipment, accurately measure, control and account for all energy and power interchanges.

9.4.11 Recognizing variations in generation and load patterns, each Generation GCP *(including tie-line operator)* shall be active in preventing inadvertent interchange accumulation.

9.5 Operating Reserves Criteria

9.5.1 To meet applicable standards for system reliability and security the TSO shall schedule for operation at all times adequate generation resources to provide a level of operating reserves, sufficient to allow adequate cover for:

(a) errors in demand forecasting, regulating requirements and system load diversity;
(b) deviations in generation and transmission equipment unavailability; and
(c) variations in internal grid needs considering such factors as
    (i) number and size of generating units;
    (ii) system equipment usage;
    (iii) forced outages; and
    (iv) maintenance schedules.

Types of Reserves

9.5.2 ***Operating Reserves*** are that generation capability above firm system demand that are required to meet the standards of an adequately responsive system for regulation, load forecasting error, mismatch between generation and demand,

equipment forced outages and scheduled outages. Operating reserves consist of Quick Reserves and Slow Reserves.

Quick Reserve

9.5.3 Quick Reserve is used for balancing supply and demand when an unexpected system event occurs within one dispatch period. Quick reserves provide capacity that the TSO can call up at short notice to correct any imbalance and can come from the supply side (generating units) or from the demand side (load management).

9.5.4 During normal operation, Quick reserves can come in the forms classified as Primary, Secondary or Tertiary reserve as follows:

(a) **Primary Reserve** is an automatic increase or decrease in active power output of a generating unit in response to a system frequency fall or rise, in accordance with the primary control capability and additional mechanisms for controlling active power. This change in active power output must be in accordance with the technical characteristics and loading of the generating unit, without any time delays other than those necessarily inherent in the design of the governor control system. Primary reserve (positive and negative) must respond immediately and must be fully active within **10 seconds** and sustained for at least **one hour**.

(b) **Secondary Reserve** is the automatic response to frequency changes that is fully available within **30 seconds** from the time of frequency change to take over from the Primary reserve, and which is sustainable for a period of at least **one hour.**

(c) **Tertiary Reserve** is required to balance supply and demand for changes within a one-hour dispatch interval and is used to restore Secondary reserve when required. Tertiary reserve must be fully activated within **10 minutes** from the instruction of the TSO and shall be sustained for at least **two hours**.

9.5.5 Pursuant to sub-section 9.5.4(a), all online generating units must have their turbine governors in service and unblocked to meet (mandatory) regulating reserve requirements as specified in the sub-section 9.6.1(b) of the LEGC.

Emergency Reserve

9.5.6 Emergency reserve is typically made up from contracted interruptible load, gas turbines and emergency generation facility. Emergency reserve is a less frequently used reserve though it can be relied upon as a Quick reserve during abnormal LITS conditions for returning the LITS to normal operating conditions while slower reserves are being activated. Emergency Reserve can be used by the TSO for supply-demand balancing, and for addressing network stability and voltage constraints. Emergency Reserve shall be fully active within **ten minutes** from an instruction of the TSO and shall be sustained for at least **two hours**.

Slow Reserve

9.5.7 Slow reserve (or non-spinning reserve) is the component of Operating reserve that is not operating or synchronized to the system, but which is available to serve demand within a specified time. Slow reserve is used to restore Quick reserve when required usually for compensating imbalance resulting from day-ahead prediction errors or unexpected generating unit trips.

9.5.8 A Slow (or non-spinning) reserve shall comprise the steady output available from a generating unit that can be synchronized to the LITS and loaded up within ***thirty minutes*** of being requested to respond to an unexpected demand increase or loss of generation or transmission capacity and must be sustained for at least **4 hours**. Actual times for activation and sustained availability are subject to bilateral agreements.

Negative Reserve

9.5.9 Negative reserve is the ability of generating units to reduce their active power output for balancing the system in the case of excess of generation (i.e. situations of high frequency) and can be of the following types:

(a) Negative Primary reserve - Generating units providing Primary reserve must always be capable of providing the same amount of Negative reserve without breaching the operating limits of the generating Unit;
(b) Negative Secondary &Tertiary reserves - Generating units providing Secondary & Tertiary reserves must be capable of providing Negative Secondary & Tertiary reserve; and
(c) Negative Emergency reserve - All generating units in operation must provide negative Emergency reserve, meaning that they must follow the instructions of the TSO for reducing their loading if required.

Determination and Allocation of Operating Reserves

9.5.10 The TSO shall determine and have adequate operating reserves available at all times to ensure the security and reliability of power supply within the LITS and in accordance with the Operating reserves allocation policy in Technical Schedule TS–O of the LEGC.

9.5.11 Quick reserve at any time shall be set large enough to cover the net impact of the largest single contingent event among the following, whichever is the largest:

(a) the loss of the generating unit currently producing the highest amount of power within the LITS;
(b) the loss of generation capacity that could result from any single transmission equipment failure, fault, or other contingency; or
(c) the loss of any power in-feed from an interconnected system.

9.5.12 The TSO shall allocate and distribute the required Quick (or spinning) reserves among the generating units operating within the LITS such that the grid is able to withstand any single contingency.

9.5.13 The TSO shall determine the amount of Slow (or non-spinning) reserve that is required within the LITS and shall allocate and distribute this requirement among any available generating units provided the generating unit has not been already identified as part of the Quick reserve providers and can be synchronized and put on-line within the stipulated time of thirty minutes (ref. sub-section 9.5.8).

9.5.14 The security of supply from the LITS especially under certain contingency conditions, depends on the reliable and prompt start-up of Slow reserves whenever required. Accordingly, a generating unit designated or allocated as part of the Slow reserve providers shall ensure its readiness to start-up and generate its full allocated power within the stipulated period.

9.5.15 A generating unit that fails to meet its operating reserve obligation shall be in breach of the LEGC and shall be liable for penalties as may be provided for under the Electricity MOR.

9.6 System Voltage and Reactive Power Criteria

9.6.1 Operational planning of the LITS shall assume that:

(a) the reactive power requirements at all LITS nodes, feeders and substations are such that the power factor at these points is between 0.90 lagging and unity.

(b) all generating units shall be capable of supplying rated active power (MW) output at any point between the limits of 0.85 power factor lagging and 0.9 power factor leading as a normal requirement at the generating unit's terminal in accordance with the generating unit's Reactive Power Capability Curve.

9.6.2 Operations planning for the LITS shall ensure that voltages are maintained within the stipulated range, provided loads, and generating plants abide by the requirements prescribed under sub-section 9.6.1.

9.6.3 Where the inherent characteristics and design of a generating unit are such that it is reasonably able to operate beyond the prescribed requirements, the Generation GCP will declare such capabilities of the unit to the TSO.

Coordination of Reactive Power Compensation

9.6.4 Based on the expected power flows, the TSO shall predict the voltage profile of the LITS, the reactive power generation and reactive power reserve capacity requirements for each section of the system and the respective quantities expected from each generating unit to ensure satisfactory voltage levels.

9.6.5 The TSO shall instruct the use of voltage control devices and dispatch the reactive power output of generating units to meet the requirements as economically as possible in accordance with Section 10 of the LEGC.

Basic Reactive Power Compensation

9.6.6 All Demand GCPs connected to the LITS shall install devices in their respective networks that provide sufficient reactive power compensation to maintain their operations within the stipulated average power factor of not lower than 0.9 lagging.

9.6.7 In addition to the requirement in sub-section 9.6.1(b), generating plants shall have reactive reserve capacity to operate with power factor at 0.90 leading for up to thirty minutes and remain within the generating unit capability chart for temporary sustenance of system voltage under contingency conditions.

9.6.8 The TSO shall co-ordinate with each Generation GCP on the setting of generating unit operating points and the use of voltage control equipment to maintain transmission voltages as specified in Technical Schedule TS–L.

9.6.9 The normal provision of reactive power requirements by any generating unit operating at any power factor within the required limits shall be without compensation but dispatch instructions for operation beyond the standard requirement shall attract compensation payments from the TSO as provided under the Electricity MOR.

9.6.10 Failure of a Generation GCP to provide the normal operational requirement for voltage control upon the instructions of the TSO shall constitute a breach of the LEGC for which penalties may be assessed and applied in accordance with the Customer Service and Quality of Supply Regulations (or the Electricity MOR).

9.6.11 Provided Demand GCP's loads and Generation GCP's generating units have complied with the normal reactive power compensation requirements, it shall be the responsibility of the TSO to provide any additional reactive power compensation that is required to maintain system voltages within the stipulated range. Such reactive power compensation generally referred to as the ***"Basic Reactive Power Compensation"*** shall be to the account of the TSO as part of the general costs of operating the LITS.

Supplementary Reactive Power Compensation

9.6.12 Demand GCPs connected to the LITS shall not depend on the TSO for reactive power support; but shall provide reactive power compensation for their systems and ensure that customers having inductive load install capacitors so that the power factor at the interface with the transmission system is not less than 0.95.

9.6.13 Where a Demand GCP fails to maintain its reactive power requirements or power factor within the stipulated range, the TSO may procure or provide *supplementary reactive power compensation* to ensure that the voltage standards are achieved at the LITS node. Such non-compliant GCPs shall be liable to pay compensation to the TSO, in addition to penalties that may be imposed by the LERC in accordance with the Customer Service and Quality of Supply Regulations (or the Electricity MOR), which are commensurate with either the level of their reactive power needs that are in excess of their limits or the level of supplementary reactive

compensation deemed to have been procured by the TSO due to their failure to comply with the standards.

9.6.14 The TSO shall schedule, provide, procure and/or dispatch supplementary reactive power compensation as may be necessary to maintain system voltage within the specified limits during normal operations as well as during grid contingency conditions.

Compliance of Generation GCPs with TSO instructions

9.6.15 A Generation GCP shall comply with the instructions of the TSO and operate its generating units accordingly to provide reactive power compensation and maintain voltage levels.

9.6.16 Generation GCPs shall inform the TSO of any difficulties in operating their units to meet the standard voltage levels or in providing their reactive power compensation requirements. The Generation GCPs shall in addition ensure that automatic voltage regulators and other similar devices are continuously in service and inform the TSO accordingly whenever a generating unit is operating without its automatic voltage regulator or any such devices.

9.6.17 The inability or unwillingness of a Generation GCP to comply with the valid instructions of the TSO to operate at any point within the mandated limits shall constitute a breach of the LEGC for which penalties may be assessed and applied.

9.7 Transmission Operations Planning Studies

9.7.1 For the purposes of real-time control of the power system, the TSO shall regularly perform transmission operations planning studies on a coordinated basis to determine:

(a) the configuration and operating characteristics of facilities necessary for satisfactory operation of the LITS; and

(b) the operating limitations for normal operation when all transmission components are in service and under abnormal or emergency conditions.

9.7.2 Transmission operations planning shall be in accordance with and satisfy the N-1 contingency criteria as specified under section 7.4 of the Planning Sub-code.

9.7.3 In determining the operating limits or ratings of transmission facilities, the TSO shall consider the:

(a) Thermal and stability limits;
(b) Short and long-time loading limits; and
(c) Voltage limits.

9.7.4 The TSO shall undertake periodic studies to determine the:

(a) emergency transfer capability of interconnection transmission lines,
(b) coordination of protective relaying, and

(c) coordination of maintenance outages.

9.8 Power System Operating States

Normal state

9.8.1 The LITS shall be in a ***Normal state*** of operation when **all** the following conditions are satisfied:

(a) the operating reserves as specified in the System Operations Manual established by the TSO are sufficient;
(b) the system frequency is within the limits of 49.8Hz and 50.2Hz;
(c) voltages at all LITS buses are within the limits of ±5% of the nominal value;
(d) the loading levels of all transmission circuits and substation equipment are below 85% of their continuous ratings;
(e) all interconnection transmission lines having or likely to have an impact on the operation of the LITS are being operated within their ratings; and
(f) the LITS configuration is such that any potential fault current can be interrupted, and the faulted equipment can be isolated from the LITS and the LITS shall remain secure against an N-1 contingency event.

Alert State

9.8.2 The LITS shall be in an ***Alert state*** of operation when **any one** of the following conditions exist:

(a) the system operating reserve is less than the required margin;
(b) the system frequency is outside the limits for the Normal state, but within 49.0Hz to 51.0Hz;
(c) the N-1 contingency criterion is violated;
(d) the voltage at any LITS bus is outside the limits of ±5% of the nominal value but within the limits of ±10% of the nominal value;
(e) there is critical loading or imminent overloading of transmission lines or substation equipment;
(f) a weather disturbance has entered the TSO-controlled area of responsibility, which may affect operations of the LITS; or
(g) a social unrest or public order problem exists, which may pose a threat to operations of the LITS.

9.8.3 The TSO shall declare the power system to be in an Alert state when any of the above conditions exist on the LITS and all GCPs shall coordinate their actions to restore the LITS to the Normal state.

9.8.4 When an Alert state is declared, the TSO may take such action as it determines appropriate, including:

(a) cancelling all planned maintenance or other work affecting the security of the LITS;
(b) cancelling and denying requests for or deferring approved outages;

(c) directing those specific parts of the LITS to be returned to service, as required; and
(d) operating at security limits appropriate for an Alert state.

Emergency State

9.8.5 The LITS shall be in an ***Emergency state*** when a multiple contingency system condition has occurred without resulting in a total system collapse, in addition to the existence of any one of the following conditions:

(a) there is a generation deficiency;
(b) LITS transmission voltages are outside the limits of ±10% of the nominal value; or
(c) the loading level of any transmission circuit or substation equipment is above 110% of its continuous rating.

9.8.6 The TSO shall declare the power system to be in an Emergency state when any of the above conditions specified for an Emergency state exists on the LITS or when the TSO determines that there exists a situation which has an adverse effect on electricity supply, or which poses a significant threat to system security.

9.8.7 During an Emergency state, all GCPs shall coordinate their actions to restore the LITS to the Normal state.

9.8.8 When an Emergency state is declared, the TSO shall operate within the security limits appropriate for an Emergency state which shall include taking such necessary action as the following:

(a) cancelling all maintenance or other planned work affecting the security of the LITS;
(b) cancelling, denying requests for or deferring approved planned outages;
(c) directing that transmission or generation facilities be returned to service; and
(d) operating to security limits that is appropriate for an Emergency State.

Extreme State

9.8.9 The LITS shall be in an ***Extreme state*** when corrective measures taken by the TSO during an Emergency state have failed to maintain the security of the LITS and that has resulted in either cascading trips, islanding and/or system collapse.

Restorative State

9.8.10 The LITS shall be in a ***Restorative state*** when generating units, transmission lines, substation equipment and loads are being energized and synchronized to restore the LITS to its Normal state.

9.9 Power System Operations Criteria

9.9.1 The TSO shall operate the LITS so that it remains in the Normal State.

9.9.2 The LITS shall be operated and maintained to meet the operating limits and performance benchmarks stipulated in Technical Schedules TS – K and TS – L and other Reliability and Performance Standards under the LEGC.

9.9.3 The security and reliability of the LITS shall, in accordance with Technical Schedule TS – E, be determined based on a *single contingency criterion* which is that the LITS shall continue to operate in the Normal state following the loss of any one generating unit, a transmission line or a transformer.

9.9.4 The TSO shall operate the LITS at adequate security levels to reduce vulnerability to transient instability, dynamic instability and voltage instability problems.

9.9.5 The system frequency shall be controlled by the Quick (or spinning) reserves during the Normal state and by the timely use of Slow (non-spinning) reserves and demand management practices during the Alert state and the Emergency state. Adequate spinning reserve and non-spinning reserve shall be available to stabilize the LITS and facilitate the restoration to the Normal state following a disturbance leading to loss of generating capacity.

9.9.6 Following a contingency event or a significant change in power system conditions, it is possible that the power system may no longer be in a condition which could be considered secure on the occurrence of a further contingency event. The TSO shall take all reasonable actions to adjust the operating conditions with a view to returning the power system to the Normal operating state as soon as it is practical to do so.

9.9.7 The TSO shall ensure that adequate load shedding facilities that could be initiated automatically by frequency conditions are available and in service to facilitate the restoration of the power system to a Normal state following significant contingency events.

9.9.8 GCPs shall all be required to provide and maintain all required facilities consistent with Prudent Utility Practice and to operate equipment in a manner to:

(a) assist in preventing or controlling instability within the LITS;
(b) assist in the maintenance of, or restoration of the LITS to a Normal state of operation; and
(c) prevent uncontrolled separation of the power system, transmission break-up, or cascading outages, following any system incident.

9.10 Power System Frequency Control

9.10.1 The TSO shall use its reasonable endeavors to control the power system frequency and ensure that the power system frequency performance standards defined in Technical Schedule TS–F of the LEGC are achieved.

9.10.2 The following conditions shall assist with the effective control of power system frequency by the TSO who has the mandate and authority to direct and control the output of generating units:

(a) Generation GCPs are required to provide necessary protective devices or systems to protect their plant and associated facilities against abnormal and extreme frequency excursions on the power system;
(b) In order that adequate frequency control is always maintained on the LITS, governor-controlled generating units are required to provide the Primary reserve specified by the TSO, complying with the following requirements:
  (i) when synchronized to the LITS, the units shall operate at all times under the governor control system, unless otherwise specified by the TSO, with all generating units operating within the appropriate ranges as specified in section 9.13 and *Technical Schedules* TS–F*,* TS–P*,* TS–*K and* TS–L *of the LEGC;*
  (ii) no time delays other than those necessarily inherent in the design of the governor control system shall be introduced; and
  (iii) no frequency dead-bands shall be applied to the operation of governor control systems.
(c) The TSO shall:
  (i) arrange to have available and specifically allocate generating plant as found appropriate that can be automatically controlled either through AGC or directed by the TSO to ensure that normal load variations do not result in frequency deviations outside the defined limits for normal operation;
  (ii) procure adequate ancillary services to cater for the impact of potential power system disruptions on the power system frequency arising from the most critical single contingency event; and
  (iii) ensure that adequate facilities are always available and are under its direction to allow for the managed recovery of the LITS to its Normal state whenever required.

9.10.3 Non-dispatchable VRPPs are not required to provide Primary reserve; however, if agreed between the VRPP GCP and the TSO, they may participate and will be bound by the requirements in this section 9.10 of the LEGC as per generating units.

Restriction of Governor Action

9.10.4 Subject to sub-section 9.10.2(b), a Generation GCP shall only restrict governor action of a generating unit where the:

(a) action is essential for the safety of personnel and/or to avoid damage to the plant; or
(b) reliability of the generating unit needs to be secured; or

(c) restriction has been agreed in advance between the TSO and the Generation GCP; or
(d) restriction is in accordance with a dispatch instruction given by the TSO.

9.10.5 The TSO shall record the nature of the restriction, the reasons, and the time of occurrence and duration of the restriction.

9.11 Power System Voltage Control

9.11.1 Subject to sub-section 9.4.6, the TSO shall use all reasonable endeavors to control power system voltages and ensure that the power system voltage standards defined in Technical Schedule TS–V of the LEGC are achieved.

9.11.2 The following conditions shall assist with the effective control of power system voltage by the TSO that has the mandate to ensure that sufficient resources are available throughout the LITS to meet applicable performance standards for reactive power support and voltage control:

(a) The TSO shall:

(i) establish the necessary procedures in the relevant System Operations Manuals;
(ii) in consultation with GCPs, assess and determine the limits of operation of the power system that is associated with the avoidance of voltage failure or collapse under credible contingency event scenarios, which determination shall include a review of the dynamic stability of the power system;
(iii) translate the voltage limits of the power system into key location operational voltage target settings, transmission line capacity limits, reactive power production or absorption capacity or other appropriate limits; and
(iv) direct providers of reactive power support and voltage control service to take any actions necessary to maintain stable voltage levels in accordance with relevant provisions of Connection Agreements, applicable performance standards and contractual arrangements for ancillary services to prevent the collapse of voltages on the LITS.

(b) If voltages are outside acceptable limits, and the means of voltage control are exhausted, the TSO shall take all other reasonable actions, including directing changes to demand, selective load shedding, additional generation or reduction in transmission line flows but only to the extent necessary to restore the voltages to within the relevant limits and all GCPs shall comply with any such directions;

(c) Sufficient data acquisition equipment with suitable indicators shall be available to the TSO and Generation GCPs to monitor system voltage

settings and levels, load-tap-change settings, reactive power flow and status of reactive power supply resources; and

(d) The TSO shall arrange, coordinate, and supervise the conduct of appropriate tests to assess the availability and adequacy of the provision of reactive power to control and maintain power system voltages under Normal, Alert and Emergency states.

9.12 Protection Coordination

9.12.1 Relaying at Connection Points shall be of primary concern to the TSO because the satisfactory operation of the LITS, especially under abnormal conditions, is dependent upon the relay equipment and relay schemes in effect.

9.12.2 Each GCP shall design, implement, coordinate, and maintain its protection system in accordance with the TSO's requirements to ensure the desired speed, sensitivity and selectivity in clearing faults on the GCP's side of the Connection Point.

9.12.3 The TSO shall ensure that the LITS has adequate and coordinated primary and backup protection always to limit the magnitude of grid disturbances when a fault or equipment failure occurs.

9.12.4 Where there is an outage of one protection system of a transmission element, the TSO shall determine, in consultation with the relevant Transmission GCP, the most appropriate action to take.

9.12.5 Where there is an outage of both protection systems on a transmission element and the TSO determines this to be an unacceptable risk to power system security, the TSO may take the transmission element out of service as soon as possible and advise the relevant Transmission GCP immediately of the action taken.

9.12.6 The TSO shall coordinate the necessary inspections and tests to ensure that the protection of the power system is adequate to avoid damage to power system plant and equipment.

9.12.7 Each protection device shall be recalibrated every five years. A review of the protection settings shall also be carried out whenever there is an expansion or change to the transmission or generation facilities.

Remedial Action Schemes

9.12.8 Remedial Action Schemes (RAS), also known as Special Protection Schemes (SPS), are designed to automatically perform system protection functions other than the isolation of an electrical fault. RAS are designed to trip, or remove from service, units, or transmission facilities under a set of carefully defined conditions. RAS are normally used to increase transmission system capability under specified conditions. They may also be used to permit higher loading levels on the LITS in those instances where additional facilities cannot be built or have been delayed.

9.12.9 RAS shall be subject to procedures detailing the operation and the conditions for switching into service of the scheme. The effects of the automatic actions arising from the operation of the RAS shall be subject to the specific agreement of all GCPs involved.

9.12.10 The TSO shall monitor the status of all RAS and notify relevant GCPs of any change of status.

9.13 Ancillary Services

9.13.1 The provision of ancillary services by generating units is critical to the secure operation of the LITS and the requirement to provide them is compulsory on Generation GCPs under the LEGC, the Regulations and Generation Licenses and in accordance with the declared generating unit capabilities.

9.13.2 The TSO shall ensure the availability and adequacy of ancillary services to support the transmission of energy from generation sources to loads while maintaining, reliable operation of the transmission system to satisfy the performance and reliability standards of the LEGC and in accordance with Prudent Utility Practice.

9.13.3 The requirements for ancillary services shall be adjusted from time to time by the TSO to take into account factors including variations in power system conditions, real-time dispatch constraints, contingency events, the prevailing risk or vulnerability level of the LITS and the results of assessments of voltage and dynamic stability.

9.13.4 The TSO shall determine the ancillary services requirements of the LITS using demand forecasts for both the timeframe and for which Generation GCPs must provide the TSO with their respective ancillary services capabilities covering:

(a) Operating reserve and frequency control
  (i) Reserve capability at all operating levels based on:
    - Frequency drop
    - Response time
    - Sustainability
  (ii) automatic de-loading capability at high frequencies
(b) Voltage Control and reactive power control:
  (i) Maximum and minimum MVAr levels; and
  (ii) MVAr response to Voltage change.
(c) Black Start which is a compulsory service; and
(d) Reliability Must-Run requirements.

Standards for Ancillary Services

Operating Reserves & Frequency Control

9.13.5 The TSO is mandated to procure ancillary services *(beyond the mandatory requirements expected from Generation GCPs)* and shall contract for those components of operating reserve that constitute ancillary service as provided in

the Operating Reserves Policy in Technical Schedule TS–O to enable secure operations of the LITS at all times.

9.13.6 The TSO shall agree on an annual basis with Generation GCPs all the conditions relating to frequency control. This shall include the possible range that each participating generating unit can comply to and the time of the year when it shall be possible technically.

Quick (or spinning) Reserves

9.13.7 The total amount of capacity required from synchronized generating units capable of governor control and equipped with AGC facilities shall be determined by the TSO through studies that identify the amount of reserves and regulation required to meet system performance and reliability standards and by considering the likely variation in load over the period.

9.13.8 A generating unit that provides AGC regulation service shall meet the following criteria:

(a) the generating unit must be capable of responding to direct control signals from the TSO's Dispatch Centre in both an upward and downward direction;
(b) the output of the generating unit must be capable of being monitored continuously by the TSO through observation of the generating unit's AGC status which shall be observable, indicating whether the generating unit is on AGC or not; and
(c) the generating unit must be capable of delivering the full amount of regulating capacity contracted in both the upward and downward directions within the time limit defined by the TSO.

Slow (or non-spinning) Reserves

9.13.9 Slow reserves which are required to maintain power system security in the event of LITS or generation outages shall be provided from unsynchronized generating units capable of being started, synchronized and loaded within the time frame as specified in sub-section 9.5.8.

9.13.10 Slow (or Non-spinning) reserve shall be provided by contractually committing to the TSO a generating unit that provides a portion of capacity that is idle or unsynchronized and yet can be fully activated within the specified timeframe and can sustain the designated output level for at least *one hour*.

9.13.11 The TSO shall determine the total amount of non-spinning reserve capacity required to meet system performance and reliability standards and the determination of this requirement shall be a function of the largest generating units and load blocks on the system, as well as the combined system demand.

Voltage and Reactive Power Control

9.13.12 Reactive power compensation which is required to maintain adequate system voltages and to prevent power system failure through voltage collapse shall be provided from generating units operating outside the reactive power limits defined in the LEGC and from GCPs with the capability to supply additional reactive power above their own requirements.

9.13.13 The TSO shall conduct technical studies based on the quantities, characteristics and locations of forecast demand to determine the quantities and locations of reactive power support required to maintain voltage levels and reactive power margins at LITS nodes in accordance with the required standards.

9.13.14 Reactive power compensation and voltage control services shall be provided by contractually committing to the TSO the ability to reserve and dispatch the reactive power output of a generating unit and reactive power compensation devices.

9.13.15 Every generating unit including VRPPs shall provide a minimum amount of reactive power to the TSO, in accordance with the relevant Connection Agreements.

Black Start Capability

9.13.16 Generating plants with Black Start capability are required to enable restoration of the LITS to Normal state following a complete or partial failure of the power system.

9.13.17 The TSO shall prepare an Emergency Power System Restoration Plan (EPSRP) and determine the quantities and locations of black start generating units that are required. The determination of black start requirements for the LITS shall be made based on contingency studies performed during the preparation of the EPSRP which studies shall, at a minimum, take into account the following:

(a) a range of reasonable initiating disturbances;
(b) the magnitude, extent and likelihood of the outage, the assumed status of generation after the initiating disturbance and the system demand level at the time of the disturbance;
(c) generating unit performance, including the probability that some resources used to provide black start may fail to start; and
(d) the possibility that transmission system damage may prevent some of the target black start resources from serving their intended loads.

9.13.18 The TSO shall secure adequate black start capacity by contractually committing self-starting generating unit capacities which shall be used to restore service to the LITS after a blackout.

Reliability Must-Run Requirements

9.13.19 The TSO shall contract Reliability Must-Run (RMR) generating units to cater for situations where emergency reserve power is needed to keep the LITS secure.

9.13.20 The TSO shall:

(a) determine the needed RMR requirements by performing extensive reliability studies on the LITS, taking the scheduled outages into account; and
(b) quantify the LITS exposure to risk due to unanticipated outages and based on its assessment, determine the additional RMR agreements that may be required.

9.13.21 The TSO shall report on all RMR agreements by including the details in the reliability assessment report on an annual basis to the LERC. The report shall justify the rationale for each RMR agreement and the performance assessment of each RMR generating unit.

9.14 Demand Management

9.14.1 This section 9.14 of the Operations Sub-code applies to situations on the LITS where:

(a) there is insufficient generation capacity available from generation facilities to satisfy expected demand,
(b) there exist operating problems that affect the ability to serve load, or
(c) there is a breakdown on any part of the LITS.

9.14.2 The section identifies actions that the TSO may take or may direct GCPs to take to assist in achieving reductions in demand to either avoid or alleviate such situations.

Automatic Frequency Load Shedding (AFLS)

9.14.3 An AFLS scheme shall be implemented to maintain the frequency of the LITS and to restore it to normal range, following frequency deviations outside of the limits established in Technical Schedule TS–F of the LEGC.

9.14.4 All Demand GCPs having expected peak demands at any Connection Point more than 5MW shall provide AFLS facilities to enable automatic interruption of load.

9.14.5 The AFLS scheme shall be implemented in accordance with the philosophy stipulated in Technical Schedule TS–A.

9.14.6 The TSO, in consultation with GCPs, shall develop *Demand Management Guidelines* as part of the System Operations Manual which shall include the basis for exclusions to demand management activities that are undertaken during under-frequency conditions. The guidelines shall be updated as and when necessary.

9.14.7 Following load shedding to maintain the frequency of the LITS, the TSO shall within **60 minutes** after the action report conditions on the power system to all affected GCPs.

9.14.8 A GCP shall not restore load that has been shed until directions have been received from the TSO and the GCP shall commence the restoration of load immediately following receipt of such instruction.

9.14.9 Each affected GCP shall, as soon as practicable, provide the TSO with an estimate of the demand reduction that has occurred at its Connection Point because of an AFLS operation.

Demand Management in an Emergency Operating State

9.14.10 When an Emergency operating state has been declared by the TSO, the actions available to the TSO to safeguard the security of the LITS may include issuing directions to a GCP to take manual action to reduce demand for electricity.

9.14.11 A GCP that receives a directive from the TSO to reduce demand shall achieve the reduction in demand within five (5) minutes of receipt of the directive and shall, as soon as practicable, notify the TSO that it has complied with the directive.

9.14.12 The GCP that has reduced its demand shall not restore it until directions have been received from the TSO permitting it to do so and the GCP shall commence restoration immediately following receipt of such directions from the TSO.

9.14.13 Where demand reduction within a GCP's network may not be adequate to relieve dangerous system conditions, the TSO may instruct block load-shedding or resort to tripping of feeders or transformers at bulk supply substations.

9.15 Power System Restoration

9.15.1 A partial or total system collapse represents one of the most serious fault situations that may occur on the LITS. Due to the significance of such an incident and the urgency in restoring supply to all customers, it is imperative that all GCPs maintain a high level of awareness and understanding in respect of power system restoration which shall be the responsibility of the TSO to coordinate in an orderly and secure manner.

Restoration Plan

9.15.2 The TSO shall develop and maintain a plan, the LITS Restoration Plan, following a major contingency event or emergency involving system elements, as the TSO determines necessary, to implement effective restoration of the power system including:

(a) plans for managing major disturbances on the power system that result in partial or total system collapse;
(b) plans for the testing and verification of emergency preparedness facilities and procedures; and
(c) description of the roles of the TSO and the various GCPs in the power system restoration plan.

9.15.3 The objective of the LITS Restoration Plan shall be to ensure that in the event of a partial or total collapse, normal supply is restored to all customers as quickly and as safely as practicable in accordance with Prudent Utility Practice.

9.15.4 The LITS Restoration Plan and associated procedures shall be developed by the TSO in consultation with all GCPs and shall be reviewed and/or updated at least:

(a) **annually**;
(b) whenever changes are made in the power system configuration; or
(c) more frequently, if required.

9.15.5 Where an outside source of power is required for start-up, necessary switching procedures shall be determined and reviewed periodically with the dispatch and the operating personnel.

9.15.6 It shall be the responsibility of each GCP to ensure that any of its personnel who may reasonably be expected to be involved in power system restoration are familiar with and are adequately trained and experienced in the procedures to be carried out and shall have sufficient authority to be able to implement the plan and comply with any instructions issued by the TSO.

9.15.7 The TSO and all relevant GCPs shall verify the restoration procedure by actual testing or through simulation.

Restoration Process

9.15.8 The TSO shall issue instructions to GCPs that have generating units with black start capability to initiate a start-up.

9.15.9 Upon receipt of the instruction from the TSO, GCPs providing black start shall startup immediately to energize a part of the LITS and/or synchronize to the LITS.

9.15.10 The TSO shall issue directions to GCPs and each GCP shall be responsible for carrying out the directions in accordance with the provisions of the LITS Restoration Plan.

9.15.11 The TSO shall coordinate the rate at which load is restored to prevent adding load faster than generation and what transmission capabilities permit.

9.15.12 During total or partial collapse and as conditions are being brought back to normal, the LITS may be operated outside normal voltage and frequency standards.

9.15.13 The TSO shall inform all GCPs after the restoration of the LITS is completed that (the Emergency state no longer exists and that) the LITS is back to Normal state, and normal scheduling and dispatching operations shall then be resumed.

9.16 Outage/Maintenance Planning

General

9.16.1 The purpose of this section 9.16 of the LEGC is to enable the TSO review, assess, coordinate, control and manage the impact of outage schedules in fulfilment of its reliability-related obligation to the LITS.

9.16.2 The section

(a) defines the responsibilities of various parties with regards to the outage planning process;
(b) provides for the notification of:
    (i) outage requirements;
    (ii) the permitting of outages; and
    (iii) identification of the categories of equipment whose outage requires notification or permission prior to withdrawal from service.
(c) requires GCPs to obtain the approval of the TSO in respect of planned outage schedules;
(d) provides the TSO with the discretion to reject, defer and recall outages that may have an unacceptable impact on the reliability of the LITS; and
(e) provides for certain consequences following the cancellation of (planned) outages.

9.16.3 The TSO shall ensure that generation and transmission equipment outages are planned and coordinated to maximize resource utilization and to minimize down-time all in the pursuit of reliable service and least operating cost.

9.16.4 The planning of the temporary or final shutdown of equipment shall be undertaken sufficiently in advance to enable technical contingency measures to be implemented.

Requirements and Exceptions to Prior Approval for Outages

9.16.5 No person shall take any action that will cause an outage or affect the optimum operation of a facility or equipment that forms part of the LITS unless it is approved in writing by the TSO. Such equipment and facilities shall include the following:

(a) registered generation and auxiliary equipment connected to the LITS;
(b) protective relaying equipment and facilities; and
(c) communication and telemetry equipment required for the operation of the LITS.

9.16.6 The TSO may amend periodically and publish in the System Operations Manual, a full description of the equipment and facilities whose outage must be reported to and scheduled with the TSO in accordance with the provisions of sub-section 9.16.5.

9.16.7 GCPs may not remove from service the equipment and facilities described in sub-section 9.16.5, unless such removal from service is necessary to prevent substantial damage to the GCP's equipment, facilities or the environment or to protect the safety of employees or the public.

9.16.8 If any equipment or facility is removed from service for any of the reasons stated in sub-section 9.16.7, the GCP shall:

(a) promptly advise the TSO by phone giving the specific reasons for such action; and

(b) thereafter notify the TSO in writing within **24 hours**.

9.16.9 The TSO shall approve all schedules for equipment outages except for the following generation facilities which do not need to be reported to or scheduled with the TSO for outage unless the generation facility has been designated by the TSO as affecting the reliability of the LITS:

(a) a non-registered generation facility; and
(b) a registered generation facility having a nameplate rating of less than 2 MW.

9.16.10 The TSO may, upon request, exempt certain additional facilities and equipment from application of outage reporting and scheduling obligations set forth in sub-section 9.16.5 where the TSO determines that the granting of such an exemption is not inconsistent with the reliable and efficient operation of the LITS.

9.16.11 A GCP may submit an exemption request to the TSO at any time; however, it is only after notification of the TSO's approval of the request that the exemption shall take effect.

Responsibility for Preparation of Outage Plans

9.16.12 The TSO has overall responsibility for assessment of the risk posed to the LITS arising from maintenance and commissioning activities. The TSO shall therefore coordinate maintenance activities, plan outages, administer the outage scheduling process and shall prepare, among other things, the following outage plans:

(a) Initial Outage Plan covering the next one-year period;
(b) Provisional three-year Outage Plan (initial outage needs period inclusive); and
(c) the annual Committed Outage Plan.

9.16.13 The TSO shall take the following into account during the preparation of outage plans:

(a) forecast demand and the requirements of the LITS;
(b) needs for maintenance of grid components;
(c) actual maintenance program implemented;
(d) request by GCPs for changes in their maintenance schedules;
(e) the need to minimize total cost of the maintenance activity; and
(f) any other relevant factor.

Outage Planning Process

9.16.14 Each GCP shall determine its annual outage needs based upon its own criteria and assessments and shall provide the TSO with the outage needs for the next three years by **June 15th** of the preceding year.

9.16.15 The outage needs shall include the following information which shall also be provided whenever a GCP wishes to request for an outage on its equipment or facilities:

(a) the identification of the equipment and the capacity to be affected;
(b) a brief operational contingency and impact assessment report;
(c) the time it will take to restore the element in case of an emergency;
(d) a description of the maintenance work to be carried out;
(e) the expected duration of the maintenance work;
(f) an indication of the preferred start date for the outage and the expected completion date for the work; and
(g) an indication of whether there is flexibility in dates, the earliest start and the latest completion dates.

Initial/Provisional Outage Plans

9.16.16 Based on the outage needs information submitted, the TSO shall prepare an ***Initial Outage Plan*** for the next year and a ***Provisional Outage Plan*** for a further two years.

9.16.17 Whereas the TSO, in preparing the outage plans, shall endeavor to accommodate GCPs' requests for particular dates, the outage needs submitted by a GCP only represent a preference which shall be subject to the scheduling considerations of the TSO.

9.16.18 The *Initial Outage Plan* shall include all the outage needs provided by GCPs and which shall be circulated to all GCPs not later than **August 15th** of the preceding year.

Revised Outage Needs

9.16.19 Where the outage needs of GCPs are in conflict or are incompatible with the service requirements of the LITS such that they cannot be accepted, the TSO shall inform the affected GCPs and suggest, for their consideration, alternatives that resolve the conflict following which the affected GCPs shall submit *Revised outage needs*.

Committed Outage Plan

9.16.20 Upon receipt of the *Revised outage needs*, the TSO shall consult with affected GCPs over any unresolved conflicts and prepare and issue by **December 1st** to all GCPs, the ***Committed Outage Plan*** for the forth-coming year.

9.16.21 The *Committed Outage Plan* shall comprise a list indicating the planned outages for each GCP and the associated facility or equipment that have received the TSO's planning approval. Outage needs that are not included in the approved annual outage plan shall be deemed to have been denied by the TSO.

Outage/Maintenance Coordination

9.16.22 To ensure the coordinated implementation of the individual maintenance programs, each GCP shall develop monthly outage requests that will specify the details of the maintenance program for each week of the month, in accordance with the *Committed Outage Plan*. The outage request for each month shall be submitted to the TSO at least **thirty (30) days** before the start of the planned maintenance.

9.16.23 The TSO shall approve all monthly outage requests that are in accordance with the *Committed Outage Plan* unless unforeseen conditions make it unwise or unacceptable from the system reliability, security or safety perspective for the outage to proceed. In such cases, the TSO may deny, defer or cancel a previously approved outage if it determines, in accordance with system reliability, security or safety criteria that the planned outage poses a significant risk to the satisfactory operation of the LITS such that it would not be prudent for the outage to proceed.

9.16.24 A GCP who no longer intends to proceed with a committed outage shall notify the TSO and any withdrawn outages may only be added to the outage plans of subsequent months at the sole discretion of the TSO.

9.16.25 Where the TSO cancels or denies a planned outage from proceeding, it shall inform the affected GCP as soon as practical and cooperate with the GCP to arrange for rescheduling of the activity at the GCP's earliest convenience.

9.16.26 The TSO may, where necessary to maintain the reliability of the LITS in extreme emergency conditions, recall a planned outage that has already commenced. The TSO shall not recall an ongoing planned outage unless it has first cancelled, deferred or rejected requests for approval of all other planned outages which cancellation, deferral or rejection could eliminate the need to recall the ongoing planned outage.

9.16.27 A GCP whose ongoing planned outage has been recalled shall arrange for the accelerated return of the facility or equipment to service in accordance with the TSO's instructions.

Restoration or Return of Equipment into Service

9.16.28 GCPs shall coordinate with the TSO for the return to service of their facility or equipment following an outage taking into account the observance of the necessary safety requirements in accordance with Section 11 of the LEGC.

Outage Records and Reporting

9.16.29 The TSO shall maintain a record of all submissions towards the maintenance/outage planning and coordination process and of all forced outage notices and associated forced outage information submitted to it by GCPs.

9.16.30 The TSO shall, **within 15 days** after the end of every quarter, provide a report indicating the following with respect to outages and any related requests for compensation and disputes occurring:

(a) a list of all forced outages that occurred during the period, including planned outages that have been deemed as forced outages because they exceeded their approved duration and differentiating the outage types and provide the reasons for each outage;
(b) a list of all planned outages;
(c) a list of all outages where the approval was withdrawn by the TSO, including recalled outages together with the reasons for such withdrawal, and a record of whether the GCP submitted the matter to the dispute resolution process;
(d) a list of all outages which were withdrawn by the GCP prior to commencement of the outage; and
(e) such other outage-related information as may be requested by LERC.

9.16.31 In furtherance of sub-section 9.16.30(a) and for clarity, any planned outage that takes place at a time (or times) other than the period approved by the TSO, including outages that extend beyond the time approved by the TSO shall be considered and reported as a forced outage and referred to the LERC.

9.17 Equipment Testing

9.17.1 The testing or trial-running of any equipment, plant or facilities which could adversely affect the stability, reliability or security of LITS services or the safety of personnel or cause damage to equipment connected to the LITS shall require the prior approval of the TSO.

9.17.2 Tests for which the approval of the TSO is required shall include:

(a) the deliberate application of short circuits;
(b) generating plant capacity tests;
(c) stability tests of generating plants, such as turbine over-speed tests, governor response tests and load-rejection tests;
(d) actions such as line and equipment trip tests which could cause abnormal voltage or frequency excursions or current overload;
(e) changes to the configuration of the LITS;
(f) commissioning tests of new generation facilities; and
(g) re-commissioning tests of existing generation facilities.

9.17.3 A GCP who wishes to engage in a test of its facilities or equipment shall request the prior approval of the TSO to conduct the test.

9.17.4 The request for a test shall include all the information needed and requested by the TSO and any other parties that are likely to be affected to assess the potential impact. As a minimum, the information provided shall identify the following:

(a) the rationale for the test;
(b) the equipment involved;
(c) the test method, system configurations or setup and relevant details of contracts or agreements as they relate to the test activities;
(d) preferred and alternative dates and times for the conduct of the test;
(e) the expected impact of the test activities on power flows, voltage and frequency, and of any other network characteristics that could affect the stability and reliability of the LITS, including details of the steps or precautions to be taken to minimize the negative impact on the LITS and GCPs;
(f) details of special readings, curves, plots or observations, as available; and
(g) the names, designation and affiliation of personnel who will be involved in the test activities and methods of communication with those who may be contacted in this respect.

9.17.5 The request for the proposed test shall be made at least **fourteen (14) days** in advance of the proposed test date to allow for the needed coordination and assessment by the TSO to be done.

9.17.6 A test shall not commence without the specific approval of the TSO.

9.17.7 The TSO shall permit any of the tests referred to in sub-section 9.17.2 to be performed unless the TSO determines that the performance of the test poses an unacceptable level of risk to or will have an intolerable adverse impact on the LITS.

9.18 Testing of Generating Units by TSO

9.18.1 Subject to provisions under section 8.30, the TSO may, at intervals of not less than **twelve (12) months**, require the testing of any generating unit connected to the LITS in order to assess the performance of the relevant generating unit or determine analytic parameters for modelling purposes and the TSO is entitled to witness such tests.

9.18.2 Adequate notice of not less than **fourteen (14) days** shall be given by the TSO before the proposed date of the test indicated in sub-section 9.18.1.

9.18.3 The TSO shall ensure that the tests are conducted at a time which will minimize the departure from the unit commitment and dispatch schedule that are due to take place at that time.

9.18.4 A Generation GCP shall provide any reasonable assistance requested by the TSO in relation to the conduct of the tests.

9.18.5 Tests conducted under this section shall be conducted in accordance with test procedures agreed between the TSO and the relevant Generation GCP, and a Generation GCP shall not unreasonably withhold its agreement to test procedures proposed for this purpose.

9.18.6 A Generation GCP shall bear its own costs associated with tests conducted under this section and no compensation shall be payable for financial losses incurred as a result of these tests or associated activities.

9.19 Tests by GCPs of Own Plant Requiring Changes to Normal Operation

9.19.1 Subject to provisions under section 8.30, a GCP proposing to conduct a test on equipment which requires a change to the normal operation of that equipment, shall give notice in writing to the TSO in accordance with sub-section 9.17.5, except in an emergency.

9.19.2 The notice to be provided shall include:

(a) the nature of the proposed test;
(b) the estimated start and finish time for the proposed test;
(c) the identity of the equipment to be tested;
(d) the power system conditions required for the conduct of the proposed test;
(e) details of any potential adverse consequences of the proposed test on the equipment to be tested;
(f) details of any potential adverse consequences of the proposed test on the power system and LITS facilities; and
(g) the name of the person responsible for the coordination of the proposed test on behalf of the GCP.

9.19.3 The TSO shall review the proposed test to determine whether it could:

(a) adversely affect the normal operation of the power system;
(b) pose a threat to power system security;
(c) require the power system to be operated in a particular mode which differs from the mode in which the power system is normally operated; or
(d) affect the normal metering of energy at a LITS Node.

9.19.4 If the TSO determines that the proposed test does fulfil one of the conditions specified above then the GCP and the relevant Transmission GCP must **seek the TSO's approval** prior to undertaking the test, which approval shall not be unreasonably withheld or delayed.

9.19.5 If, in the TSO's reasonable opinion, a test could threaten public safety, damage or threaten to damage equipment or adversely affect the operation of the power system, the TSO may direct the proposed test procedure to be modified or that the test is not conducted at the time proposed or both.

9.19.6 The TSO shall advise any other GCP who might be adversely affected by a proposed test and take into consideration the concerns and any reasonable requirements of those GCPs when approving the proposed test.

9.19.7 A GCP who conducts a test under this section shall ensure that the person responsible for the coordination of the test promptly advises the TSO when the test is complete.

9.19.8 If the TSO approves of a proposed test, the TSO shall use its best endeavors to ensure that power system conditions reasonably required for the test are provided as close as is reasonably practicable to the proposed start time of the test and continue for the proposed duration of the test.

9.19.9 Within a reasonable period after any such test has been conducted, the GCP who has conducted the test must provide the TSO with a report in relation to that test, including full test results where appropriate or requested by the TSO.

9.20 Communication Systems and Facilities

9.20.1 Subject to provisions under section 8.20, the TSO is responsible for maintaining redundant means of communication that are continuously available to all GCPs, particularly, Generation GCPs including other wholesale suppliers (Import/Export licensees), Distribution and other Demand GCPs.

9.20.2 The TSO and all GCPs shall provide adequate and reliable telecommunication facilities, including telephone, facsimile, electronic mail, internally and linked up with other GCPs (where appropriate) to ensure the exchange of information necessary to maintain system reliability in accordance with Section 14 of the LEGC; and when possible, these facilities shall be redundant and diversely routed.

9.21 TSO Communication Procedures

9.21.1 Procedures for communication between operators shall be established by each GCP in working with the TSO so that communication between operating personnel is consistent, efficient, and effective during normal and emergency conditions.

9.21.2 Operating instructions and procedures shall be established by each GCP in accordance with the System Operations Manual established by the TSO to enable operations to continue during the loss of communication facilities.

Guidelines and Requirements for Notification

9.21.3 Each GCP shall provide the names of its contact persons that are engaged in carrying out the operations of its system or facility.

9.21.4 A GCP shall give reasonable prior notice to all who may be affected by operational actions, such as switching or parameter adjustments that it intends to execute. The notice shall be given sufficiently in advance to allow others to consider the impact and prepare.

9.21.5 A notification of an operation shall, whenever possible, be communicated in writing and shall be of sufficient detail to enable the recipient of the notification to consider and analyze the implications and risks arising.

9.21.6 Where there is insufficient time for notification to be given in writing before the scheduled operation, then the notification shall be communicated by voice call to enable the action to be taken without delay and this shall be followed by a written confirmation of the notification soon after the action has been completed.

9.21.7 A notification shall include the name, position and other identification of the individual issuing the notice. The individual issuing the notice shall be competent and capable of discussing the technical merits, alternatives and implications of the notice.

9.21.8 The recipient of the notification may ask questions to clarify the notification and the issuing individual shall respond promptly and fully to any questions or requests for clarification or additional information.

9.21.9 While in no way limiting the specific requirements for notification as set out in this section 9.21, the TSO and GCPs shall from time to time review the operations and events that require notification.

Notification of Planned TSO Operations

9.21.10 Prior to carrying out any operation such as switching or parameter adjustment on a LITS equipment or device, the TSO shall inform all GCPs who may be affected or their designated operators of the intended action.

9.21.11 The notification shall give details of the operation to be carried out, the intended time and the expected or possible impact and effect to be experienced and suggest the corresponding actions expected of the recipient of the notification, if any.

Notification of GCP Operations

9.21.12 A GCP shall notify the TSO of any operations within the GCP's facility which will or may have an operational effect on the LITS.

9.21.13 The TSO may use the information gathered from the GCP's notification to notify any other GCP whose facility or operations, in the reasonable opinion of the TSO, is likely to be affected by the notification issued by the GCP.

Notification of Alert Conditions and Events

9.21.14 A GCP shall advise the TSO without delay, as soon as it becomes aware of any condition that poses a risk to the smooth operation of the LITS, including the following specific conditions:

(a) Security emergency - when civil or public order problems which may affect grid operations exist;
(b) Operating reserves - when the Operating reserve is less than required;
(c) Overload - when there is critical loading or imminent overloading of transmission lines or equipment;
(d) Weather disturbance - when weather conditions or activities pose a risk to grid operations; and

(e) Act-of-God - any Act-of-God event or other relevant condition that poses a threat to grid operations.

9.21.15 The TSO shall assess the risks and potential impact on the LITS as soon as it becomes aware of any condition described in sub-section 9.21.14. If it considers it necessary, the TSO shall declare a state of Alert and notify all GCP's who may be affected accordingly. A GCP may be furnished with additional relevant information upon request.

9.21.16 For the duration of the state of Alert, each GCP upon receipt of the Alert notice shall take the necessary steps to place and maintain its plant or equipment in the operational mode that it is best able to withstand the anticipated disturbance, unless otherwise instructed by the TSO.

9.21.17 Subject to provisions under Section 10 of the LEGC, during the period while an Alert notice is still in effect, the TSO may vary the scheduling and dispatch instructions from those dictated by the merit order procedures prescribed in section 10.10 to manage the risks.

9.22 System Disturbance Events/Faults Monitoring and Recording

Purpose

9.22.1 Recorded information about transmission system faults or disturbances is essential to:

(a) determine the performance of system components and to aid in post-disturbance analysis;
(b) identify equipment malfunctions and the cause of swings that may have contributed to a disturbance; and
(c) analyze protection system and control deficiencies for corrective action to be taken to reduce the risk of recurring disturbances.

Disturbance Monitoring Requirements

9.22.2 Disturbance monitoring equipment including sequence-of-event fault recording and dynamic disturbance recording equipment which are necessary to ensure that data is available to analyze system performance and the causes of system disturbances, shall be installed by the Transmission GCP at appropriate points within the LITS as determined by the TSO.

9.22.3 The installed monitoring equipment shall be capable of capturing power quality information such as voltage and frequency profiles, voltage dips and surges, and voltage imbalance.

9.22.4 A GCP may also install disturbance monitoring equipment within any part of its facility to track any relevant system disturbances that may occur.

9.22.5 A Transmission GCP shall provide information to the TSO on the disturbance monitoring equipment installed and operational within the LITS, and the data/signals monitored at each location.

9.22.6 Data from transmission system disturbance monitoring equipment shall be in a consistent time- synchronized format and following a disturbance, data from all recorders shall be systematically retrieved, preferably automatically, and correlated.

9.22.7 To ensure provision of a meaningful data, the recorders shall be synchronized to standard time and equipped with GPS-synchronized clocks for time and date stamping. Sequence-of-event recorders shall be provided with time resolution between one and one hundred milliseconds which is necessary to determine the sequence in which events occurred.

9.22.8 A Transmission GCP shall maintain a database of the disturbance monitoring equipment and shall provide such information to the TSO on request.

9.22.9 The TSO, in consultation with GCPs, shall provide other details of minimum technical specifications, data format and standards for disturbance monitoring equipment, including any updates as may be found necessary.

Monitored Data

9.22.10 The basic data or signals to be monitored and recorded shall include, but not be limited to the following:

(a) the transient and dynamic response of each generating unit in terms of real and reactive power output;
(b) the voltage at the generating unit terminal;
(c) generating plant bus frequency;
(d) generating unit field voltage;
(e) generating unit field current;
(f) the system voltage at the high voltage side of the unit step-up transformer;
(g) power system stabilizer output;
(h) AGC pulses;
(i) active and reactive power flow at a Connection Point;
(j) substation busbar voltage and frequency;
(k) circuit breaker and protective device status; and
(l) required locations of recorders.

9.22.11 All major transmission substations and generating stations in the LITS shall be equipped with disturbance monitoring equipment in addition to any other locations determined and recommended by the TSO for installation of a recorder.

9.23 Operations Monitoring Reporting Requirements

Reporting of Emergency, Automatic or Unplanned TSO Operations

9.23.1 Under circumstances where the TSO needs to carry out an operation urgently or it is not possible to provide notification prior to the execution of an operation, the TSO shall proceed with the action and thereafter inform GCPs of the occurrence of the operation without undue delay.

9.23.2 Immediately following an emergency, automatic or unplanned operation of LITS equipment or devices, the TSO shall inform each GCP whose system may or could have experienced an operational effect and give details of what has happened.

9.23.3 The TSO shall also inform the GCPs as to the likely duration of the LITS operating condition and provide updates as appropriate, and when the condition has ended the TSO shall inform the GCPs as soon as it is reasonably possible.

Routine Monthly Reporting

9.23.4 The TSO shall prepare and submit within **fifteen (15) days** of the succeeding month, a monthly report on operations of the LITS for the previous month. The report shall be submitted to the GCAC, the LERC and copies made available to all GCPs.

9.23.5 The monthly LITS operations report shall include an evaluation of events and other problems that occurred within the LITS for the previous month, the measures taken to address them and the recommendations to prevent recurrence in the future.

9.23.6 In addition, the monthly report shall contain data and information on the following performance characteristics of the LITS:

(a) Frequency profile;
(b) Voltage profile at selected LITS Nodes;
(c) Major generation and transmission outages;
(d) Transmission constraints; and
(e) Instances of persistent/significant non-compliance with the LEGC.

Quarterly and Annual Reports

9.23.7 Subject to the performance reporting requirements under Section 14 of the LEGC, the TSO shall prepare and submit to LERC quarterly and annual reports on the performance of the LITS. The quarterly and annual reports shall evaluate the performance of the LITS against established targets, standards and benchmarks for reliability, security and quality of service in accordance with Section 12 of the LEGC.

9.23.8 The reports may also indicate constraints, if any, along with details of the GCPs responsible for causing the constraints and any actions being taken by these GCPs and the TSO to address each constraint.

9.24 Incident/Fault Reporting and Investigation

General

9.24.1 This section 9.24 provides procedures to be adopted for reporting faults, forced outages and Significant Incidents which may occur in the LITS or a GCP's network or facility which may have an operational impact on others. It also describes the procedure for setting up joint investigation of a Significant Incident.

Reporting of Major Incident or Significant Incident by a GCP

9.24.2 A GCP shall notify the TSO through a report, as soon as practicable and in any event within **twenty-four (24) hours** of any forced outage, malfunction, fault or Significant Incident to a LITS component or the GCP's network or facility that may have an impact on other GCPs or the quality, reliability or security of LITS services and may include the following:

(a) Generation GCPs shall report loss of output and tripping of units and governing control to the TSO within **fifteen (15) minutes** of the event occurring;

(b) Demand GCPs shall report the loss of major loads (larger than 2 MW) to the TSO within **fifteen (15) minutes** of the event occurring, and similarly, warning of the reconnection of such loads shall be given with at least **fifteen (15) minutes** advance notice;

(c) Incidents affecting any interconnected tie-line shall be reported to the TSO and the Transmission GCP within the times specified in the relevant Interconnection Agreements and Protocols; and

(d) Incidents on the LITS that involve sabotage or suspected sabotage, as well as threats of sabotage shall be reported to the TSO.

9.24.3 The report mentioned in sub-section 9.24.2 shall include all the necessary information on the circumstances of the incident to enable the TSO and the Transmission GCP readily and correctly investigate and remedy any operational deficiency.

9.24.4 Where the TSO determines that an incident which was reported by a GCP is Significant, or has significantly impacted LITS services provision, the TSO may request the GCP to submit a detailed written report of the event.

9.24.5 The TSO is not required to forward the GCP's report to third parties but may use the information obtained in preparing its report for other GCPs who may have been affected by the incident.

Reporting of Major Incident or Significant Incident by the TSO

9.24.6 The TSO shall notify as soon as practicable, and in any event within **twenty-four (24) hours**, the Transmission GCP or its designated representative of any forced outage, disconnection, under- or over-voltage incidents, quality of supply contraventions, malfunction, fault or Significant Incident to a LITS component.

9.24.7 The notice in sub-section 9.24.6 shall include all the necessary information on the circumstances of the incident to enable the Transmission GCP readily and correctly investigate and remedy any operational deficiency.

9.24.8 If a GCP determines that an incident which was reported earlier by the TSO is of significance, the GCP may request the TSO to submit (or cause to be submitted) a written report containing details of the incident.

9.24.9 The GCP shall not pass on the report to third parties unless the TSO's permission is sought and granted.

Guidelines for Written Reports

9.24.10 A report prepared under this section 9.24 may contain a confirmation of oral notification with more details relating to the major incident/fault or Significant Incident and shall, as a minimum, include the following details of the incident (where applicable):

(a) time and date of event;
(b) location;
(c) plant and/or equipment directly involved;
(d) description and cause of event;
(e) conditions before the event;
(f) demand and/or generation (in MW) interrupted and duration of interruption;
(g) all relevant system data including copies of records of all recording instruments including disturbance recorder, event logger, etc;
(h) sequence of tripping with time;
(i) details of relay operations; and
(j) remedial measures taken.

Investigation of Incidents

9.24.11 A Transmission GCP shall investigate the causes of any incident of forced outage or equipment fault/failure reported by the TSO and immediately effect all advisable temporary containment or remedial actions.

9.24.12 Upon completion of the immediate or remedial actions the Transmission GCP shall submit its investigation report of the incident to the TSO.

Investigation of Major or Significant Incidents

9.24.13 Any major or Significant Incident that materially affects the quality of the LITS service to a GCP shall be formally investigated. These may include interruptions of supply, disconnections, under or over voltage incidents, quality of supply contraventions, and others.

9.24.14 The TSO shall at its sole discretion initiate an investigation into a major or Significant Incident that occurs on the LITS for the following purposes:

(a) to establish the probable causes of the incident;
(b) analyze the chronology and development;

(c) assess the impact;
(d) draw conclusions; and
(e) to outline the measures necessary for prevention or mitigating the impact of similar incidents in the future.

9.24.15 The procedure to be followed by the TSO shall include the following:

(a) The TSO shall invite an affected GCP to make available all relevant required information to the TSO subject to information exchange confidentiality obligations described under Section 14 of the LEGC, where necessary.
(b) A preliminary incident report shall be prepared and submitted within **three (3) days**.
(c) The final report shall be submitted by the TSO to LERC through the GCAC within **three (3) months**.

9.24.16 A GCP who is directly affected by a Significant Incident may request for a joint investigation of the incident. The request for joint investigation shall be made in writing to the TSO, giving reasons for the request. A joint investigation shall be undertaken if warranted, in the opinion of the TSO.

9.24.17 A joint investigation shall be organized by the parties concerned and independent experts may be invited to take part in the investigation by mutual agreement between the parties.

9.24.18 The form and procedure of joint investigation of a particular incident shall be agreed upon in advance by the parties concerned.

9.24.19 The results of the joint investigation shall be recorded in a report, copies of which shall be lodged with the TSO who shall make copies available to LERC through the GCAC within **ten (10) days** upon receipt of the final report.

Section 10: Scheduling And Dispatch Of Generation & Ancillary Services

10.1 Background, Purpose, and Scope

10.1.1 Scheduling the operations of generating units and ancillary services is a major component of the TSO's operational activities. The optimal schedule is influenced by factors on both the demand-side and supply-side as well as limitations and constraints of the LITS.

Purpose

10.1.2 The purpose of the scheduling and dispatch process is to ensure that the continuously changing demand on the grid is met in the most economic manner bearing in mind the limitations on the transmission system, security requirements and other constraints.

10.1.3 The TSO projects demand, considers the generating units that are available to provide supply given the existing constraints within the LITS, and then schedules generation in merit order to meet the projected demand at minimal cost and in accordance with the LITS Performance and Reliability standards and Safety rules and standards.

Scope

10.1.4 The Scheduling and Dispatch Sub-code defines, among others, the following:

(a) responsibilities of the TSO and GCPs in the scheduling and dispatch process, including transactions of Import/Export Licensees on the CLSG interconnected system;
(b) load forecasting obligations, procedures and methodologies;
(c) operational criteria for the preparation of the generation schedule;
(d) generation and ancillary services scheduling;
(e) pre-dispatch and post-dispatch planning; and
(f) the central dispatch procedures and issuance of dispatch instructions.

10.2 Responsibilities of the TSO

10.2.1 The TSO shall provide the generation schedule, demand forecast and ancillary services requirements for the LITS.

10.2.2 The TSO has the obligation to ensure that there is sufficient generation to meet demand at all times in the most optimal manner, making provision for reserve requirements, while maintaining the integrity of the LITS to ensure quality and security of supply.

10.2.3 The TSO shall undertake the generation scheduling activity which requires generating unit data as basis for preparing a merit order table for use in the preparation and issuance of the generation schedule.

10.2.4 Subject to sub-section 10.2.2 the TSO shall be responsible for:

(a) collating and preparing the demand forecast on the LITS;
(b) determining the generating capacity needed to meet the demand requirements of the LITS, including energy consumption, losses, internal usage, operating reserves, etc.;
(c) preparation and issuance of the generation schedule in accordance with the procedures described in this Sub-code;
(d) issuing of dispatch instructions for the scheduled generating units following the procedures outlined in this Sub-code and the Operations Sub-code;
(e) ensuring that appropriately located generating units are available and scheduled to provide ancillary services;
(f) rescheduling of generation during unplanned events in accordance with the rules provided in this Sub-code;
(g) coordinating import/export transactions and other international interconnection operations from the Liberian side in accordance with regional Power Pool protocols and arrangements;
(h) keeping an electronic log of dispatch instructions and monitoring compliance with dispatch instructions;
(i) reporting any non-compliance outside the tolerance band to the GCAC and LERC, together with any explanation for the non-compliance as advised by a Generation GCP; and
(j) fully documenting the operation of the generation scheduling process, including the principles adopted in making the calculations required.

10.2.5 The TSO shall submit to LERC annually a recommended set of dispatch tolerance bands for all classes of generating units considering the unit's fuel source, physical limitations on ability to control generation output, and any relevant locational issues.

10.2.6 The LERC will consider the recommendations submitted under sub-section 10.2.5 and publish an approved set of dispatch tolerance bands.

10.2.7 For the avoidance of doubt dispatch tolerance bands for non-dispatchable renewable generators (VRPPs) shall take into consideration the variability of their fuel source (or primary resources) and reasonable efforts to forecast these variations in formulating an offer.

10.3 Responsibilities of Transmission GCP

10.3.1 A Transmission GCP shall provide data on the availability, capability and operating states of transmission facilities and equipment as the basis for determining the operational limits of the LITS for generation scheduling and dispatch.

10.3.2 Unless subject to an agreed outage, a Transmission GCP is required to offer all assets under its control to the TSO for dispatch. A Transmission GCP will advise the TSO as soon as possible of any material change in equipment capability that comes to its notice. Such advice shall include a description of the reason necessitating the change.

10.3.3 A Transmission GCP shall follow, within dispatch tolerance bands, all dispatch instructions properly issued by the TSO, except were doing so would endanger people or equipment or breach its legal obligations.

10.4 Responsibilities of Generation GCPs

10.4.1 A Generation GCP shall comply promptly with the TSO's request, to submit its *Capability and Availability Declaration* data, generation scheduling and dispatch parameters (including generating capacity, start up and stopping times, and ramp rates) and any other relevant data as may be requested.

10.4.2 A Generation GCP shall ensure that all dispatch instructions from the TSO relating to a scheduled generating unit or plant are implemented.

10.4.3 A Generation GCP nominated to provide ancillary services shall be responsible for ensuring that its generating units can provide the necessary support when so instructed by the TSO.

10.4.4 A Generation GCP will advise the TSO as soon as possible of any material change in unit capability that comes to its notice. Such advice shall include a description of the reason necessitating the change.

10.5 Responsibilities of Demand GCPs

10.5.1 A Distribution GCP or Large Consumer GCP (i.e. Demand GCP) connected to the LITS shall submit to the TSO its demand data to be used in the demand forecasting process which is required for the generation scheduling activity.

10.5.2 All Demand GCPs must advise the TSO of the technical capability of their equipment in a form and to a time schedule advised by the TSO. A GCP will advise the TSO as soon as possible of any material change in equipment capability (for off-take of power/energy) that comes to its notice.

10.5.3 A Demand GCP shall implement, within dispatch tolerance bands, all dispatch instructions pertaining to demand management control during the period while an emergency persists.

10.6 Demand Forecast and Forecasting Process

10.6.1 The preparation of demand forecasts is essential for operational planning and to ensure reliable operation and service delivery from the LITS. Demand forecasting is an integral part of the generation scheduling and dispatch process.

10.6.2 A Demand GCP connected to the LITS shall forecast the total and the net (after deducting embedded generation) energy and power demand that it expects to impose at each nodal point of the LITS.

10.6.3 A GCP shall prepare and provide to the TSO, at least **one (1) week** in advance, the forecast hourly load profiles for each day of the next two weeks. These forecasts are to provide an indicative estimate of the total generation capacity and the corresponding generation schedule needed to meet the forecast demand requirements of the LITS over the relevant dispatch periods.

10 .6.4 The following factors shall be considered in the development of the demand forecasts, to the extent that the factors are relevant to the particular forecast:

(a) historic demand data as recorded, including transmission losses and station service consumption;
(b) growth patterns in the annual demand and load profiles of existing loads;
(c) load management expectations and expected energy output from embedded generating facilities including non-dispatchable renewable generation sources (VRPPs);
(d) demand forecasts for new connections or step increases in the requirements of existing consumers;
(e) known weather patterns and forecasts;
(f) major events or anticipated activities which are likely to affect demand;
(g) expected changes in economic activity; and
(h) any other relevant information provided by GCPs.

10.6.5 The TSO shall collate all demand information provided by the relevant GCPs and (the TSO) shall produce the following schedules and demand forecasts in accordance with the timetable prescribed in Technical Schedule TS–T:

(a) dispatch schedule for each hour of the day ahead;
(b) hourly load forecasts for each of days 2 to 7 (inclusive) ahead;
(c) weekly demand forecast for 4 weeks ahead giving the daily energy forecast as well as the peak and off-peak demand forecasts for each day; and
(d) monthly demand forecast for the period 12 months ahead of the current month, giving for each month the energy forecast, peak and off-peak demand forecasts, including also the typical hourly profiles of total system load for working and non-working days in the first month only.

10.6.6 The TSO shall develop a methodology to collate the information obtained and acquire the appropriate tools to create the indicative demand forecasts for the entire LITS.

10.6.7 The demand forecasts produced by the TSO shall be indicative only as the TSO has no direct influence over GCPs' in the decisions about their levels of demand.

10.6.8 The demand forecast shall be adopted and used in operational planning and more specifically, for the purposes of determining the dispatch schedules, operating reserves, short- and medium-term capacity reserve requirements, in accordance with the power system security and reliability standards.

10.7 Generation Margin

10.7.1 The LITS shall always have adequate operating reserve to respond to normal variations in demand and to respond to a sudden reduction in generation during emergency conditions and the impacts of grid-connected variable renewable energy generation in accordance with the power system operations criteria specified in section 9.9 of the Operations Sub-code.

10.7.2 The TSO shall allocate the required spinning reserve to strategically located generating plants as stipulated under section 9.13 of the LEGC to achieve the required levels of primary and secondary regulation.

10.7.3 The TSO shall allocate adequate non-spinning reserve to cover uncertainties in generating unit availability as stipulated under section 9.13 of the LEGC.

10.8 Scheduling and Dispatch Criteria

10.8.1 A generation schedule shall be compiled daily by the TSO as a statement specifying which generating units may be required for the next following scheduled Day.

10.8.2 The TSO shall consider the following as criteria in the scheduling and dispatch of generation and ancillary services:

(a) the synchronized generating capacity shall be sufficient to match, at all times, the forecast demand and the required operating reserves (as prescribed in sections 10.6 and 10.7 respectively) to ensure the security and reliability of the LITS;
(b) the availability of adequate generating capacity to ensure that the grid will continue to operate in Normal State, even with the loss of the largest generating unit or power import from a single interconnection, whichever is larger;
(c) minimizing the impact of technical and operational constraints of the grid and generating units; and
(d) maintenance of frequency control requirements to ensure security and stability of the LITS.

10.9 Scheduling and Dispatch Data

10.9.1 A Generation GCP shall submit to the TSO all required generation data as specified in the System Operations Manual **one (1) day** ahead of the dispatch Day.

10.9.2 The generation data and information to be submitted shall consist of the Capability and Availability Declaration, generating unit scheduling and dispatch parameters, and other relevant generation data and information including:

(a) details of any special factors which may have a significant impact on the output of a scheduled generating unit;
(b) any temporary change to the registered data of the scheduled generating unit indicating the duration of the temporary change; and
(c) any temporary change of a generating unit's availability to provide ancillary services and the duration of the temporary change.

10.9.3 A Generation GCP shall without delay notify the TSO of any change in the submitted Capability and Availability Declaration, generation scheduling and dispatch parameters and other relevant generating plant data.

10.9.4 The Transmission GCP shall notify and provide details of any transmission system constraints which may have a significant impact on the output of a scheduled generating unit.

10.9.5 A Distribution GCP or any other Demand GCP shall notify the TSO of the following:

(a) its hourly demand forecast (i.e. requirements for power and energy) **one (1) day** ahead of the dispatch Day;
(b) constraints on its distribution network or GCP system which may need to be taken into account in the scheduling and dispatch process; and
(c) the requirements for the following which the TSO may need to consider for reliability and stability of the LITS:
    (i) control measures for voltage and reactive power (or MVar reserves), and
    (ii) ancillary services.

10.10 Merit Order Operation

10.10.1 Generation scheduling requires generator data to enable the TSO to prepare a merit order to be used in the preparation and issue of a generation schedule for dispatch instructions.

10.10.2 Based on the data required as stated in sub-section 10.10.1, the TSO shall ensure that there is sufficient generation to always meet system demand in the most economic manner, together with an appropriate margin of reserve, while maintaining the integrity and security of the LITS and quality of supply.

10.10.3 The TSO shall employ merit order operation of all generation or supply sources to optimally meet the collective power demand on the LITS irrespective of the market arrangements covering the demand, whether by bilateral contracts or other commercial trading arrangements. The commercial arrangements and contractual

bases of each component of demand shall nevertheless be considered in determining the settlement obligations of GCPs.

10.10.4 To meet the continuously changing demand on the LITS in the most economical manner, generating units shall, as far as practicable, be stacked for dispatch by the TSO in accordance with "the least variable cost of operation and maintenance inclusive of cost of fuel (where applicable) and consumables (denoted as "operating costs") of producing electricity from each unit excluding the unit's capital cost and other fixed costs.

10.10.5 The generating units with the least operating costs shall be used to meet the demand for power with the required margin for operating reserves.

10.10.6 Recognizing that the merit order for generation is dependent upon the chosen timeframe for optimization, (i.e. the merit order that produces the least cost for one-day only is different from that which results in the least cost for the week, the month or the year), merit order dispatch within the LITS shall take into consideration the various time frames.

10.10.7 The merit order Schedule for a hydro system is primarily based upon the annual energy plan for the hydro units and the costs for hydro units are based upon:

(a) efficiency of the unit;
(b) the reservoir or pond level;
(c) run-of-river status; and
(d) Long-Run Marginal Costs (LRMCs).

10.10.8 For the purposes of merit order dispatch, generating units shall be listed in a Merit Order Table according to the lowest to highest operating costs.

10.11 Merit Order Table

10.11.1 Using the operating cost or price data submitted by each Generation GCP for its generating units and in accordance with the provisions of the LEGC, the TSO shall prepare a Merit Order Table based on ascending operating costs or prices such that the scheduled generating unit that has the lowest price, per kilowatt-hour, shall be at the top of the Merit Order Table.

10.11.2 The Merit Order Table shall be updated by the offered generating unit data for the next availability declaration period. The updating shall take into consideration not only changes to the cost of fully loaded units, but also the difference in the loading cost curves for each unit and for each plant.

10.11.3 The updated Merit Order Table shall be used in selecting the generating unit that will be committed for the Day-ahead generation schedule.

10.12 Generation Scheduling Procedure

10.12.1 Generation scheduling procedures include:

(a) collation of hourly demand forecasts for the next Dispatch Day by the TSO;
(b) submission to the TSO of the scheduling and dispatch data prescribed in section 10.9;
(c) submission to the TSO of any revised generation scheduling data or dispatch parameters for the following Availability Declaration period by each Generation GCP; and
(d) use of the information provided by all GCPs in the preparation of a Generation Schedule for the next Dispatch Day.

10.12.2 In preparing the Generation Schedule, the TSO shall take into account the criteria and all other factors specified under sections 10.8 and 10.9 including any cross-border power exchange or trade transactions as governed by sub-regional interconnection protocols and other inter-utility bilateral agreements.

10.12.3 The Generation Schedule, as compiled by the TSO shall in addition be:

(a) in accordance with the Merit Order Table;
(b) sufficient to match the forecast system demand together with the required reserve margins as defined by the Operations Sub-code; and
(c) sufficient to maintain system frequency within the required limits.

10.13 Preparation of the Generation Schedule

10.13.1 The TSO shall prepare, each day, an hourly demand forecast, taking into account system losses, for the next Dispatch Day.

10.13.2 By **10:00h** each day, each Generation GCP shall submit to the TSO, in writing, generating unit Capability and Availability Declaration data to be used in preparation of the Generation Schedule for the next day from 00:00h to 24:00h.

10.13.3 If a generating unit's Capability and Availability Declaration for the next Dispatch Day is not submitted within the prescribed deadline, the Generation GCP shall be deemed to have submitted on such day an Availability Declaration in the same value and terms as indicated in the most recent Capacity and Availability Declaration and the TSO shall use this data in preparing the Generation Schedule.

10.13.4 By **10:00h** each preceding day, all Distribution GCPs and other Demand GCPs who wish to draw power or energy from the LITS shall submit to the TSO in writing all information stated in sub-section 10.9.5 as input for preparation of the next day's Generation Schedule.

10.13.5 If no data is received within the prescribed deadline from a Demand GCP, the TSO shall make assumptions based on the most recent data submitted and other known factors for the requirements of the relevant Demand GCP.

10.13.6 Scheduled generating units shall be committed in accordance to the Merit Order Table, until the forecast demand and system losses are fully covered. Additional generating units shall be committed to cover the Operating reserve requirements

and at this stage, a day-ahead unconstrained Generation Schedule shall be developed.

10.13.7 Following the development of the unconstrained Generation Schedule, the TSO shall determine the feasibility of the unconstrained Generation Schedule, considering any constraints within the LITS.

10.13.8 The unconstrained Generation Schedule shall be adjusted as may be necessary to develop the final constrained Generation Schedule, after taking the constraint factors into account.

10.13.9 Scheduled generating units that are not included in the Generation Schedule shall be set aside for possible inclusion in the latter stage of the generation scheduling process.

10.13.10 The Generation Schedule shall reflect the true operating characteristics of generating units. If a scheduled generating unit becomes available at a different capacity the relevant Generation GCP shall notify the TSO and provide a revised Capability and Availability Declaration within the prescribed deadlines. If provided within the prescribed deadlines, the TSO shall take the revised Capability and Availability Declaration into account in the preparation of the final day-ahead Generation Schedule.

Adjustments to Generation Schedule

10.13.11 The TSO may deem it necessary to adjust the output of the generation scheduling process, before the issue of the Generation Schedule. Such adjustments may be necessary due to the following factors:

(a) changes in offered availability and dispatch parameters of generating units, brought to the attention of the TSO after the commencement of the generation scheduling process;
(b) changes to system demand forecasts;
(c) changes in transmission network configuration and equipment availability, resulting in constraints not previously foreseen; and
(d) any other condition which in the opinion of the TSO would result in additional risk to the security of the LITS including:
    (i) volatile weather situations giving rise to low confidence in demand forecasts;
    (ii) severe (unpredicted) weather conditions imposing high risk to the LITS;
    (iii) impending strikes or political unrest posing a high risk to the LITS or parts thereof; and
    (iv) limitations or deficiencies of computational algorithms of the TSO scheduling process.

10.13.12 Any of the factors listed in sub-section 10.13.11 may result in a generating unit being chosen out of merit. Any deviation from the use of the Merit Order Table for dispatch shall be reported by the TSO, including details of the reasons or those responsible for the deviation. These reports shall be consolidated into a weekly report by the TSO to all GCPs, the GCAC and the LERC.

10.14 Revision of Generation Schedule

10.14.1 If a revision in the availability declaration, generation scheduling and dispatch parameters or other relevant generation data is received by the TSO prior to 15:00h on the day preceding the relevant scheduled Day, the TSO shall, if there is sufficient time prior to the issue of the generation schedule, take into account the revised availability declaration, generation scheduling and dispatch parameters or other relevant generation data in preparing the generation schedule.

10.14.2 If a revision in availability declaration generation scheduling and dispatch parameters or other relevant generation data is received by the TSO at or after 15:00h on each day but before the end of the next following scheduled Day, the TSO shall, if it has to re-schedule the units available to generate, take into account the revised availability declaration, generation scheduling and dispatch parameters or other relevant generation data in that re-scheduling.

10.14.3 If an event on the LITS occurs which requires substantial amendment in the data being used in preparing the Generation Schedule, the TSO may issue a revised Generation Schedule to the extent necessary, because of such events.

10.15 Issuing of Generation Schedule

10.15.1 The final Generation Schedule for the next dispatch Day shall be issued by the TSO to GCPs at **15:00h** each day except if a Significant Incident occurred while the Generation Schedule is being prepared, where the TSO may extend the deadline for issuance of the final Generation Schedule.

10.15.2 The final Generation Schedule shall indicate the:

(a) hourly output of each scheduled generating unit for the following Dispatch Day;
(b) generating units that are providing specific ancillary services; and
(c) interconnection power transactions.

10.15.3 The Generation Schedule received by each Generation GCP shall contain only information relating to its generating units.

10.15.4 The TSO may make available to Generation GCPs indicative synchronizing and de-synchronizing times expected of the scheduled units before issue of the Generation Schedule to confirm length of time for notification of dispatch instruction and compliance of synchronization instructions. A Generation GCP shall immediately acknowledge the indicative times together with confirmation of their compliance.

10.15.5 When the required period for notice to synchronize is within 30 minutes of synchronization, causing the unit to be unable to meet the indicative dispatch instructions, the Generation GCP shall immediately inform the TSO.

10.16 Dispatch Instructions

10.16.1 The TSO shall issue dispatch instructions to all Generation GCPs for the scheduled Day at any time during the period beginning immediately after the issue of the Generation Schedule for that scheduled Day.

10.16.2 Dispatch instructions shall take into account the Capacity and Availability Declaration, generation scheduling and dispatch parameters, and other relevant generating plant data supplied to the TSO.

10.16.3 The dispatch instruction shall contain, at the minimum, the following:

(a) the specific generating unit to which the instruction applies;
(b) the active power (MW) and reactive power (MVar) output required;
(c) notice and change in notice to synchronize or de-synchronize scheduled generating units in a specific timescale;
(d) target time of ramp-up and ramp-down rates for generating units; and
(e) the time of issue of a dispatch instruction.

10.16.4 The dispatch instruction may also include:

(a) details of the type of reserves to be carried by each generating unit, including specifications of the duration in which that reserve may be dispatched;
(b) an instruction for generating units to provide ancillary services and other operational requirements;
(c) target voltage levels at instructed generating capacity level or the individual reactive power output at the bus or Connection Point;
(d) requirements for changes in AGC mode; and
(e) an instruction to carry out tests as specified in the Operations Sub-code.

10.16.5 The TSO shall maintain records of the following dispatch instructions in an electronic format or a written logbook or both:

(a) synchronizing and de-synchronizing instructions; and
(b) active power (MW) and reactive power (MVar) dispatch instructions.

10.16.6 For each of the instructions listed in sub-section 10.16.5, the required action, time of issuance of the instruction and the time the action is to be implemented shall be recorded.

10.16.7 The TSO shall issue to all Generation GCPs (including Import/Export licensees) through an appropriate means of communication (telephone and confirmed by email or fax), the dispatch instruction regarding their day-ahead hourly Generation Schedule.

10.16.8 The hourly loading as defined by the Generation Schedule and issued to scheduled generating units shall remain valid, unless superseded by another dispatch instruction from the TSO.

10.16.9 A generating unit/plant shall be deemed to have complied with a dispatch instruction when it achieves an output within the allowable tolerance of its declared available capacity for both active and reactive power and within the time for the change according to its registered operating parameters and characteristics.

10.16.10 In the event of two or more generating units having the same price, the TSO shall dispatch the generating unit that will result in a smaller system loss.

10.16.11 Dispatch instructions may be subsequently cancelled or varied. Generating units that are declared to be available but not included in the Generation Schedule may be issued with dispatch instructions.

10.16.12 A generating unit that has been declared as available shall be ready to provide power within 30 minutes of being instructed.

10.16.13 Where a Generation GCP has received a dispatch instruction to change the output of a synchronized generating unit, it shall carry out the instruction to achieve the new target within the unit's registered operating parameters and characteristics and within the time specified by the TSO.

10.16.14 The form of instructions and terms to be used by the TSO in issuing of instructions are to be mutually agreed by all the relevant parties.

10.16.15 A dispatch instruction for operating reserves shall specify the type of reserve that the generating unit is required to provide.

10.16.16 A dispatch instruction for emergency load reduction shall contain the quantity and magnitude of load to be dropped and the time the load reduction is to be implemented.

10.16.17 In the event that while carrying out a dispatch instruction, an unforeseen problem arises, the TSO shall be notified without delay by telephone.

10.16.18 Where a Generation GCP is unable to comply with a dispatch instruction correctly issued by the TSO, it shall inform the TSO by telephone without delay and the Generation GCP shall follow up to provide a new declaration.

10.16.19 The dispatch instruction to shut down a generating unit shall specify the shutdown time.

10.16.20 Where a Generation GCP has not informed the TSO of its inability to comply with a dispatch instruction, but the TSO ascertains that the GCP is not in compliance with a dispatch instruction, the GCP shall be deemed to have breached the LEGC and the prescribed sanctions or penalties shall apply.

Action Required by Generation GCPs

10.16.21 A Generation GCP shall comply with all dispatch instructions issued by the TSO.

10.16.22 If an unforeseen problem arises, which affects the safety of the unit, plant or personnel, the Generation GCP may disregard dispatch instructions and take necessary corrective actions and shall notify the TSO.

10.16.23 De-synchronization may take place without the TSO's prior approval if it is done solely on the grounds of safety of the plant or personnel.

10.16.24 De-synchronization because of low-frequency-relay operation shall be reported to the TSO immediately.

10.16.25 A Generation GCP shall, without delay, notify the TSO of any changes to or loss (temporary or otherwise) of operational capability of its unit that is synchronized or instructed to be synchronized or designated for operation as Operating reserve.

10.16.26 Where a Generation GCP or a particular generating unit fails to respond to a dispatch instruction within a tolerable time and accuracy (in accordance with generating unit's declared technical characteristics and Prudent Utility Practice), the generating unit shall be declared and identified as non-conforming and the relevant Generation GCP may face financial penalties or other sanctions imposed under its License for breach of the LEGC.

Instruction to Distribution GCPs and other Demand GCPs

10.16.27 The TSO shall issue instructions directly to a Distribution GCP or other Demand GCP for special actions relating to:

(a) demand management,
(b) load transfer,
(c) disconnection, or
(d) restoration of load.

10.17 Reactive Power Dispatch

10.17.1 The TSO may issue dispatch instructions to a Generation GCP to adjust the reactive power output of any scheduled generating unit that has been instructed to be synchronized.

10.17.2 The reactive power output of the scheduled generating unit in respect of which a dispatch instruction is given shall then, without delay, be adjusted in accordance with its declared operating characteristics to the new target reactive power so instructed within a tolerance of plus or minus two percent (+/-2%) of the target.

10.17.3 Generating units having achieved the new target reactive power output shall allow the reactive power output to vary under AVR control in accordance with the applicable declarations for ancillary services and generating unit operating characteristics.

10.17.4 Dispatch instructions in relation to reactive power may include target voltage levels to be achieved by the generating unit on the transmission system at the LITS Connection Point and a generating unit so instructed must comply without delay and achieve that target not later than two (2) minutes after the instruction time, or such longer period as the TSO may instruct.

10.17.5 Under certain conditions, such as low system voltage, an instruction to achieve maximum reactive power output at instructed MW output may be given, and a Generation GCP shall take appropriate action to maximize reactive power output unless constrained by plant operational limits or on safety grounds relating to plant or personnel.

10.17.6 Under certain conditions such as high system voltage, an instruction to achieve maximum reactive power absorption at instructed active power output may be given and a Generation GCP shall take appropriate action to maximize reactive power absorption unless constrained by plant operational limits or on safety grounds relating to plant or personnel.

10.17.7 The issue of a dispatch instruction relating to reactive power shall be made with due regard to any resultant change in reactive power capability and may include reduction in active power generation in order to increase reactive power capability.

10.17.8 Where an instruction to synchronize is given or where a generating unit is synchronized and a MW dispatch instruction is given, a MVar dispatch instruction consistent with the generating unit's relevant parameters may also be given. In the absence of a MVar dispatch instruction with an instruction to synchronize, the MVar output shall be maintained at the minimum value possible.

10.17.9 MVar dispatch instructions issued by the TSO shall reflect the limits contained in the applicable registered generating unit parameters and characteristics.

10.17.10 Under system fault conditions, where reactive power output is driven outside its declared operating characteristic limits, the Generation GCP shall immediately inform the TSO of the situation. However, if the Generation GCP reasonably believes that the situation may be dangerous to personnel or plant, then appropriate action may be taken to remedy the situation.

10.18 System Emergency Conditions

10.18.1 The TSO may instruct a Generation GCP to operate outside the limits implied by the current Capacity and Availability Declarations when the prevailing conditions of the LITS constitute an emergency condition. When issuing such an instruction, the TSO shall inform the Generation GCP that the instruction is being issued under a system emergency condition to maintain the integrity of the LITS.

10.18.2 Where the TSO has issued an emergency instruction requiring the operation of a generating unit outside the applicable Capacity and Availability Declaration limits, the Generation GCP shall comply with the instruction unless in the reasonable opinion of the Generation GCP the safety of personnel or plant will be unduly compromised in complying with the instruction.

10.19 Ancillary Services Agreement

10.19.1 The TSO shall use reasonable endeavors to enter into agreements to provide sufficient ancillary services to meet system performance requirements, considering those that are available or provided under Connection Agreements.

10.19.2 The TSO may direct a GCP to provide ancillary services agreed to be provided under a Connection Agreement and a GCP so directed shall use reasonable endeavors to comply with any such directive.

10.19.3 Unless otherwise agreed between the parties, payment by the TSO under an Ancillary Services Agreement may contain but shall not be limited to:

(a) components based on either or both contracted capabilities and a measure of the ancillary service that is provided;
(b) a component reflective of demonstrable opportunity cost (i.e. lost revenue or opportunity) incurred by the GCP in providing the ancillary service; and
(c) a component to provide the GCP with a fair return in respect of any additional direct costs associated with providing the ancillary service.

10.19.4 A GCP shall not unreasonably refuse to provide ancillary services.

10.19.5 The TSO shall, through the System Operations Manual, develop methods and procedures to determine, control and monitor the performance of GCPs who provide ancillary services.

10.19.6 The TSO shall randomly monitor and check each provider of ancillary service for compliance, in accordance with the requirements of the LITS.

10.19.7 When justifiable in terms of power system security, the TSO may direct any GCP to provide an ancillary service where the GCP's plant can do so.

10.19.8 The TSO shall offer compensation to a GCP in respect of the ancillary services provided where:

(a) the TSO directs a GCP to provide ancillary services and the GCP provides the ancillary services; and
(b) there is no Ancillary Services Agreement in place with that GCP in respect of the required ancillary service.

10.19.9 If compensation offered by the TSO for provision of ancillary services is not accepted by the GCP and the level of compensation cannot be agreed between the parties, the GCP may seek a determination of a reasonable level of compensation in accordance with the dispute resolution procedures of the LEGC.

10.20 Dispatch, Monitoring and Testing of Ancillary Services

10.20.1 In real-time dispatch timeframe, it is necessary to regularly monitor and manage the provision of the various ancillary services. The instructions for these services shall be issued by the TSO and sent directly to the relevant GCP.

10.20.2 Any information that is brought to the attention of the TSO, either by way of direct communication with an ancillary service provider or through other data, shall be logged.

10.20.3 Monitoring of ancillary service performance by the TSO shall be by a combination of on-going monitoring, unannounced tests and detailed analysis of response to actual contingency events by GCPs.

10.20.4 Where the TSO determines that a GCP has not responded to its instruction or there is an apparent deficiency in terms of ancillary service performance, the GCP shall in the first instance be contacted by the TSO and the deficiency discussed. The TSO shall record any reasons offered for the deficiency or non-responsiveness.

10.20.5 Where there is continuing non-responsiveness, deficiency or variation from dispatch expectations on the part of a GCP, the occurrence shall be logged for review by the GCAC and the GCP advised to that effect. Logged details shall include specific information offered by the GCP and all other evidence that is available.

SECTION 11: SAFETY SUB-CODE

11.1 Background, Purpose and Scope

11.1.1 The electromechanical systems that have been interconnected to form the LITS are designed so that when operated normally they are safe, but they contain inherent dangers. Personnel of the TSO, GCPs and their agents often must work on or in proximity to the LITS facilities or equipment connected to the LITS. To ensure safe working conditions for these situations, it is necessary for the TSO and GCPs to operate in accordance with standard Safety Rules and Procedures.

Purpose

11.1.2 The Safety Sub-code provides standard operating procedures for coordination, establishment and maintenance of necessary safety protocols and guidelines that ensure safe working conditions for personnel working on or in proximity to LITS equipment or GCP's equipment at Connection Points. The general arrangement involves making electrical equipment dead and providing secure isolation and grounding such that the equipment cannot be inadvertently made live.

Scope

11.1.3 The Sub-code does not impose a particular set of safety rules to be adopted by the TSO or GCPs but sets out the principles and arrangements which govern the interface between the parties. Each GCP shall develop and adopt its own safety rules which shall be guided by the principles in the Sub-code.

11.1.4 This Safety Sub-code applies to:

(a) the TSO;
(b) Transmission GCPs;
(c) Generation GCPs including VRPPs;
(d) Distribution GCPs; and
(e) Other Demand GCPs.

11.2 Preparation of Safety Rules

11.2.1 All Transmission GCPs and Demand GCPs that have equipment or facilities connected to the LITS shall prepare comprehensive safety rules which must be followed to achieve safety from the inherent dangers of their operations and whenever work is to be carried out on or near to the facility.

11.2.2 The safety rules developed and established by each GCP shall be based on a philosophy that persons will be protected from the inherent dangers.

11.2.3 The safety rules shall define procedures and responsibilities for achieving safety of all persons and shall include the following provisions:

(a) making available the equipment concerned for the work to be carried out;
(b) establishing safe conditions for work which may be achieved by either
    (i) limiting the scope of work,
    (ii) conducting tail board meetings prior to commencement of actual task,
    (iii) isolation of equipment from a system, or

(iv) adopting specialized procedures and appropriate tools required to be applied when the work must be done on equipment which remains energized;

(c) authorizing the commencement of work;
(d) receiving the authority to commence work and executing the work;
(e) supervising safety during the work and clearing the authority when the work is terminated;
(f) cancelling the authority on termination of the work; and
(g) restoring the system to normal operation.

11.2.4 Safety procedures for personnel working on or in proximity to the LITS shall in addition be governed by the TSO's requirements for safety coordination, as may from time to time be in force.

11.3 General Guiding Principles for Safety Coordination

11.3.1 This section 11.3 sets out the guiding principles that shall be adopted under the LEGC to fulfil the requirements of safety.

11.3.2 The physical arrangement of equipment and facilities at a LITS Node shall be designed with safety as a primary consideration. Standard designs shall be utilized for ease of operation and maintenance and to also promote standardization of switching procedures.

11.3.3 The arrangements mentioned in sub-section 11.3.2 shall provide means to properly isolate equipment for maintenance and allow appropriate working clearances for installed equipment (*at least to comply with IEC 61936)* as well as for construction of future facilities. In addition, the appropriate interlocking device shall be provided.

11.3.4 GCPs shall adopt safety procedures in respect of any service or equipment connection to ensure the safety of personnel and/or plant for the performance of works or tests to be carried out.

11.3.5 The primary means of achieving safety when work is to be carried out on equipment shall be by isolation. In the case of mechanical equipment this shall be followed by draining, venting and purging as appropriate. In the case of high voltage equipment, this shall be followed by grounding.

11.3.6 Wherever practicable the isolating devices used shall be locked and where possible, the grounding devices shall also be locked, and the safety key kept in a key safe.

11.3.7 Approved specialized procedures shall be required for the work where normal isolation procedures cannot be applied.

11.3.8 Persons shall be formally appointed to carry out defined duties, where safety is concerned.

11.3.9 Application of safety rules shall ensure that safety is maintained within the entire power system.

11.3.10 In the process of safety coordination, the provisions of the relevant national laws and regulations in terms of occupational health and safety shall be mandatory.

11.3.11 The TSO shall coordinate the activities of persons responsible for the testing, monitoring and maintenance of facilities or equipment connected to the LITS, in order to ensure that testing and maintenance are carried out in a safe manner.

11.4 Safety Coordination Procedure

11.4.1 The TSO shall make available to all GCPs a copy of its Safety Rules concerning the LITS and connection point facilities.

11.4.2 A GCP shall also make available to the TSO a copy of its current local safety instructions concerning safety precautions on its facilities.

11.4.3 Prior to connection of facility/equipment to the LITS the TSO and the GCP must have approved each other's relevant local safety instructions and procedures in relation to the Connection Point.

11.4.4 In the event that a GCP wishes to change the local safety instructions that apply to its facilities at the Connection Point, it shall inform the TSO and other relevant GCPs in writing substantiating the necessity for the proposed change.

11.4.5 Works or tests on any equipment at the Connection Point shall be carried out only in the presence of persons designated by the TSO.

11.4.6 A GCP shall seek authority from the TSO and the relevant Transmission GCP if it wishes to access any LITS equipment.

11.4.7 The TSO shall coordinate, establish and maintain the necessary isolation and grounding when works and/or tests are to be carried out on a LITS facility or a GCP's electrical system that is connected to the LITS.

11.4.8 When works or tests are to be carried out within the LITS the TSO shall ensure that the necessary safety precautions are coordinated and implemented on the systems that may be affected.

Safety Coordinators

11.4.9 The TSO and a GCP shall each appoint safety coordinators who shall, for the stated tasks or period, be responsible for the coordination of safety precautions when work is to be carried out on the LITS or parts of it at their respective sides of the Connection Point. A back-up authorized person from each party shall be appointed to act as safety coordinator at any time that the first authorized person is unavailable.

11.4.10 The safety coordinators shall be responsible in all matters concerning safety of personnel and equipment and shall be competent to carry out the functions set out to achieve safety on the LITS at all times.

11.4.11 Only authorized persons of the TSO and the GCP(s) will carry out safety activities at all times.

11.4.12 In the event of a need to replace the person appointed as safety coordinator, all other affected persons shall without delay be notified of the identity of the new safety coordinator.

11.4.13 Contact between safety coordinators of the TSO and GCP(s) will be made via normal operational channels, and accordingly telephone numbers for each safety coordinator shall be registered and available at the TSO and GCP(s) premises at all times.

11.4.14 If work is to be carried out on the LITS which necessitates the provision of safety precautions in accordance with the provisions of this section 11.4, the requesting safety coordinator who requires safety precautions to be provided shall contact the relevant implementing safety coordinator(s) to coordinate the establishment of safety precautions throughout the work.

11.5 Operating Instructions

11.5.1 The TSO may at its sole discretion delegate or issue Operating Instructions to agents of GCPs to perform required switching operations.

11.5.2 Operating instructions shall include, but not limited to:

(a) detailed switching sequences (which meet as a minimum, the requirements of the TSO's safety rules) to be followed;
(b) control and operational procedures; and
(c) identification of operational boundaries.

11.5.3 All switching operations for isolation and restoration of the complete transmission system equipment or circuit shall be recorded in the sequence of their performance in the logbooks of the parties concerned.

11.5.4 The TSO and GCP(s) shall maintain safety logs in which all messages relating to safety coordination shall be recorded in chronological order. The safety logs shall be retained for at least two years.

11.5.5 Before any work is carried out by a contractor at a LITS Node, the TSO and the relevant Transmission GCP shall ensure that contract personnel designated to work in such installations are either competent to work at such installations or are supervised by competent personnel.

11.5.6 When any safety precautions become ineffective for any reason the relevant safety coordinator shall inform the other safety coordinator(s) without delay of the loss of Integrity of the Safety Precautions and the reasons thereof.

11.6 Isolation and Grounding Principles

11.6.1 The TSO, the Transmission GCP and each connected GCP shall adopt isolation and grounding principles no less stringent than those outlined in this section 11.6.

11.6.2 Isolation shall be implemented by any of the following:

(a) a disconnect switch that is secured in an open position by a lock and affixing a safety tag to it or secured by such other method in accordance with the local safety instructions of the Transmission GCP or other GCP, as the case may be; or

(b) an adequate physical separation in accordance with the local safety instructions of the Transmission GCP or other GCP in addition to placing a safety tag at the switching points.

11.6.3 Where isolation is achieved by means of an isolating device, the device shall allow the isolating position to be maintained in a manner that minimizes the risk of inadvertent, accidental or unauthorized operation and that when put in this position, a notice or “tag” to that effect shall be attached.

11.6.4 Grounding shall be implemented by any of the following:

(a) a grounding switch secured in a closed position by a lock and with a safety tag affixed to it or secured by such other method in accordance with the local safety instructions of the Transmission GCP or other GCP as the case may be; or

(b) an adequate physical connection which shall be in accordance with the methods set out in the local safety instructions of the Transmission GCP or other GCP, in addition to a safety tag which shall be placed at this point of connection and all related switching points.

11.6.5 Where grounding is achieved by means of a grounding device, the grounding position shall be maintained in such a manner as to minimize the risk of inadvertent, accidental or unauthorized operation and that when put in this position, a notice or “tag” to that effect shall be attached.

11.6.6 The confirmation of grounding shall be recorded in the respective safety logs of the requesting safety coordinator and implementing safety coordinator.

11.6.7 The implementing safety coordinator shall ensure that the established safety precautions are maintained until requested to be removed by the relevant requesting safety coordinator.

11.7 Authorization for Testing

If a safety coordinator wishes to authorize a test on any LITS equipment, the coordinator shall carry out the test only after the following procedure has been implemented:

(a) Confirmation shall be obtained from the other safety coordinator(s) or other GCPs that no person is working on or testing or has been authorized to work on or test any part of the system within the points of isolation identified for the test;

(b) All safety precautions other than the current safety precaution have been cancelled; and

(c) The other safety coordinators or the other GCPs agree for the conduct of testing in that part of the system.

PART D: STANDARDS OF PERFORMANCE

Part D, the Standards of Performance, sets out the performance indicators and benchmarks for quality and reliability of supply. It also contains the sub-code for metering which describes the metering requirements of electricity flows injected into or off-taken from the LITS including the applicable standards and installation arrangements for metering. This Part further stipulates standards and requirements for data and information exchange among the various actors and outlines guidelines and requirements for periodic reporting to the LERC and other relevant authorities.

SECTION 12: BENCHMARKS AND INDICES FOR STANDARDS OF SUPPLY

12.1 Background, Purpose and Scope

12.1.1 Power system performance and reliability encompasses all aspects of providing reliable electricity supply to customers efficiently. The concept of reliability is described as "the degree to which the performance of the elements of the system result in power being delivered to customers within accepted standards and in the amount desired". This definition contains the concepts of adequacy and security.

12.1.2 Adequacy is *"the ability of the system to supply the aggregate power and energy requirements of the consumers at all times"* and Security is "*the ability of the system to withstand sudden disturbances*".

12.1.3 Reliability of a power system pertains to its ability to satisfy the load demand under the specified operating conditions and policies. A reliable power system, therefore, is one which only allows few interruptions to customers' services.

12.1.4 Pursuant to sub-section 12.1.3, reliability as regards the LITS is a measure of the ability of the LITS to adequately perform its designated functions given the conditions within which it must operate.

Purpose

12.1.5 The purpose of the Standards of Performance Sub-code of the LEGC is to:

(a) specify the various indices that are used to monitor the performance of the TSO and GCPs;
(b) define the minimum level of quality of electric power supply within the LITS;
(c) define the minimum reliability standards, benchmarks and performance targets for the LITS; and
(d) to provide GCPs with the basis to design, operate and maintain their systems and equipment to fit the environment within which they operate.

12.1.6 The reliability of the LITS shall be quantified in terms of the probability or frequency of encountering an outage or an inadequate state, or the period that a system spends in these states. Reliability may be evaluated in terms of the frequency, duration, and magnitude or severity (*in terms of impact on load curtailment)* of any adverse events or deviations from the stipulated service standards.

12.1.7 Maintaining acceptable reliability of the LITS means that the LITS is dimensioned and operated so that:

(a) the impacts of disturbance situations are minimized;
(b) there are provisions for restoring the LITS to the Normal state; and
(c) disturbance incidents are cleared as quickly as possible.

Scope

12.1.8 The performance standards prescribed in this Sub-code apply to the TSO and the following GCPs:

(a) a Generation GCP;
(b) a Transmission GCP;
(c) a Distribution GCP; and
(d) any other Demand GCP directly connected to the LITS.

12.1.9 The TSO shall monitor and report to the GCAC and the LERC on the performance of the LITS in terms of quality and reliability (i.e., adequacy and security) of supply.

12.2 Standards for Power Quality and Reliability

12.2.1 The quality of power supply shall be considered acceptable when none of the following conditions are present:

(a) the system frequency has deviated from the nominal value of 50 Hz by more than 0.2 Hz (≥ 0.4%) or otherwise contrary to the limits stipulated in Technical Schedule TS – F;
(b) voltage magnitudes are outside the allowable deviation of 5% of the nominal value or otherwise contrary to the limits stipulated in Technical Schedule TS–V;
(c) there is imbalance in the magnitude of the phase voltages or otherwise contrary to the limits stipulated in Technical Schedule TS–V;
(d) the phase displacement between the voltages is not equal to 120 degrees or otherwise contrary to the limits stipulated in Technical Schedule TS–V;
(e) voltage fluctuations that cause flicker are outside the allowable limits or otherwise contrary to the limits stipulated in Technical Schedule TS–V; or
(f) voltage harmonics exceed the limits stipulated in Technical Schedule TS–V.

12.2.2 The reliability of power supply from the LITS in any period is acceptable when the operating parameters used for assessment of quality of supply are within the limits provided in Technical Schedule TS–L.

12.2.3 Reliability performance targets shall be set for the LITS by the LERC based on benchmarks for indices provided in this Section 12 of the LEGC and in accordance with Technical Schedule TS–K.

12.3 Voltage Variations

12.3.1 The objective of voltage level and reactive power regulation is to:

(a) achieve the specified LITS voltage standards;
(b) prevent over-voltage and under-voltage situations which may pose a danger to equipment and the security of the grid; and
(c) minimize transmission system losses.

Voltage limits – Normal State

12.3.2 The voltage on each electrical bus at each LITS Node while the power system is in the Normal state shall be regulated to within ±5% of the nominal voltage and all bus-voltages and line-voltages shall remain within the prescribed limits, except under abnormal conditions such as the occurrence of a system fault outside of the design, planning or operating standards.

Voltage limits - Alert State

12.3.3 When the power system is in the Alert State, the voltages within the LITS shall be regulated to within ±10% of the nominal voltages and this situation shall not persist for more than ten (10) minutes.

Voltage limits - Emergency State

12.3.4 When the power system is determined to be in an emergency state, voltage levels within the LITS shall be regulated to within ±10% and this situation shall not persist for more than thirty (30) minutes.

Voltage unbalance

12.3.5 The phase voltages of a 3-phase supply at a LITS Node shall nominally be of equal magnitude and 120 degrees apart in phase angle. Deviations will result in decreased efficiency, negative torque, vibrations and overheating and when severe, voltage unbalance could lead to malfunctioning of some equipment.

12.3.6 Phase voltage unbalance shall not exceed one percent (1%) when the LITS is in the Normal State and two percent (2%) when in the Alert State.

Voltage harmonics & limits

12.3.7 Harmonics are sinusoidal voltages and currents having frequencies that are integral multiples of the fundamental frequency. Voltage harmonic distortions are grouped into three categories: odd triplens (multiples of the third harmonic), other odd harmonics, and even harmonics, with different severity levels and effects on equipment for each category.

12.3.8 The maximum permissible harmonic limits shall be as defined in IEC/TR3 61000-3-7 standard or the IEEE Standard 519-1992 -" Recommended Practices and Requirements for harmonic control in the electrical power system".

12.3.9 A GCP shall take preventive or corrective action, where necessary, to mitigate harmonic distortions and comply with the specified standard.

Voltage flicker

12.3.10 "Voltage Flicker" is a rapid change or fluctuation in voltage *(typically caused by consumer equipment)* that distorts or interferes with the normal sinusoidal voltage waveform of the transmission system due to a relatively large current inrush when customer equipment, such as a large motor, is suddenly switched on, or from the sudden increased demand from a welding equipment, for example. The current inrush acting over the network impedance is the mechanism that produces the voltage dip (sudden fall) and the corresponding voltage swell (sudden rise) when the equipment concerned is off-loaded. If the fluctuation is of a magnitude and frequency perceptible to the eye, it becomes flicker which could range from annoying to complete interference of normal activity.

12.3.11 Since voltage fluctuation on the LITS affects other users of the system, the TSO shall direct the management of flicker on its lines and station buses.

12.3.12 The maximum permissible voltage flicker limits shall be as defined in IEC/TR3 61000-3-7 standard or the IEEE Standard 519-1992 - "Recommended Practices and Requirements for harmonic control in the electrical power system".

12.3.13 A GCP shall promptly identify the sources of voltage flicker and voltage depressions that are more than the maximum permissible limits and implement corrective actions accordingly.

12.4 Reactive Power and Power Factor

12.4.1 Every generating unit shall be capable of operating within the power factor limits stipulated in Technical Schedule TS–P.

12.4.2 Upon the instruction of the TSO at any time, a generating unit shall be required to operate continuously to provide reactive power within the capability limits of the generating unit.

12.4.3 It is desirable that loads on the LITS have power factors at or close to unity as that represents the most efficient use of the LITS' capability and minimizes energy losses. A Distribution GCP, Large Consumer GCP or any other GCP that is off-taking power from the LITS shall operate its system to ensure that the power factor of its load, measured at the Connection Point does not fall below 0.90 lagging and shall not exceed unity.

12.4.4 Penalties in addition to compensation payment to the TSO shall be applied for loads whose power factor fall below the 0.90 limit at rates to be determined and published by the TSO with LERC approval from time to time based upon the load level and the burden for extra reactive power support imposed on the LITS.

12.5 System Frequency Limits

12.5.1 The TSO shall maintain system frequency within the LITS in accordance with Technical Schedule TS–F.

12.5.2 The TSO shall maintain system frequency between 49.8 Hz to 50.2 Hz, when operating the system in the Normal state. System frequency variations outside the prescribed limits shall be included in the LITS Performance Report in accordance with Technical Schedule TS–R only when the duration of the variation exceeds a continuous period of ten (10) minutes.

12.5.3 System operations outside the frequency range defined in sub-section 12.5.2 but within the range of 49.5 Hz to 50.5 Hz shall be permitted for a period of ten (10) minutes when operating the system in the Alert State.

12.5.4 All frequency excursions outside the limits and for a period exceeding the stated durations in sub-section 12.5.3 shall be considered as the LITS operating in Emergency State, and shall be included in the LITS Performance Report in accordance with Technical Schedule TS–R.

Frequency withstand capability

12.5.5 Every generating unit shall have the capability of operating in synchronism when the system frequency momentarily falls within the frequency range of 48.75 Hz to 51.25 Hz without automatically disconnecting from the LITS.

12.5.6 During emergency conditions, all generating units shall continue to be connected to the LITS provided the system frequency remains within the range stipulated in sub-section 12.5.5 except when doing so will result in damage to a generating unit.

12.5.7 A Generation GCP shall be responsible for providing adequate protection for its generating units against damage for frequency excursions outside the range specified in sub-section 12.5.5.

Load shedding scheme

12.5.8 All GCPs off-taking power from the LITS including Distribution GCPs and Large Consumer GCPs shall cooperate with the TSO to implement an automatic load shedding scheme to provide for load disconnection when system frequency decays.

12.5.9 The operations of the AFLS scheme as provided in sub-section 9.14.5 shall be defined from time to time by the TSO in consultation with other GCPs.

12.6 Protection Relays

12.6.1 Protective relay systems perform a critical service by detecting and initiating fault clearing thereby protecting the power system from prolonged voltage depression, transient instability, and equipment damage. The design and setting of protective relay systems requires a delicate balance between dependability and security. A relay system needs to be dependable enough to initiate a trip for all faults within its zone of protection and shall be secure enough to avoid initiating trips for faults that occur outside of that zone.

12.6.2 Pursuant to sub-section 12.6.1, protective relay systems shall be designed and maintained to operate at sufficiently high standards to minimize mis-operation.

12.6.3 The ability of a protection scheme to initiate the tripping of a circuit breaker associated with faulty equipment shall be measured by the *System Protection Dependability Index* and which shall not be less than 95%.

12.7 Monitoring and Reporting of LITS Performance

12.7.1 The performance of the LITS shall be assessed with reference to the following three defined ranges of voltage and frequency at each LITS Node:

(a) a “normal unlimited time operation” range which applies when the system is in a Normal State;
(b) a “contingency” range when the system is in the Alert State where continued operation is allowed for a period, although the system is not in a Normal state; and
(c) an “emergency” range when the system is in an “Emergency State” typically as the result of an emergency or multiple contingency condition such that operation is only permitted for a limited correction period and continued operation of the system in that range is not allowed.

12.7.2 A uniform system of recording and reporting of LITS performance shall be defined by the TSO in consultation with the GCAC and implemented by all GCPs.

12.7.3 The same equipment reliability indices shall be used for all LITS facilities in similar situations and the Performance Standards as set out shall also be applicable to all. The benchmarks for service delivery may however vary between LITS nodes because of differences in configuration, equipment redundancy and other local factors.

12.7.4 Subject to reporting requirements under section 14.11, the TSO shall compile and submit to the GCAC and the LERC every quarter and annually a System Reliability Performance Report for the LITS, giving details of the actual levels achieved in respect of the performance and reliability indices defined in this Sub-Code.

12.7.5 A copy of the System Reliability Performance Report shall be published or posted at the TSO's Website for access by all GCPs.

12.7.6 The performance of the LITS shall be evaluated by the TSO at quarterly, half-yearly and annual intervals, to compare the actual performance of the LITS with the benchmarks set by the LERC for that period.

Reliability performance indices

12.7.7 The LERC in consultation with the GCAC shall prescribe indices and benchmarks that shall be used to evaluate the performance of the LITS. Historical data for the past two years may be used to derive performance benchmarks to be specified for the reliability indices.

12.7.8 The following indices shall, at the minimum, be monitored and calculated for the purposes of assessing the performance of the LITS:

(a) System Average Interruption Duration Index (SAIDI) - Total duration of connection point interruptions in a period divided by the number of connection points in the system;
(b) System Average Interruption Frequency Index (SAIFI) - The average interruptions per connection point which is calculated by dividing the total number of interruptions at all system connection points by the number of connection points in the system;
(c) Unavailability - Percentage of time the entire transmission system (or a particular class or circuit) is not available for the transmission of electricity, and it shall be calculated as the sum of planned, unplanned, and disturbance outage durations divided by the total hours that the system or the relevant circuit should have been available in a given period; *[Availability = 1 – Unavailability]*
(d) Loss of Supply - A sustained disturbance on the transmission system, that results in the loss of electricity supply service to one or more customers. The cause of this disturbance can be initiated either by a distribution or transmission event, with the cause being noted, tracked and reported;
(e) System Minutes Lost - This index is calculated by dividing the amount of energy not supplied by the system peak demand for that year and expressing the value in minutes;
(f) Index of Transmission Reliability (ITR) - Represents the percentage of time that transmission circuits are available for the transmission of electricity from one terminal to another or others (ITR is a measure of unplanned unavailability of the transmission system. It is deduced by using outage time due to unplanned outages or disturbances on the system and excludes outage time due to planned outages); and
(g) Transmission Line Faults - Number of faults per 100 km of circuit lines.

Quality performance indices

Voltage & Power factor

12.7.9 The TSO shall report on the following for each LITS Node with respect to voltage and power factor deviations outside the limits stipulated for the Normal state:

(a) the number of occurrences of deviation incidents;
(b) the total duration of deviation incidents;
(c) the maximum continuous period of deviation; and
(d) the maximum and minimum values recorded indicating the time and date of occurrence.

Frequency

12.7.10 The TSO shall report on the following with respect to frequency deviations from both the normal and emergency limits stipulated:

(a) the number of occurrences of deviation incidents;
(b) the total duration of deviation incidents;
(c) the maximum continuous period of deviation; and
(d) the maximum and minimum values recorded indicating the time and date of occurrence.

Efficiency performance indices

12.7.11 The TSO shall report on the following with respect to energy balance within the LITS:

(a) total energy received, supplied and net energy at each LITS Node;
(b) energy used at each LITS Node; and
(c) Transmission Loss Ratio (TLR) which is calculated as the total transmission system losses divided by the total energy entering the LITS expressed in percentages.

Equipment loading reporting

12.7.12 The TSO shall identify the transmission circuits and power transformers that are loaded over 85% of their nameplate rating for more than 10% of total operating time each year and shall report this to the GCAC and LERC **annually** as part of the System Reliability Performance Report along with the plans to relieve such loading problems.

Event inclusions and exclusions for performance reporting

12.7.13 A power interruption shall include any outage which may be due to the tripping action of protective devices during faults or the failure of transmission lines and/or power transformers and which results in the loss of service to a GCP or a group of GCPs.

12.7.14 For the purpose of reporting on LITS reliability, the following shall be reported separately and excluded from calculations of indices:

(a) planned outages where GCPs have been notified in accordance with the relevant notification provisions contained in the Operations Sub-Code;
(b) outages caused by Force Majeure conditions; and
(c) outages due to fundamental shortage of generation capacity.

SECTION 13: METERING SUB-CODE

13.1 Background, Purpose and Scope

13.1.1 Section 13 of the LEGC sets out the requirements for standards, procedures and guidelines in respect of metering at a Connection Point within the LITS, to ensure accurate and transparent accounting, billing and settlement for power and energy transactions over the LITS from generation and trading sources, through transmission up to the points of bulk off-take of power and energy for distribution and consumption.

Purpose

13.1.2 The purpose of the Metering Sub-code includes the following:

(a) definition of the minimum acceptable accuracy and minimum standards for metering at the connection points of the LITS to facilitate energy accounting, billing and settlement which all constitute commercial transactions;
(b) setting out the provisions relating to design, specifications, installation, maintenance, testing and certification of metering facilities and equipment;
(c) description of the provisions relating to security and rights of access to metering data, settlement and auditing;
(d) specification of responsibilities and rights of:
    (i) the TSO as both market operator and responsible for system operations,
    (ii) GCPs in relation to ownership and management of metering systems,
    (iii) provision and use of metering data; and
(e) definition of procedures for resolution of metering disputes.

Scope

13.1.3 The Metering Sub-code covers transactions relating to interchange of power and energy that is:

(a) entering or exiting from the transmission system; and
(b) entering or exiting from a GCP's facility or network at the Connection Point.

13.1.4 The Metering Sub-code applies to:

(a) the Market Operator (MO)
(b) the TSO and
(c) GCPs, which in this Part includes the following:
    (i) Transmission GCPs,
    (ii) Generation GCPs directly connected to the transmission network,
    (iii) Distribution GCPs,
    (iv) Large Consumers directly connected to the transmission network, and
    (v) Traders (Import /Export Licensees) that engage in PPA/PSA transactions over the international interconnected tie lines.

13.2 General Metering Principles

13.2.1 The key principles underlying energy metering shall be as set out in this section 13.2.

13.2.2 A Connection Point at which energy is injected into or extracted from the LITS shall have a metering facility for the purposes of energy accounting.

13.2.3 Active and reactive energy and power demand shall be measured at all such Connection Points in the LITS to determine both the input and output quantities.

13.2.4 Two revenue metering facilities, Main Meter and a Check Meter, are required at the Connection Point.

13.2.5 Each metering facility shall measure power and energy flow and shall be arranged to ensure continuous recording even in the event of failure of one of the metering facilities.

13.2.6 The Main Meter shall be the revenue meter and the Check Meter shall be used to provide metering data when a revenue meter or its current transformer or voltage transformer is out of service as provided for under section 13.6.

13.2.7 The revenue metering facilities shall be located as close as practicable to the Connection Point.

13.2.8 The Transmission GCP or other relevant GCP shall provide adequate space in panels and rooms at substations or Connection Points for installation of the meters.

13.2.9 The Check Meter installation shall involve the provision of a separate metering facility using separate current transformer cores and separately fused voltage transformer secondary circuits, preferably from separate secondary windings.

13.2.10 The metering facility shall comply with the prescribed standards and equipment shall be manufactured to prescribed and internationally recognized quality standards.

13.2.11 A metering facility shall be:

(a) secure,
(b) registered with the TSO/MO, and
(c) capable of providing data for electronic transfer to a metering database maintained by the TSO/MO.

13.2.12 Energy meter data shall be based on units of watt-hours (for active energy) and var-hours (for reactive energy) and shall be collated at defined metering intervals.

13.2.13 A GCP is entitled to access the metering database in respect of its own production, demand or consumption of power and energy.

13.2.14 Historical data shall be maintained in the metering database for thirteen (13) months in accessible format and for six (6) years in archive.

13.2.15 The owner of a metering facility may replace its metering facility at any time after it has been installed, subject to the provisions of this Metering Sub-code.

13.3 Positioning of Main and Check Metering Systems

13.3.1 As a general rule, both the Main Metering System and the Check Metering System, will be located as close as practicable to the Connection Point. Where there is a material difference in location, an adjustment for losses between the location of the Metering System and the Connection Point will be calculated by the MO/TSO and agreed to by the GCP. Such loss adjustments may include transformer and line loss compensation resulting from the distance of the metering system to the physical location of the Connection Point.

Generating station meter locations

13.3.2 Main Metering System at a generating station shall be located at the actual Connection Point on the:

(a) HV side of the step-up transformer of the generating unit for energy fed into the LITS; and
(b) HV side of the station auxiliary transformer for Generation GCP's own energy consumption.

13.3.3 Check Metering at the generating station shall be provided either through:

(a) a Redundant Meter located at the same point as the Main Metering System as specified in sub-section 13.3.2; or
(b) Verification Metering with meter located at the Connection Point of each outgoing feeders of the generation substation.

Distribution GCP's network meter locations

13.3.4 Main Metering System *(at a distribution system Connection Point)* shall be located at the low voltage side of the substation power transformer that connects the distribution system to the LITS.

13.3.5 Check Metering at a distribution system Connection Point with the LITS shall be provided either through:

(a) a Redundant Meter located at the same point as the Main Metering System as specified in sub-section 13.3.4; or
(b) Verification Metering with meters located at each of the outgoing medium voltage distribution feeders; or
(c) Verification Metering with meters located at the high voltage side of the substation power transformer that connects the LITS with the distribution system, in exceptional cases where neither (a) or (b) could be applied.

Other Demand GCP system meter locations

13.3.6 Main Metering System shall be located at the actual Connection Point between the LITS and the Demand GCP facility or network.

13.3.7 Check Metering for a Demand GCP's Connection Point shall be provided either through:

(a) a Redundant Meter located at the same point as the Main Metering System as in sub-section 13.3.6; or
(b) Verification Metering with the meters located at each incoming feeder from the LITS into the substation.

International Interconnection line meter locations

13.3.8 Main Metering System shall be located at the Connection Point, at the Liberian side of the substation where the line interconnects with the LITS or in accordance with the Interconnection Agreement.

13.3.9 Check Metering shall be obtained in accordance with the Interconnection Agreement.

13.4 Ownership of Metering Systems & Associated Responsibilities

13.4.1 With the exception of metering systems for Generation GCPs, unless something different is agreed and authorized by the MO/TSO, all Main Metering systems and Redundant Check metering systems shall be owned by the Transmission GCP, and Verification Metering systems owned and provided by the other relevant GCP.

13.4.2 For Generation GCPs with generating units or plant directly connected to the LITS, Main Metering System and Redundant metering system shall be owned by the relevant Generation GCP, and the Verification Check metering systems owned by the Transmission GCP.

13.4.3 The Main and Redundant metering systems accounting for Generation GCP consumption from the LITS through an auxiliary transformer shall be owned by the Transmission GCP. A Verification Metering system shall be owned and provided by the relevant Generation GCP when required.

13.4.4 For International Interconnections with the LITS, Main Metering System shall be owned by the Transmission GCP (the NGC), unless something different is agreed in the relevant Interconnection Agreements. Ownership of Check Metering Systems shall be governed by the relevant Interconnection Agreement.

13.4.5 Owners of metering systems shall be responsible for investment, installation, maintenance, repair and replacement of metering equipment and the management of metering data collection at the Connection Point and transmission to the MO/TSO's Central Coordination Metering Database.

13.4.6 A Central Coordination Metering Database of all metering installations on the LITS shall be kept by the MO/TSO. It is the sole responsibility of the MO/TSO to ensure that this Central Coordination Metering Database is kept up to date. The MO/TSO shall formulate the appropriate processes to ensure this occurs by detailing procedures, timing of data collection from the GCP metering databases and general formatting as well as input fields of the database.

13.4.7 An owner may also have its own metering database that it keeps and tracks its local metering information and may utilize the services of any Metering Services Provider accredited by LERC for these purposes including installation, site inspections, technical audits and maintenance of the metering systems.

13.4.8 Regardless of ownership, the MO/TSO shall be responsible for approving the initial design, the testing, commissioning and sealing of any commercial metering system in the LITS.

13.4.9 A GCP who owns the substation where a metering equipment is located shall provide the MO/TSO with:

(a) 24-hour unrestricted access to the facilities where the metering system is located;
(b) adequate space for installing communications devices; and
(c) reliable power supplies.

13.4.10 Any remote communications to the metering equipment, meters, data registers, and databases will be the responsibility of the TSO including the operation and maintenance of the communication equipment, as well as the services associated with remote reading.

13.5 Metering Facility Features

13.5.1 A metering facility shall consist of some or all of the following features:

(a) current transformers;
(b) voltage transformers;
(c) a secure and protected wiring from the current transformer and the voltage transformer to the meter;
(d) a revenue class meter (Main and Check Meter) and a data recorder which may be internal (within the meter) or external to the meter or a combination;
(e) an appropriately constructed panel on which the meter and data logger are mounted with a facility to keep the metering facility secure from interference;
(f) a communication interface equipment such as modem, isolation devices, telephone service, radio transmitter and data link equipment;
(g) an auxiliary electricity supply to the meter;
(h) tests links and fusing;
(i) lightning protection;
(j) a totalizing equipment, integrating pulse recorder and time source; and
(k) a monitoring system to alert the TSO/MO of any failure of critical components of the metering facility.

13.5.2 In addition to conformity with the principles specified in section 13.2, a metering facility shall:

(a) contain a device which has a visible or an equivalent accessible display of, at a minimum, the cumulative total energy measured by that metering facility;
(b) be capable of separately registering and recording flows in each direction where bidirectional active energy flow occurs;
(c) provide for full four quadrant registering and recording of flows when active and reactive energy flow in both directions;
(d) be capable of communicating from the site of the metering facility to the metering database located at any site that may be specified by the TSO/MO; and
(e) include facilities for storing metering data for at least thirty-five (35) days.

13.6 Use of Meters

13.6.1 Data from the Main Meter shall be the primary source of metering data for billing purposes.

13.6.2 Check Metering can be obtained through Redundant Metering or Verification Metering as follows:

(a) Redundant Metering: the metering equipment is installed at the same Connection Point where the Main Meter is installed. In principle, Main and Redundant Meter measurements shall be coincident; and
(b) Verification Metering: the metering equipment or set of metering equipment is installed in different locations other than the Main Meter location, and whose measurements permit the verification of the Main Meter measurement through

simple calculations that eliminate the effect of the network element that could exist between them.

13.6.3 Check metering data shall be used for validation, substitution in the event of the failure of the Main Meter and account estimation of revenue metering data.

13.6.4 Energy consumed at a generating station and drawn from the LITS shall be measured by using a revenue meter and the Generation GCP shall pay for this energy.

13.7 Minimum Requirements for Metering Facility Equipment

13.7.1 Minimum standard requirements for a metering facility equipment are as specified in this section 13.7. A GCP may, at its own cost, install a metering facility equipment of higher-level accuracy.

Voltage Transformers

13.7.2 The voltage transformer (VT) of a metering facility equipment shall comprise three units from a three-phase set, each of which shall comply with the relevant provisions of the IEC 60044 Standard or its equivalent national standard for metering and corresponding to the accuracy class of 0.2.

13.7.3 The voltage drop in each phase of the voltage transformer connections of the same accuracy class shall not exceed 0.2V. The VT shall be connected only to a billing meter with a burden that shall not affect the accuracy of measurement.

13.7.4 A voltage changeover scheme shall be provided where more than one VT is available.

Current transformers

13.7.5 The current transformer (CT) of a metering facility equipment shall comprise three units for a three-phase set, each of which shall comply with the relevant provisions of the IEC 60044 Standard or its equivalent national standard for metering and corresponding to the accuracy class of 0.2.

13.7.6 The CT's rated secondary current shall be 1A or 5A. The neutral conductor of the CT shall be effectively grounded at a single point and shall be connected only to a billing meter with a burden that shall not affect the accuracy of measurement.

Meters

13.7.7 Meters shall be solid-state multifunction meters, of three-phase four-wire type rated for the required site, and shall comply with the updated and current versions of IEC 60687 and IEC 61268 Standards or equivalent national standards and correspond to accuracy classes as prescribed in Technical Schedule TS–H.

13.7.8 The meters shall measure and locally display at least the kW, kWh, kVar, kVarh and kVA parameters with features for pulse output.

13.7.9 Main Meter and Check Meter shall be connected to different sets of CTs and VTs.

13.7.10 A cumulative record of the parameters measured shall be available on the meter and where a bidirectional meter is used it shall have corresponding records available for both directions.

13.7.11 Where a combined active energy and reactive energy meters are provided, a separate record shall be provided for each measured quantity and direction.

13.7.12 The loss of auxiliary supply to the meter shall not erase the cumulative records.

13.7.13 A metering facility shall provide a pulse output for each measured quantity. The pulse output shall have the following characteristics:

(a) it shall be for a three-wire terminal with pulse duration in the range from 40 to 80 milliseconds, preferably selectable and with selective pulse frequency or rate;
(b) it shall have a minimum pulse frequency that complies with the IEC 60044 Standard or its equivalent national standard for the shortest integration period and the accuracy class of the meter; and
(c) it shall be galvanically isolated from the VTs and CTs being measured, and from the auxiliary supply input terminals.

13.7.14 A metering equipment shall be of proven quality, fully type tested, individually tested and accepted by the TSO/MO. Appropriate test certificates shall be kept by the TSO/MO or the Transmission GCP. All metering equipment shall be supported with evidence of approval from an accredited laboratory recognized under the International Certification Scheme.

Integrating Pulse recorders

13.7.15 Integrating pulse recorders of a metering facility equipment shall be capable of recording integrated demand periods adjustable between fifteen (15) minutes and sixty (60) minutes.

13.7.16 Each recorder shall be capable of transferring the data through communication channels to be provided to the metering database by the TSO. A RTU shall be installed at the meter location that can be interrogated by the data acquisition computer at the Dispatch Center.

13.7.17 The integrating pulse recorder shall provide a record for reference at a future time. The record shall be suitable for reference for a period of at least one (1) year after it is generated. The integrating pulse recorder shall be regularly interrogated and the (interrogation) record shall be maintained by the recorder for sixty (60) days.

13.7.18 The recorder's time and the meter's time shall be based on the UTC Standard time. The time reference used with the recorder shall ensure that the accuracy of the integrating pulse recorder is with a time error of no more than plus-or-minus one (±1) second.

13.7.19 Reprogramming of an integrating pulse recorder shall be done as soon as possible, within one billing cycle, if there is a time error.

13.8 WAPP Interconnections

All metering facilities at WAPP interconnection points shall, at the least, meet the requirements of the LEGC.

13.9 Metering Register

13.9.1 The TSO shall keep and maintain a Metering Register containing static metering information associated with metering facilities to facilitate the following:

(a) the registration of a Connection Point, metering point and the relevant GCPs;

(b) verification of compliance with the LEGC; and
(c) auditable control of changes to the registered information.

13.9.2 The content of the metering register will include, but not be limited to the following:

(a) a unique meter identification/serial number;
(b) location of the commercial meters and metering systems;
(c) the owner of each commercial meter;
(d) the identification of the GCP(s) concerned;
(e) meter manufacturer, type and model;
(f) specifications of the metering equipment including accuracy;
(g) the adjustment factors including circuit losses to be applied;
(h) metering system function (main, check, redundant or verification, export, import etc);
(i) organization which issued the certification of the meter and metering equipment; and
(j) the calibration and tests performed on the meters and/or the metering equipment at least during the last 5 years.

13.9.3 The TSO/MO shall update the metering register from time to time, to ensure that accuracy of the register is maintained.

13.9.4 Where the data/information in the metering register indicates that the meters or metering equipment do not comply with the requirements of this Sub-code, the MO/TSO will advise the owner of the non-compliance, and the owner will rectify the situation forthwith unless a derogation is granted under Section 4 of the LEGC.

13.10 Certification of Meter and Metering Equipment

13.10.1 Each GCP shall ensure that all meters and metering equipment for which it is responsible shall, at the Effective Date of the LEGC and thereafter, be certified, calibrated or compensated in accordance with the LEGC to meet the accuracy requirements stated in section 13.7 of the Sub-code.

13.10.2 Electricity meters may be purchased ready certified, in which case, independent certification shall be provided by the manufacturer.

13.10.3 Despite sub-section 13.10.2, the adequacy of any certification issued by a manufacturer shall require prior approval by LERC, which may require performing additional test or verifications by an authorized Meter Test Station.

13.10.4 Existing uncertified meters and metering equipment shall be replaced with certified meters or shall be tested to confirm that their accuracy conforms to the LEGC within the permitted recalibration interval by an authorized Meter Test Station for issue of the required certification.

13.10.5 All test requirements under sub-section 13.10.4 shall be performed not later than one (1) year from the Effective Date of the LEGC.

13.10.6 Certification of meters issued by an authorized Meter Test Station, or the approval issued by LERC in case of manufacturer-issued certifications, as the case may be, shall be issued for a pre-definite period not exceeding fifteen (15) years, and shall clearly indicate the

minimum required calibration tests and their frequency to maintain its validity during the period.

13.10.7 The minimum set of tests a manufacturer or an authorized Metering Test Station shall perform to verify compliance with this Metering Sub-code and issue the corresponding certification shall be in accordance with Appendix B of the LEGC.

13.10.8 The TSO/MO shall be granted access to such metering equipment upon reasonable notice and at reasonable times, in order to make or inspect any adjustments thereto and to witness any tests or participate in any inspection thereof required pursuant to this Sub-code.

13.11 Meter and Metering Equipment Testing

Instrument transformer testing

13.11.1 Testing of instrument transformers at the Connection Point shall be performed by the TSO and the relevant GCP during the test and commissioning stage and then at least once every five (5) years or as the need arises due to questions of accuracy.

13.11.2 All tests shall be carried out in accordance with acceptable international standards and the cost of the routine testing shall be met by the owner of the metering system.

13.11.3 An instrument transformer shall not be connected to a load beyond its rated burden and shall be operated at the optimum burden range to achieve maximum accuracy of the metering system.

13.11.4 Burden tests shall be conducted during commissioning, re-installation or relocation or when requested by the GCP or the TSO. Loading resistors for compensating low burdens may be allowed if the accuracy level is sustained.

Meter testing and calibration

13.11.5 The TSO and the GCP shall test the meters at least once a year and recalibrate or replace such meters if found to be outside the acceptable accuracy stipulated in the LEGC.

13.11.6 The TSO and the GCP shall notify each other, at least **seven (7) days** in advance, when the Main or Check meters are due to be tested and the cost of the routine testing shall be met by the owner of the metering system.

13.11.7 Suitable isolation facilities shall be provided to facilitate testing and calibration of the metering facility.

13.11.8 Suitable drawings and supporting information detailing the metering facility shall be made available for maintenance, testing and auditing purposes.

13.11.9 Test equipment used in the calibration of instrument transformers or meters shall be certified to values of accuracy and precision which are, at least, twice as accurate as the required accuracy of the equipment under test.

13.11.10 Solid-state watt-hour standards of 0.2% or better accuracy shall be used in the testing of watthour meters. All watt-hour standards shall be certified as accurate every twelve (12) months.

Request for tests

13.11.11 A GCP may request the TSO/MO to arrange for a test of any metering equipment where it has cause to believe that the performance of the equipment is not within the accuracy limits specified in the LEGC.

13.11.12 The requested test shall be carried out by an independent accredited agent appointed by the TSO/MO and approved by the parties. The test may be witnessed by the concerned parties if they so wish.

13.11.13 Where the metering equipment fails the requested test, the owner shall pay for the cost of the test; but where the meter equipment passes the test, the party who requested the test shall pay for the cost of the test.

Test failure

13.11.14 Where, following a test, the accuracy of the metering system is shown not to comply with the requirements of the LEGC, the certification issued for the meter or metering equipment which has failed the test will automatically expire, and a new one will be required.

13.11.15 The owner will at its own cost:

(a) consult with the TSO/MO and the relevant affected GCP regarding the errors found and the possible duration of the existence of the errors; and
(b) make repairs or replacements to the metering system to restore the accuracy to the required standards.

13.11.16 Where a metering system is found to be faulty, or non-compliant or outside the accuracy stated in section 13.7, then the owner shall inform the TSO/MO and GCPs that have an interest in this metering system of the failure. Such notification shall include the plans by the owner to restore the metering system to compliance with the LEGC and the procedures to be followed to determine any estimated readings during the restoration period, including any revised readings that were provided during the period that the metering system was faulty or non-compliant.

13.11.17 In the event that a GCP *(who is the owner of the faulty metering equipment)* cannot or does not comply with its obligations to repair, adjust or replace or renew a defective component, the TSO/MO or the relevant affected GCP shall have the right to carry out such repair, adjustment, replacement or renewal and to recover its own costs, expenses and profit thereon from the owner forthwith on demand (such profit to be based on a reasonable rate of return which shall be approved by LERC).

13.12 Maintenance of Metering Equipment

13.12.1 Maintenance of metering equipment shall only be performed at pre-appointed times after notice has been served to all interested parties.

13.12.2 Maintenance of the metering equipment at the Connection Point shall be performed by the respective owners of a Main Meter or the Check Meter in the presence of the other party who may have elected to be present.

13.12.3 All test results, maintenance programs and sealing records shall be kept for the life of the metering equipment and equipment data and test records shall be made available to authorized parties.

13.12.4 A meter shall be considered faulty only if it is determined that the meter does not comply with the prescribed accuracy standards.

13.12.5 Upon any observation by a GCP or the TSO that a meter may not be operating properly, the other party shall be notified, as soon as reasonably practicable of the existence of a fault and the length of time the fault may have existed.

13.12.6 The meter owner shall ensure that checks and appropriate repairs are made to the metering facility as soon as reasonably practicable after becoming aware of the fault or malfunction.

13.12.7 Until any meter or metering equipment affected by an outage, defect or malfunction is repaired, adjusted or replaced, the affected GCPs and the TSO/MO shall ensure that suitable proxy data is obtained or estimated and recorded for the period that the fault condition persists.

13.13 Metering Equipment Security, Meter Reading and Metering Data Access

13.13.1 The TSO/MO and the relevant GCPs shall provide seals and other appropriate devices to prevent or detect unauthorized interference with the metering facility equipment.

Sealing

13.13.2 Following the Effective Date of the LEGC, or following any test or inspection carried out according to section 13.11, all meters and metering equipment shall be sealed by or on behalf of the TSO/MO and, if necessary, the relevant affected GCP, except where sealing is impossible or impractical having regard to the physical and electrical configuration at each Connection Point.

13.13.3 Sealing shall be in accordance with the procedures stated in Appendix C.

13.13.4 No seal applied pursuant to this Sub-code shall be broken or removed except in the presence of, or with the prior consent, of the owner, the TSO/MO and, if appropriate, the affected GCP affixing the seal, or on whose behalf the seal has been affixed, unless it is necessary to do so in circumstances where:

(a) both Main and Check meters are malfunctioning or there occurs a fire or other similar hazard and such removal is essential and such consent cannot immediately be obtained *(in which case the person that has affixed the seal and has not given such consent shall be informed immediately thereafter);* or

(b) such action is required for the purposes of sub-section 13.11.17.

13.13.5 Where verbal consent is given under sub-section 13.13.4, it must be confirmed in writing forthwith.

13.13.6 All relevant GCPs shall ensure that physical access to meters and metering equipment is, where practicable, restricted to personnel who are required to have such access for the proper performance of their duties and have received permission for such access.

13.13.7 A record of any such access in sub-section 13.13.6 shall be maintained by the TSO/MO and the GCP on whose premises the meter and metering equipment are located, and copies of such records shall be provided to the relevant affected GCP upon request.

13.13.8 In addition all meters and metering equipment, where practicable, must be made secure, if necessary, by making the lock and keys subject to access restrictions similar to those in sub-sections 13.13.6 and 13.13.7.

13.13.9 Each GCP or TSO/MO shall control the issue of its own seals and sealing pliers bearing a distinctive mark and shall keep an accurate register of all such pliers and the authorized persons to whom they are issued.

Meter reading and access to metering data

13.13.10 The TSO/MO shall download integrating pulse metering data for each Connection Point at pre-defined intervals for billing and settlement purposes. Each GCP shall be provided full access to the data for its Connection Point.

13.13.11 The pulses from two or more meters may be combined into one integrating pulse recorder provided all the other requirements of this Sub-code are met.

13.13.12 The meter pulses that need to be integrated into the recorder are:

(a) active energy and active power demand, imported to and exported from the LITS; and

(b) reactive energy and reactive power demand imported to and exported from the LITS.

On-Site meter reading

13.13.13 Provision shall be made by the TSO/MO and GCPs to permit on-site as well as remote interrogation of the integrating pulse recorder.

13.13.14 Where on-site meter reading is necessary, it shall be witnessed by authorized representatives of all concerned parties including the relevant GCP whose consumption is measured by the metering system on the agreed date and time and as stipulated in the Connection Agreement or Amended Connection Agreement.

Electronic data transfer capability

13.13.15 All metering facilities shall have the capability of electronic data transfer.

13.13.16 The TSO shall provide appropriate security against corruption of data in transmission.

Restriction of unauthorized access to metering data

13.13.17 The TSO/MO and all GCPs shall take all reasonable measures to prevent unauthorized access and or possible alteration to settings and calibrations.

13.13.18 Only the owner of the metering system will change data and settings within its metering equipment and in the presence of:

(a) the MO/TSO, or its authorized representative or with the written agreement of the MO/TSO; and

(b) the relevant GCP, or its authorized representative or with written agreement of the relevant GCP.

13.13.19 Access to metering data by any GCP, including the provision of any remote access equipment required, will be at that GCP's cost, unless agreed otherwise in writing by the parties concerned.

Audit of Databases

13.13.20 The TSO/MO shall submit to an audit by the LERC when reasonably requested and shall allow access by the LERC or its officially appointed agent to the central database for the audit.

13.13.21 GCPs shall submit to an audit by the TSO/MO and/or the LERC when reasonably requested and shall allow access to all applicable Information for the audit to the TSO/MO, the LERC or an agent appointed by the TSO/MO or the LERC to carry out the audit.

13.14 Billing and Settlement Procedure

13.14.1 The billing and settlement procedure shall be as specified in the relevant PPAs and/or Energy Supply Agreements or in accordance with the MOR.

13.14.2 The TSO/MO and relevant GCPs shall agree to adjustments to metering data to account for system losses and unaccounted-for energy.

13.15 Settlement Audit Procedure

13.15.1 A GCP shall have the right to request for an audit of the settlement data related to its account and the right to choose an independent party approved by all concerned parties and qualified to perform the audit. Interested GCPs and the TSO shall cooperate in the auditing process.

Allocation of audit cost

13.15.2 The defaulting party following an audit conducted under sub-section 13.15.1 shall be responsible for all the costs of the independent auditor, unless otherwise agreed.

Audit results

13.15.3 The results of an audit conducted shall be issued in a report and discussed with the TSO/MO who shall issue a response to the Audit Report, including any adjustments in account billing and payments proposed.

Audit appeals

13.15.4 Where a GCP disagrees with the TSO/MO's response to the audit report, the TSO/MO's response may be appealed to the GCAC and the LERC.

13.16 Confidentiality

13.16.1 Metering data and associated metering database constitute confidential information and shall always be treated as such. The TSO/MO shall ensure that metering data is protected from access by unauthorized persons.

13.16.2 The TSO/MO shall not provide metering data from a metering facility to any person other than the metered entity to whom the data relates except when:

(a) the data must be supplied for law enforcement purposes;
(b) for the purpose of complying with a regulatory or legal requirement; or
(c) it is otherwise permitted by the LEGC.

SECTION 14: DATA AND INFORMATION EXCHANGE SUB-CODE

14.1 Background, Purpose and Scope

14.1.1 The TSO has an obligation to ensure that the LITS is operated in a safe, reliable and secure manner. To achieve this, the TSO shall obtain from and provide to GCPs power system data and information needed for the maintenance of system security. The exchange of data and information will enable GCPs to carry out their obligations and to meet statutory reporting requirements.

Purpose

14.1.2 The Data and Information Exchange Sub-code is based on the requirements of the LEGC and other statutory requirements. The Sub-code defines the reciprocal obligations of the TSO and GCPs regarding the provision of information and exchange of data for the implementation of the LEGC.

Scope

14.1.3 The TSO shall obtain from GCPs, the technical and operational information needed for the discharge of the TSO's responsibilities to provide open, fair and non-discriminatory access to the LITS for all GCPs.

14.1.4 The requirements of this Sub-code are complementary to any data and information exchange requirements defined or prescribed in other Sections of the LEGC.

14.2 Information Exchange Interface

14.2.1 The TSO shall designate an office as its contact office for the exchange of data and information pertaining to real-time operation of the LITS.

14.2.2 A GCP shall designate an office as its point of data and information exchange and shall provide the TSO with all the relevant details of contact for its offices.

14.2.3 A GCP shall identify the following for each type of information exchange:

(a) the name(s), title(s)/position(s) and contact details of the person(s) designated by the GCP to be responsible for provision of information;
(b) the name(s), title(s)/position(s) and contact details of the person(s) designated by the GCP to be responsible for requesting information; and
(c) the purpose for which the information is required.

14.2.4 GCPs shall agree on appropriate procedures for the transfer of information.

14.3 Implementation Principles for Data and Information Exchange

14.3.1 The TSO and all GCPs shall keep readily available, complete and accurate records of all data required for the proper administration of the LEGC.

14.3.2 The information exchanged between the TSO and a GCP may be either confidential (bilateral) information or public information intended for all parties. The provider of the information shall indicate whether the information being provided should be considered confidential or public.

14.3.3 The TSO shall make available critical data to allow a GCP to make rational and informed decisions regarding the operations of the LITS.

14.3.4 The TSO will provide open and timely exchange of relevant information among GCPs, to facilitate the secure and reliable operation of the LITS.

14.3.5 The TSO shall publish all relevant non-confidential information in a timely manner, or make them accessible by all GCPs, in an open and non-discriminatory manner.

14.3.6 In the case of electronic data sharing, access to LITS information shall be provided on read-only basis.

14.3.7 A GCP shall be responsible for the procurement and maintenance of the required communication systems as well as the data communication costs of its systems used for the purpose of data and information exchange.

14.4 Information Exchange Categories

14.4.1 The information requirements are generally divided into the following categories:

(a) planning information,
(b) operational information and
(c) post-dispatch information.

Provision of Information to the TSO

14.4.2 Despite (the categorization in) sub-section 14.4.1 the TSO may require information of a technical nature, to the extent not supplied under any other provisions of the LEGC, to be supplied by GCPs to enable it (the TSO) to undertake the following:

(a) analysis and evaluation of equipment and service performance of the LITS as well as the preparation of the LITS performance reports;
(b) survey of LITS conditions;
(c) assessment of risks to LITS operations;
(d) analysis of LITS equipment performance; and
(e) analysis and validation of policies of the LEGC.

14.4.3 The TSO shall, for the purposes of sub-section 14.4.2, send a written request to a GCP, setting out the information it reasonably requires, the preferred medium and format for the submission and the time by which it reasonably requires a response to the request.

14.4.4 A GCP shall use all reasonable endeavors to provide the required information in the required format and within the time stated.

14.4.5 Unless specifically provided in other Sections of the LEGC, communications with the TSO on all other matters shall be with the Head Office of the TSO.

14.5 Planning Information

14.5.1 A GCP shall provide on a regular basis such information as the TSO may reasonably request for the purposes of planning and development of the LITS and to enable the TSO to fulfil its statutory or regulatory obligations. GCPs shall submit the information to the TSO without unreasonable delay.

14.5.2 The planning information to be provided to the TSO shall be as specified in the Planning Sub-code and any other information which may from time to time be required.

14.5.3 The Transmission GCP shall provide other relevant GCPs with information about equipment and systems installed at HV transmission substations.

14.5.4 The TSO shall keep an updated technical database of the LITS for purposes of modelling and studies on the LITS.

14.5.5 The TSO shall provide Distribution GCPs and other Demand GCPs with any information that may be reasonably required for the proper planning and design of their networks to enable them to comply with their obligations under the Connection Sub-code.

14.5.6 A Distribution GCP or any other Demand GCP shall, upon a request to upgrade an existing connection or when applying for a new connection, provide the requisite information specified in the Connection Sub-code.

14.5.7 A Generation GCP shall submit to the TSO all maintenance planning information regarding each unit at each power station, as specified in the Operations Sub-code.

14.6 Operational Information

Commissioning information

14.6.1 Records of commissioning shall be maintained for reference by the GCP for the operational life of the plant and shall be made available, within **seven (7) days** to the TSO upon notification of such request.

14.6.2 The TSO shall keep commissioning records of operational data for the operational life of the plant connected to the LITS.

14.6.3 A GCP shall communicate changes made to a commissioned equipment during an outage to the TSO before the equipment is returned to service.

Network information exchange

14.6.4 A GCP shall promptly provide to the TSO, on request, network information that is considered reasonable for the security and integrity of the LITS.

14.6.5 The TSO shall communicate network information required for safe and reliable operation to the contact points designated by each GCP as required.

14.6.6 The network information exchange shall be both electronic and paper based and shall be within the timeframe agreed upon between the parties.

Generating plant performance data

14.6.7 A Generation GCP shall provide the TSO with the performance parameters of each generating unit at its power plant such as availability, reliability, capacity declaration etc. as detailed in the LEGC and the relevant Connection Agreement.

Demand GCP performance data

14.6.8 The performance measurements of all Distribution GCPs and other Demand GCPs shall be supplied to the TSO and the Transmission GCP in accordance with the relevant provisions of the Connection Agreement.

SCADA infrastructure

14.6.9 The information exchange shall support data from the SCADA system.

14.6.10 Each LITS node shall be accessible to the SCADA system which shall be used for storage, display and processing of operational data.

14.6.11 All GCPs shall make available outputs of their respective operational equipment to the SCADA system.

14.6.12 SCADA RTUs shall be installed in accordance with sub-sections 8.21.1 and 8.21.2 for the transmission of signals and indications to and from the TSO. The signals and indications which must be provided by GCPs for transmission by installed SCADA equipment are those specified in sub-section 8.21.5 of the Connection Code, together with such other data or information as the TSO may reasonably request, from time to time, by notice to GCPs.

14.6.13 All SCADA, metering, computer and communications equipment and the data or information carried by the LITS shall be secure from unauthorized access. Procedures governing security and access shall be agreed with GCPs but shall allow for adequate access to the equipment and information by the relevant GCP and TSO for the purposes of maintenance, repair, testing and recording of measurements.

14.7 Post-Dispatch Information

General post-dispatch information

14.7.1 The TSO shall provide all GCPs (and MO) with the following information on a daily basis regarding the post-dispatch performance over the LITS:

(a) Hourly system total MW loading;
(b) Hourly individual power station MW sent out;
(c) Hourly system constraints and constrained generation;
(d) Hourly international tie-line power flows; and
(e) Pre-determined system load flow data.

Generation settlement

14.7.2 The TSO shall provide generation balancing information to relevant GCPs (and MO) to facilitate generation settlement based on bilateral agreements and supported with appropriate metering apparatus of the relevant GCPs.

14.7.3 The GCPs that provided the balancing service as stated in sub-section 14.7.2 shall make this information available to the relevant (receiving) GCPs, within an agreed period and shall keep this information confidential if classified as such.

Ancillary Services settlement

14.7.4 The TSO/MO has the sole responsibility for securing ancillary services and accordingly shall request all data required for settlement of ancillary services from GCPs who shall make this information available to the TSO/MO, within an agreed period. Should this information be classified as confidential, GCPs shall treat it as such accordingly.

Additional unit post-dispatch Information

14.7.5 The TSO shall provide additional operational information regarding generating unit dispatch and overall dispatch performance as specified in Technical Schedule TS–X.

14.8 Time Standard

14.8.1 The time standard used shall be the UTC Standard and all information relating to time shall be referenced to it.

14.8.2 To maintain synchronization, each LITS node shall be provided with a connection to GPS satellite receivers that enable all relevant devices to maintain time synchronization.

14.9 Data Retention and Archiving

14.9.1 The TSO and all GCPs shall maintain sufficient records to support audit and verification requirements and to support monitoring of compliance with the provisions of the LEGC. They shall also maintain adequate data and records, in sufficient detail, to support event diagnostics and trouble shooting.

14.9.2 The TSO shall maintain a complete and accurate record of all operational data supplied or maintained under the LEGC.

14.9.3 All operational data shall be so maintained for a period of not less than five (5) years, commencing from the date the operational data was first supplied or first created, if earlier.

14.9.4 The TSO shall allow GCPs access to its records of operational data.

14.9.5 The obligations for data retention and archiving shall be the responsibility of the information owner.

14.9.6 The systems for the storage of data and information to be used by the parties shall be of their own choice and installed at their own cost.

14.9.7 The GCAC may at any time audit the data retention and archiving systems of GCPs and that of the TSO.

14.9.8 A GCP shall store operational information that is kept electronically for a period of at least five (5) years or for the life of the plant or equipment concerned, whichever is the longer.

14.9.9 A GCP shall ensure reasonable security against unauthorized access, use and loss of information. To this end, a GCP shall, among other things, develop and implement a backup strategy for the information system equipment.

14.10 Operational Communication and Data Retention Requirements

14.10.1 Adequate communication facilities and procedures shall be established between the TSO and each GCP to allow for the timely transfer of information.

14.10.2 The communication facilities for voice and data that are to be installed and maintained between the TSO and a GCP shall comply with the applicable IEC and ITU standards for SCADA and communication equipment.

14.10.3 The communication facilities shall support data acquisition from RTUs. The TSO shall be capable of monitoring the state of the LITS via telemetry from the RTU connected to a GCP's plant, facility or substation.

14.10.4 The TSO and GCPs may in place of the above systems adopt the use of new technologies and methodologies for communication of information, where there is a

recognizable benefit in quality, reliability and features and to do so would be reasonable in the circumstances.

Telephone/fax

14.10.5 Each GCP shall be responsible for the provision and maintenance of telephone and facsimile equipment as required.

14.10.6 A GCP shall provide no fewer than two separate Public Switched Telephone Network circuits to its control room.

14.10.7 A GCP shall provide no fewer than one facsimile unit, connected to a dedicated Public Switched Telephone Network at its Control facility.

14.10.8 The TSO may provide one or more telephone extensions to be connected to the TSO's private operational telephone system. This facility shall be reserved for operational purposes only and shall be attended by an authorized person and answered without delay. GCPs shall be responsible for optimizing the reliability and security of this telephone service.

14.10.9 The TSO shall install and operate a system for recording of all operational voice communication with GCPs. The historical archives of these voice recordings shall be available for at least six (6) months and shall be made available to authorized persons when required.

Computer equipment

14.10.10 A GCP shall provide appropriate Information Technology (IT) and data networking equipment to allow data exchange such as electronic mail, dispatch instructions, etc between the TSO and the GCP. The equipment shall only be used by the GCP for operational communications with the TSO.

File Transfers

14.10.11 The structure and format for data transfer shall be negotiated and defined by the supplier and receiver of the information.

14.10.12 The transfer media shall be mutually agreed by the parties involved.

14.10.13 The parties shall make adequate arrangements for data backup purposes to enable the recovery of information in the event of equipment or communication failure.

14.11 LITS Performance Data

14.11.1 The following LITS performance indicators and operational information shall be compiled and made available by the TSO to LERC, and to GCPs upon request, within the timeframes as specified in Technical Schedule TS– T:

(a) Daily:
  (i) Power and energy generation by each generating facility registered with the TSO;
  (ii) Hourly actual demand of the previous day in MW; and
  (iii) Reserve amounts during the morning and evening peaks of the previous day in MW.

(b) Monthly:

(i) Energy balance indicating internal generation, imports, exports, energy available for sale and transmission losses;
(ii) Generating plant Availability;
(iii) Number and total duration of frequency excursions outside statutory limits;
(iv) Number and total duration of voltage excursions outside statutory limits; and
(v) Outage time at each LITS Node.

(c) Annually:
(i) Annual energy balance for the year;
(ii) Annual peak demand in MW, date and time;
(iii) Annual minimum demand in MW, date and time; and
(iv) Outage time at each LITS Node.

14.11.2 A Transmission GCP shall make available all information collected via recorders installed at substations to the TSO for analysis. The TSO shall make this information available to affected GCPs on request.

14.11.3 The TSO shall publish **weekly** in accordance with Technical Schedule TS– T, a report on the power system performance for the previous week, including a report on Significant Incidents and operating conditions relevant to the operation of the LITS.

14.12 Events Reporting

14.12.1 In the case of a Significant Incident which has been notified by a GCP to the TSO, the GCP shall provide a written report to the TSO.

14.12.2 In the case of a Significant Incident which has been notified by the TSO to a GCP, the TSO shall provide a written report to all affected GCPs.

14.12.3 The reports referred to in sub-sections 14.12.1 and 14.12.2 shall, where applicable, address at least the following:

(a) time and date of Significant Incident;
(b) location;
(c) plant and/or equipment involved;
(d) brief description of the Significant Incident;
(e) estimated time and date of return to service;
(f) supplies/generation interrupted and duration of interruption;
(g) generating unit – frequency response achieved;
(h) generating unit – MVar performance achieved; and
(i) any other information that the TSO or GCP reasonably considers may be required in relation to the Significant Incident

14.13 Confidentiality Obligations

14.13.1 A GCP shall use all reasonable endeavors to keep as confidential any information classified as such and which comes into the possession or control of that GCP or of which the GCP becomes aware.

14.13.2 The information owner may request the recipient of the information to enter into a confidentiality agreement before information established to be confidential is provided.

14.13.3 A GCP shall not:

(a) disclose confidential information to any third party without the written consent of the owner or provider of the information.
(b) use or reproduce confidential information for any purpose other than that for which it was disclosed or for purposes contemplated by the LEGC; and
(c) permit unauthorized persons to have access to confidential information.

14.13.4 A GCP shall use all reasonable endeavors to prevent unauthorized access to confidential information which is in the possession or control of that GCP.

14.13.5 A GCP shall ensure that any person to whom it discloses confidential information observes the provisions for confidentiality in relation to that information.

14.13.6 A GCP shall report any unauthorized disclosure of information that is governed by a confidentiality agreement as soon as practicable after it has become aware of the unauthorized disclosure and shall provide all reasonable assistance to ensure recovery or destruction of that confidential information as may be deemed appropriate by the information owner or provider.

Exceptions to confidentiality of information

14.13.7 The confidentiality provisions in this section 14.13 of the LEGC do not prevent the disclosure, use or reproduction of information:

(a) if the relevant information is at the time generally and publicly available other than as a result of breach of confidentiality by a GCP or any person to whom the GCP has disclosed the information;
(b) by a GCP for the use of an employee or officer of the GCP or a related body corporate of the GCP, or a legal or other professional adviser, auditor or other consultant which require the information for the purposes of the LEGC, or for the purpose of advising the GCP;
(c) with the consent of the person or persons who provided the relevant information under the Code;
(d) to the extent required by law or by a lawful requirement of any government or governmental body, authority or agency having jurisdiction over a GCP or its related bodies corporate;
(e) if required in connection with legal proceedings, arbitration, expert determination or other dispute resolution mechanism relating to the LEGC;
(f) if required to protect the safety of personnel or equipment; or
(g) of an historical nature in connection with the preparation and submission of reports under the LEGC.

Disclosure of confidential information

14.13.8 A GCP who needs to disclose confidential information shall consult with the provider of the information prior to its release and inform those affected by the information disclosure.

PART E: RENEWABLE ENERGY PROVISIONS

Part E constitutes the Renewable Energy Sub-code which provides the basic technical performance requirements that a VRPP needs to comply with in order to connect its generating facility to the LITS in the Republic of Liberia. This Part defines the rules and minimum standards that the TSO and the Transmission GCP shall consider when connecting a VRPP to the LITS to ensure safe, reliable and secure operation of all facilities connected to the LITS.

SECTION 15: RENEWABLE ENERGY SUB-CODE

15.1 Background, Purpose and Scope

15.1.1 The ELL provides for the policy to promote the development of renewable energy resources in the electricity generation mix of the country using appropriate RETs. However, some RETs such as wind and solar PV present variable resource availability that should be harnessed. This requires the establishment of guidelines to facilitate the connection and dispatch of output from variable renewable energy sources to the LITS without degrading system operation, performance and security.

15.1.2 Significant deployment of these variable RETs can decrease total inertia on the system, thus increasing the need for frequency regulation but reducing the total regulation capability available.

15.1.3 The capability to withstand disturbances on the network which result in temporarily depressed voltages is critical in maintaining power system stability and in preventing exacerbation of disturbances leading to the risk of cascading outages. It is in this area that more stringent requirements have been applied for these RETs (Wind power and solar PV).

Purpose

15.1.4 This Section 15 of the LEGC specifies minimum grid connection technical and design conditions for a Variable Renewable Power Plant (VRPP) with Wind or Solar PV resource harnessing technology that is connected to or seeking connection to the LITS, in accordance with international best practices and standards so that they will be able to contribute to stability of the LITS.

Scope

15.1.5 The requirements in this Renewable Energy Sub-Code shall apply to all wind and solar photovoltaic RETs referred to as VRPPs with a design capacity of 2 MVA or larger connected or seeking connection to the LITS.

15.1.6 The provisions in the Sub-code constitute the basic technical performance requirements that a VRPP GCP needs to comply with to connect its generating facility to the LITS covering the following:

(a) the definition of rules and standards that the TSO shall follow when connecting VRPPs to the LITS; and
(b) the provision of guidance and basis for both the TSO and the VRPP GCP to cooperate through supply of necessary data and information about their systems to ensure safe, reliable and secure operation of the LITS and connected VRPPs.

15.1.7 A VRPP GCP seeking connection to the LITS shall comply with this Sub-Code in addition to all other applicable requirements in the other Sections of the LEGC.

15.2 Technical Connection Conditions

General

15.2.1 As a general rule in implementing this Sub-code, a VRPP GCP shall at all times comply with all applicable requirements and conditions of connection for generating units in the

other Sections of the LEGC and in accordance with its Connection Agreement with the TSO.

Frequency range of operation

15.2.2 A VRPP shall be capable of remaining connected to the LITS within the frequency ranges and for the specified periods in Table 1.

Table 1: Frequency Ranges of Operation (Must remain connected conditions)

Frequency range (Hz)	Minimum operation period
47.5 ≤ F < 48.75	90 minutes
48.75 ≤ F < 51.25	Unlimited (Continuous range)
51.25 < F ≤ 51.5	90 minutes
51.5 < F ≤ 52	15 minutes

15.2.3 A VRPP shall be allowed to disconnect from the LITS when it operates outside the frequency and for the time ranges specified in Table 1.

15.2.4 There shall be no technical restriction regarding the delivery of active power or reactive power within the frequency range of 49 Hz to 51 Hz and a VRPP shall be permitted unrestricted operation within this frequency range, except that high frequency response effects set in at frequencies >50.2Hz thus limiting active power output as shown in Figure 1 and in accordance with sub-section 15.4.7.

15.2.5 The minimum active power output that a VRPP shall be capable of delivering *(at various prevailing frequencies at the PoC)* is as shown in Figure 1. The frequency dependent power limits according to Figure 1 relate to the technical capability under the condition that sufficient primary energy of the RET (i.e. wind speed, solar irradiation) is available. Additional limits due to limited primary energy may apply but these limits are not frequency dependent.

Voltage Range of Operation

15.2.6 There shall be no disconnection of any unit of a VRPP module if voltage at the PoC remains within plus or minus ten percent (+/-10%) of the nominal voltage or within IEC-voltage limits for continuous operation *(referred to as the Continuous Voltage Range)*, whichever is the narrower voltage range.

15.2.7 There shall be no restrictions regarding the provision of active or reactive power when the VRPP is operating with voltage at the PoC between plus or minus five percent (+/-5%) of the nominal voltage, referred to as the *Unrestricted Voltage Range.*

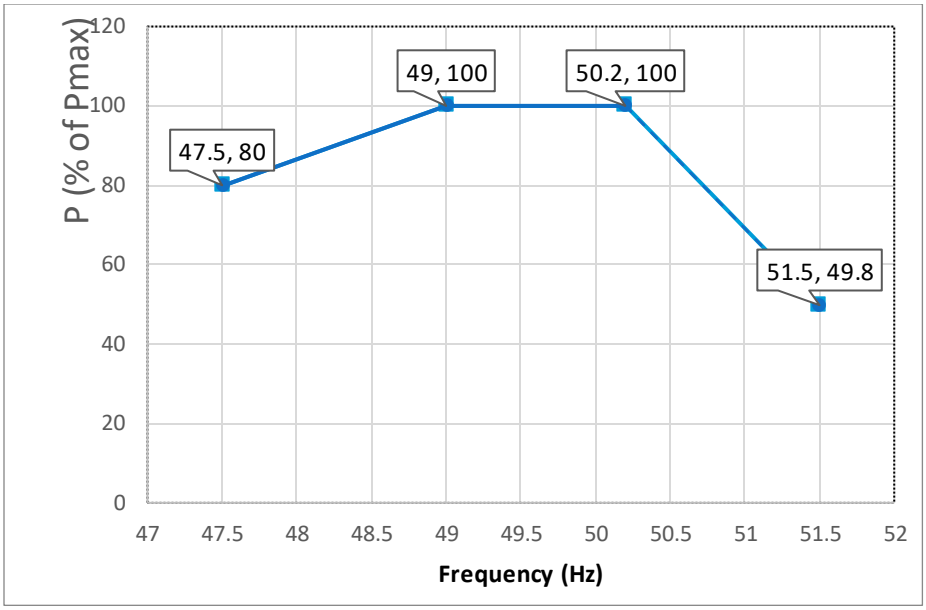


Figure 1: Maximum Active Power Capability as a Function of Frequency

Power Quality

15.2.8 The power quality of a VRPP shall be determined in terms of measurement of the following parameters at the PoC:

(a) Voltage variation and voltage unbalance;
(b) Flicker; and
(c) Harmonics.

15.2.9 A VRPP shall ensure that the power it injects into the LITS is within the limits prescribed in the subsequent provisions for each of the parameters listed in sub-section 15.2.8.

Voltage variations and Voltage unbalance

15.2.10 Voltage variations at the PoC resulting from regular switching operations *(such as switching operation on a wind turbine within a wind farm or switching of a shunt reactor/capacitor)* within the VRPP shall not deviate more than two percent (2%) of the nominal voltage.

15.2.11 The maximum permitted voltage change at any point within the VRPP's network (or system) shall be limited to five percent (5%) of the nominal voltage in respect of changes resulting from:

(a) switching of several units within a VRPP;
(b) connection of a complete VRPP; or
(c) disconnection of a complete VRPP.

15.2.12 A VRPP shall not cause phase voltage unbalance exceeding one percent (1%) in the Unrestricted Operation Range and two percent (2%) when in the Continuous Operation Range and shall also be capable of withstanding the same in the LITS.

15.2.13 Voltage unbalance shall be measured in terms of negative sequence voltage in percent of nominal voltage.

Flicker

15.2.14 The TSO shall apportion flicker emission limits to each VRPP using the methodology specified in IEC 61000-3-7 and based on flicker planning levels according to:

(a) Technical Schedule TS–V of the LEGC;
(b) existing background flicker levels;
(c) possible future installations; and
(d) the total size of a VRPP to be connected.

15.2.15 In the absence of any flicker limits apportioned by the TSO, flicker caused by a VRPP shall not exceed the emission limits (HV-EHV) of 0.3 for both *Pst* and *Plt* parameters.

Harmonics

15.2.16 The TSO shall apportion individual harmonic distortion limits to each VRPP using methodology specified in IEC61000-3-7 and based on a planning level for THD according to:

(a) Technical Schedule TS–V of the LEGC,
(b) existing background flicker levels,
(c) possible future installations and
(d) the total size of a VRPP to be connected.

15.2.17 In the absence of any apportioned limits issued by the TSO, harmonic voltage distortion limits at the PoC as prescribed in Table 2 shall apply.

Table 2: Harmonic Voltage Distortion limit for LITS-connected generators

Voltage at PoC (kV)	Individual Voltage Distortion (%)	Total Voltage Distortion-THD (%)
36 < V ≤ 66	3.0	5.0
66< V ≤ 225	1.0	1.5

Reactive Power Capability

15.2.18 A VRPP shall operate within a power factor range of 0.95 leading to 0.95 lagging, measured at the PoC.

15.2.19 A VRPP shall be capable of varying power factor continuously in the entire range of 0.95 under-excited to 0.925 over-excited during operation with maximum active power output and voltage within the Unrestricted Voltage Range of operation.

15.2.20 A VRPP shall be capable of varying reactive power at the PoC within its reactive power capability range as defined by Figure 2, when operating within the Unrestricted Voltage Range and at an active power output level between five percent (5%) and a hundred percent (100%) of the rated power.

15.2.21 The VRPP module shall be designed in such a way that when operating under conditions specified in sub-section 15.2.20, the operating point can lie anywhere within its maximum and minimum capability (within the blue boundaries) according to Figure 2. [*These reactive power limits will be reduced pro rata to the amount of plant in service.]*

15.2.22 If voltage is outside the Unrestricted Voltage Range but within the Continuous Voltage Range the reactive power capability limits of a VRPP shown in Figure 2 can be adjusted to the voltage dependent limits according to Figure 3.

15.2.23 The voltage dependent limits adjustment requirement in sub-section 15.2.22 applies once automatic tap changer(s) of the grid transformer(s) or any switched shunts in the VRPP module have operated. In the period(s) that the automatic tap changer is not functional the VRPP module is required to reduce active power export so that reactive power capability can be provided.

15.2.24 In the case of operation with active power below five percent (5%) of P_n, there is no reactive power capability requirement but, in this range, reactive power must be within the tolerance range of plus or minus five percent (+/-5%) of P_n, specified by points **A** and **B** in Figure 2. Point **A** is equivalent (in MVar) to minus five percent (–5%) of rated output and point **B** is equivalent (in MVar) to plus five percent (+5%) of rated output.

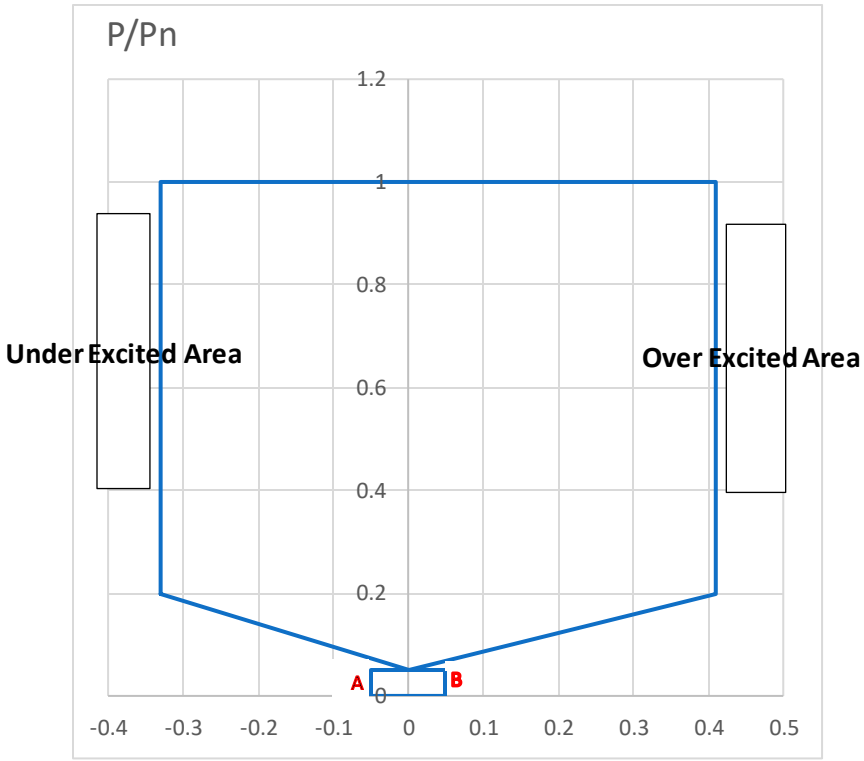


Figure 2: Reactive power requirements for LITS connected VRPPs at Unrestricted Voltage Operation Range mode (full/partial active power output conditions)

[Note: Pn in MW corresponds to the rated installed capacity of a VRPP minus the sum of the installed capacity of all units being temporarily out of service (e.g. on maintenance).]

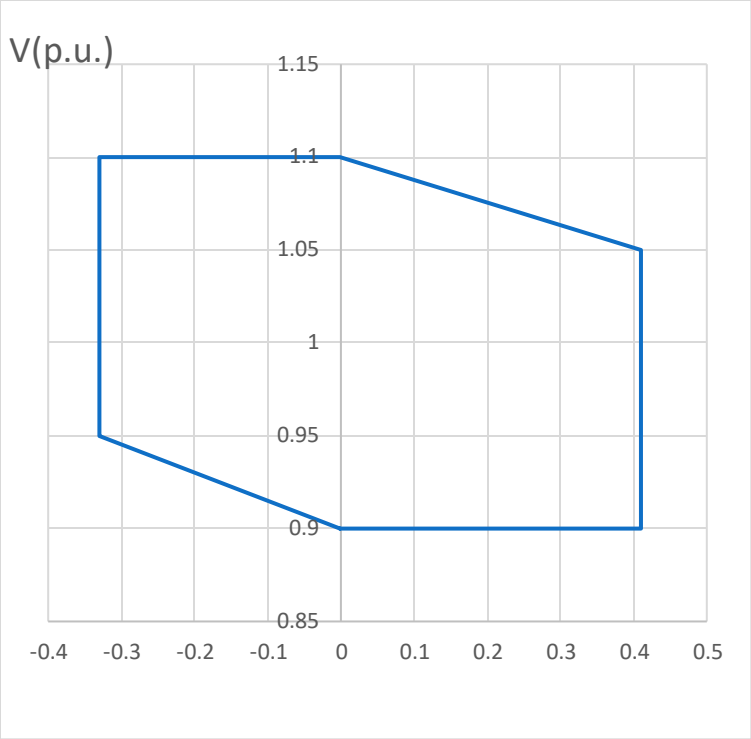


Figure 3: Reactive power requirements for LITS connected VRPPs corresponding to voltage (for different Connection Point voltages outside the Unrestricted Voltage Operation range)

15.3 Reactive Power Control and Voltage Control Requirements

General

15.3.1 A VRPP shall be equipped with the following functions using set points and gradients to execute, upon instruction from the TSO:

(a) reactive power control functions capable of controlling the reactive power supplied by the VRPP module at the PoC; and
(b) a voltage control function capable of contributing to voltage support at the PoC.

15.3.2 The parameter settings shall be agreed between the TSO and the VRPP GCP or shall be as documented in the relevant System Operations Manual.

15.3.3 The following control functions shall each be supported by a VRPP:

(a) Voltage control;
(b) Q control; and
(c) Power factor control.

15.3.4 The control function and applied parameter settings (or target values) for reactive power and voltage control functions shall be determined by the TSO and implemented by the VRRP GCP.

15.3.5 The agreed control functions and initial parameters together with possible range of target values shall be documented in the Connection Agreement.

Voltage droop control

15.3.6 Voltage Droop Control is a control function which helps to control the voltage at the PoC based on a target and slope (droop) approach.

15.3.7 A VRPP shall be able to perform the voltage control function at the PoC within its dynamic range and voltage target specified by the TSO in accordance with the droop-characteristic defined in Figure 4. Droop in this context, is the percentage change in voltage from the voltage setpoint which will cause a change in reactive power exchange from zero to a Q_{max}, or zero to Q_{min} as appropriate.

15.3.8 When the TSO choses a "droop" characteristic, the "droop" shall be specified by the maximum voltage change in per unit (p.u.) at maximum reactive power output (Q_{max}).

15.3.9 If the voltage control target is changed by the TSO, such change shall be completed within the timescale specified in sub-section 10.17.4 after the receipt of the new set-point value.

15.3.10 The maximum permitted deviation of the actual voltage from the target voltage shall be no greater than zero-point-five percent (0.5%) of the nominal voltage, that is 0.005 p.u.

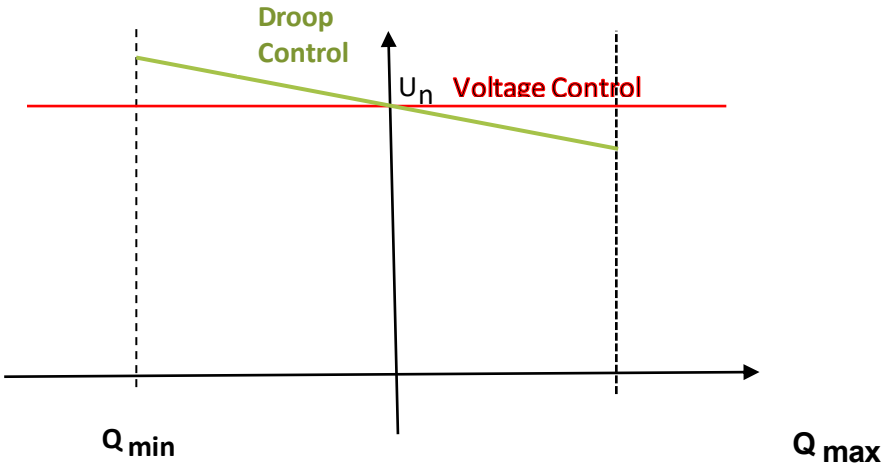
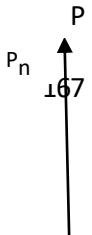


Figure 4: Voltage Droop Control for LITS-connected VRPP

15.3.11 When the VRPP attains its dynamic design limits, the control function shall maintain this position (maximum or minimum reactive current) and await possible overall control from the tap changer or other voltage control functions. A VRPP should be designed not to trip at this time unless permitted to do so by the TSO as per section 10.17 of the LEGC.

Reactive power control (Q control)

15.3.12 A VRPP shall be capable of controlling reactive power at the PoC (Q control) either to a constant reactive power target (Q-target) or an active power dependent reactive power target [Q(P)] as illustrated in Figure 5 where the vertical, light-blue line (independent of active power) represents an example of Q-target control or the green line (in function of active power) represents an example of the Q(P) control.



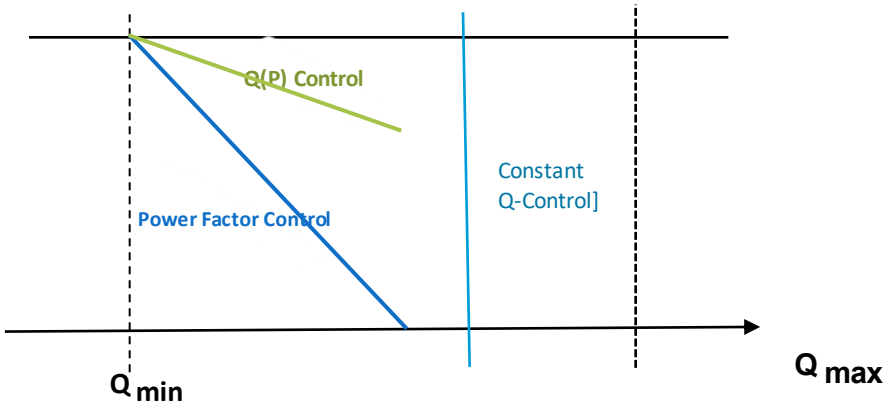


Figure 5: Reactive Power & Power Factor Control functions for the VRPP module

15.3.13 The TSO shall define the actual settings of the Q/ Q(P) control characteristic (shape of the Q(P)-characteristic, target values) which will always start from unity power factor (i.e. zero MVar).

15.3.14 If the control target is changed by the TSO, such change shall be completed within the timescale specified in sub-section 10.17.4 after receipt of the new target value.

15.3.15 The maximum permitted deviation of actual reactive power from the Q-target shall be no greater than two percent (2%) of rated power, that is 0.02 p.u., beyond which the automatic control system should act to restore the operating point on to the characteristic within two (2) minutes after change of Q-target during steady system conditions.

Power factor control (cosφ-control)

15.3.16 Power factor control is a control function controlling the reactive power to maintain a constant power factor at the PoC.

15.3.17 A VRPP shall be capable of controlling power factor at the PoC either to a constant power factor target (cosφ-target) or an active power dependent power factor target (cosφ(P)) as illustrated by the blue line in Figure 5.

15.3.18 The TSO shall define the actual settings of the cosφ or cosφ(P) control characteristic [cosφ-target or the shape of cosφ(P)-characteristic].

15.3.19 If the control target is changed by the TSO, such change shall be completed within the timescale specified in sub-section 10.17.4 after receipt of the new target value.

15.3.20 The maximum permitted deviation of actual power factor from the cosφ-target shall be no greater than $\Delta\cos\varphi=0.005$, beyond which the automatic control system should act to restore the operating point on to the characteristic set cosφ-target within the timescale specified in Section 10.17.

15.4 Active Power Curtailment of a VRPP Output

15.4.1 It may be necessary for the TSO to curtail a VRPP's active power output for system security reasons.

15.4.2 A VRPP module shall be capable of setting an active power curtailment set point given in MW to limit active power following receipt of an instruction from the TSO.

15.4.3 If the TSO issues an instruction to a VRPP GCP to set an active power curtailment set-point, the GCP shall begin to respond to the new set-point within two (2) minutes and should ramp to the new active power curtailment set-point at the ramp rate agreed with the TSO within plus or minus one percent (±1%) accuracy of deviation from the rated power set-point.

15.4.4 Any active power curtailment set-point shall apply until such times as the TSO releases the active power curtailment set-point.

15.4.5 The type of communication between the TSO and a VRPP GCP shall be in accordance with Section 14 of the LEGC (Data and Information Sub-code) or otherwise must be agreed between the parties and specified as part of the Connection Agreement (as prescribed in sub-section 15.9.4).

High frequency active power reduction requirement for VRPPs

15.4.6 During high frequency operating conditions within the LITS, each VRPP shall be required to operate at a mandatory reduced active power output to stabilize grid frequency.

15.4.7 When the frequency on the LITS exceeds 50.2 Hz, each VRPP shall be required to reduce active power as a function of change in frequency as illustrated in Figure 6.

15.4.8 High frequency response must operate with a minimum ramp rate of 100% of rated power per minute as provided by the primary frequency control time scales.

15.4.9 The required reduction in active power output should commence within two (2) seconds of the frequency exceeding 50.2 Hz and be continuously and linearly proportional as far as it is practicable to the characteristic in Figure 6.

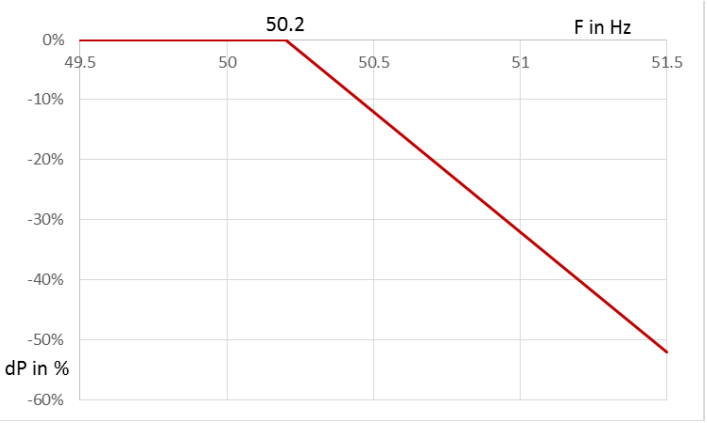


Figure 6: Mandatory high frequency response for all LITS connected VRPPs

Primary and secondary frequency control

15.4.10 Unless otherwise required by the TSO, a VRPP is exempted from primary or secondary frequency control capabilities except for high frequency response according to sub-section 15.4.9.

15.5 Behavior of VRPP During Abnormal Voltage Conditions

Fault Ride-through Requirements

15.5.1 Fault ride-through refers to the ability of a VRPP to remain connected during a system voltage disturbance. Four main characteristics typically provide the requirements for VRPPs in the event of a voltage disturbance:

(a) Conditions for which the VRPP must remain connected;
(b) Active power provision during a fault;
(c) Voltage support requirements during the disturbance; and
(d) Restoration of active power after the fault has been cleared.

Remain-connected voltage conditions

15.5.2 A wind or solar PV VRPP shall remain connected to the LITS for voltage disturbances on any or all phases, where the system phase voltage measured at the connection point remains above a specified level for a specified length of time.

15.5.3 The remain-connected requirements take the form of a 'voltage verses time' profile as illustrated in Figure 7 which dictates the level of voltage drop or increase that a VRPP must be capable of withstanding along with the time for which the voltage drop or increase should be endured.

15.5.4 *Area A* shows that the VRPP shall be able to operate continuously between voltages of 0.9 p.u. and 1.1 p.u. and shall stay connected to the network and uphold normal production.

15.5.5 *Area B* is the area between the LVRT Bound and the bottom of the continuous operating range, at 0.9 p.u. In Area B the VRPP shall stay connected to the network. As illustrated in Figure 7 the VRPP shall be able to withstand voltage drops to zero, measured at the PoC for a minimum period of 0.15 seconds without disconnecting. Less severe voltage drops result in an increase in the length of endurance time of the connected VRPP, and just below 0.85 p.u. the voltage drop shall be endured for nearly two (2) seconds. At 0.85 p.u. the voltage drop shall be endured a minimum of three (3) seconds.

15.5.6 *Area D* is the area between the HVRT Bound and the top of the continuous operating range, at voltage of 1.1 p.u. In *Area D* the VRPP shall stay connected to the network and as illustrated in Figure 7 the VRPP shall be able to withstand voltage increases up to 1.2 p.u. for at least two (2) seconds.

15.5.7 *Area C* (below the LVRT Bound) and *Area E* (above the HVRT Bound) respectively at voltages below 0.9 p.u and above 1.2 p.u and outside the continuous operating range, are the areas where disconnection of the VRPP is allowed.

15.5.8 If the voltage reverts to the Continuous Voltage Range (between 0.9p.u and 1.1p.u) during a fault sequence (e.g. resulting from reclosing), subsequent voltage drops or voltage spikes shall be regarded as new LVRT or HVRT condition. If several successive fault sequences occur and the voltage remains outside of the normal voltage operating range, the successive series of faults shall be considered as one continuing fault condition.

Active power provision and reactive current flows during fault

15.5.9 During a voltage dip the controllable VRPP shall provide active power in proportion to retained voltage and maximize reactive current to the LITS without exceeding its declared limits.

15.5.10 The maximization of reactive current during a fault shall continue for at least six hundred milliseconds (600 ms) or until the voltage recovers to within the normal operational range of the LITS, whichever is the sooner.

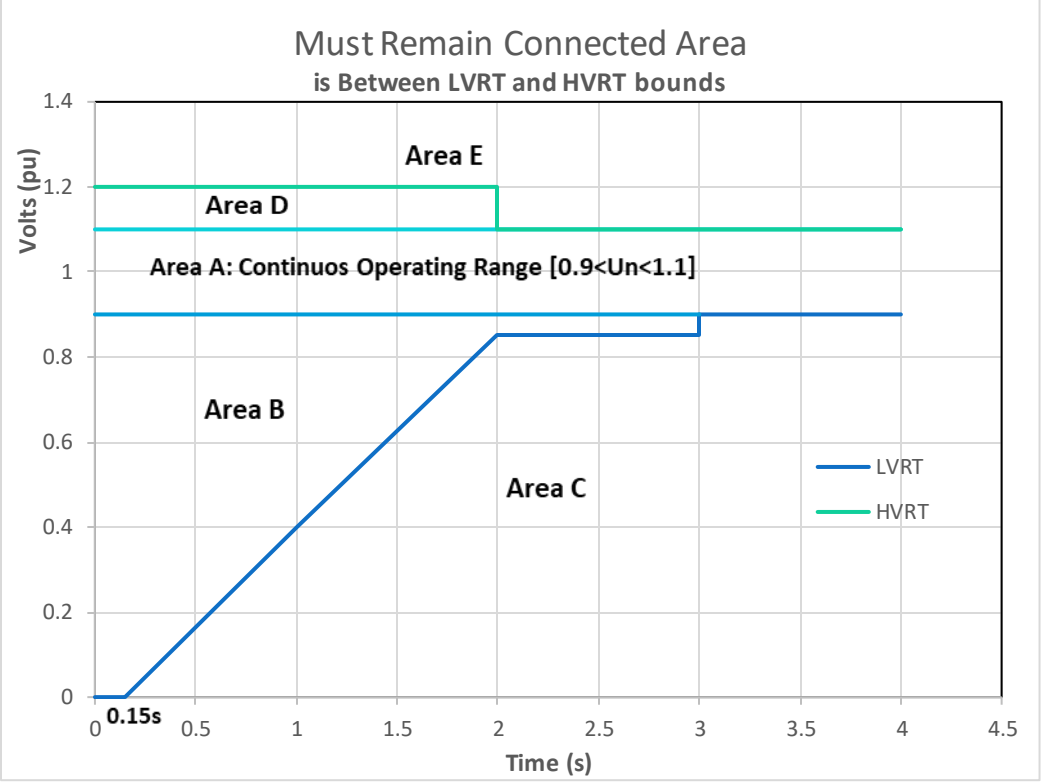


Figure 7: LVRT and HVRT capability for LITS connected VRPPs

Reactive current support of voltage during LVRT/HVRT situations

15.5.11 During LVRT and HVRT situations, both symmetrical and asymmetrical, all the units of a VRPP shall support the voltage by injecting or absorbing additional reactive current ΔIq at the generator terminals proportional to the change of the unit's terminal voltage ΔV_t, as shown in Figure 8.

15.5.12 The factor of proportionality between additional reactive current and voltage deviation is named K ($\Delta Iq = K\Delta V_t$) and the factor K must be settable in the range of $0 \leq K \leq 10$.

15.5.13 The absolute value of current (I) in each of the three phases of the unit's terminals may be limited to rated current (1 p.u.).

15.5.14 During dynamic performance, after sixty (60) milliseconds the additional current must have settled, meaning that it shall remain within a tolerance band of plus-or-minus twenty percent (±20%) around the value according to Figure 8.

15.5.15 During LVRT and HVRT conditions, the active current (I_P) shall be reduced in proportion to the voltage change ΔV_t.

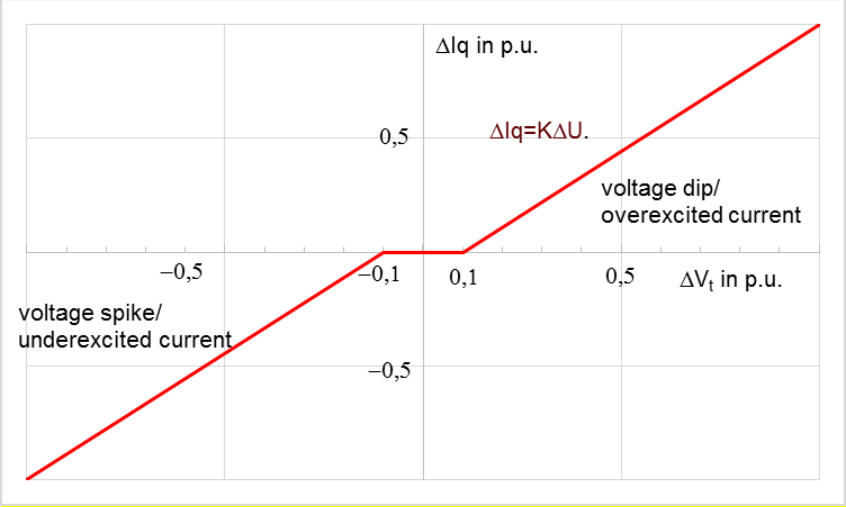


Figure 8: Reactive current support ΔIq during LVRT and HVRT situations at the unit's terminals

Notes:

1. Voltages and currents in this section 15.5 are defined to be positive sequence components of fundamental frequency value of voltages and currents respectively. This applies to pre-fault and post-fault voltages and currents.
2. The additional reactive current ΔIq shall be injected in addition to the pre-fault voltage.
3. The positive sign of ΔIq in Figure 8 is voltage supporting injection of reactive power.
4. The voltage deviation ΔV_t is defined by the difference between the pre-fault and the post-fault voltage.
5. The pre-fault current and pre-fault voltage are defined by the one-minute average of current and voltage respectively.

Active and reactive power recovery after fault

15.5.16 The controllable VRPP shall provide at least ninety percent (90%) of its maximum available active power as quickly as possible and in any event within one second (1s) of the voltage recovering to the normal operating range.

15.5.17 During voltage recovery, a VRPP shall not absorb more reactive power than prior to the LVRT situation.

15.6 Automatic Synchronization Capability

15.6.1 A VRPP GCP shall install an automatic synchronization device and automatic close equipment that enables the connection of a VRPP to the LITS automatically, with a delay of five (5) minutes if the LITS is in a Normal state as defined in sub-section 9.8.1 of the LEGC.

15.6.2 During automatic connection or synchronization, a VRPP GCP must ensure compliance with “rapid voltage change” requirements prescribed in sub-sections 15.2.10 and 15.2.11 of this Sub-code.

15.7 Protection and Fault Levels

15.7.1 A VRPP GCP shall design, implement, coordinate and maintain its protection system to ensure the desired speed, sensitivity and selectivity in clearing faults on the VRPP’s side of the PoC.

15.7.2 Protection functions required for protecting the LITS from getting out of normal operating ranges as provided in the relevant parts of the LEGC will be specified by the TSO, including trip-settings, response times for over- or under-voltage protection, and over- or under-frequency protection.

15.7.3 A VRPP shall be equipped with effective detection of islanded operation in all system configurations and shall have the capability to shut down generation of power in such condition within two (2) seconds.

15.7.4 The islanded operation of a VRPP with part of the LITS is not allowed unless specifically agreed with the TSO.

15.7.5 The coordination among protections at the Connection Point must be agreed between the TSO and the VRPP GCP.

15.7.6 The circuit breaker used for connection switching of a LITS-connected VRPP shall be equipped with a disconnection system to ensure safe operation during re-connection or re-synchronization to the LITS.

15.7.7 The TSO may request that the set values for protection functions of a VRPP be changed following commissioning if it is deemed to be of importance to the operation of the LITS, except that, such a change shall not result in a VRPP being exposed to negative impacts from the LITS falling outside of the design requirements.

15.7.8 The TSO shall inform a VRPP GCP of the highest and lowest short-circuit current that shall be expected at the PoC as well as any other information about the LITS as may be necessary to define the VRPP's protection functions.

15.7.9 Where a VRPP’s protection equipment is required to communicate with the TSO’s protection equipment it must meet the communications interface requirements specified by the TSO in accordance with this Sub-code as well as section 9.20 and other relevant Sections of the LEGC.

15.8 VRPP Impact on System Reserve Requirements

15.8.1 Increasing penetration of wind and solar PV VRPPs can increase the need for various kinds of reserves. The variability of a VRPP’s output requires higher levels of both planning and operating reserves to offset the greater chance of being or going off-line when needed.

15.8.2 VRPPs also contribute little or no inertia to the system, increasing the need for frequency regulation, which may lead to a need for higher levels of spinning reserve requirements for the LITS.

15.8.3 The TSO shall take into account the factors mentioned in section 15.8. when establishing both planning and operating reserve requirements for the LITS.

15.9 Communication and Control

15.9.1 A VRPP shall be equipped to receive target values for control purposes from the TSO such as voltage or reactive power control according to section 15.3, active power curtailment according to section 15.4 and other control functions as may be applicable.

15.9.2 A VRPP GCP shall be responsible for providing data relating to MW forecast and availability estimates of a VRPP, at least for prediction intervals of 2 days-ahead, 1 day-ahead and 4 hours-ahead of real-time.

15.9.3 The data mentioned in sub-section 15.9.2 shall be made available to the TSO by a VRPP GCP on a daily basis by means of an electronic interface in accordance with the reasonable requirements established by the TSO according to the Data and Information Exchange Sub-code of the LEGC.

15.9.4 All additional requirements with regard to exchange of information not addressed in this Sub-code and other Sections of the LEGC will be agreed between the TSO and a VRPP GCP in the Connection Agreement.

Requirement for VRPP SCADA communication capability

15.9.5 A VRPP GCP shall provide SCADA with the capability to transmit data and receive instructions from the TSO in accordance with section 8.21 of the LEGC to protect system reliability.

15.9.6 A VRPP GCP shall install equipment necessary to automatically communicate to the TSO the expected and real-time renewable generation output and data for the purposes of generation forecast.

PART F: DEFINITIONS

Part F, the Definitions, provides meanings and definitions for special words and technical terms used in the text to bring out the meanings in the context that they have been used in the LEGC.

In this Liberia Electricity Grid Code (LEGC), unless the context otherwise requires—

Access	means the contracted right to use an electrical system to transfer electrical energy.
acre-foot	means the volume of water that will cover one acre to a depth of one foot and is a unit for measuring the volume of water. One acre –foot equals 325,851 gallons or one million gallons equals 3.07 acre –feet.
active energy	means the electrical energy produced, flowing or supplied by a electric circuit during a time interval, being the integral with respect to time of the instantaneous active power, measured in units of Watt-hours or standard multiples thereof: i.e. 1000Watt-hours = 1 Kilo Watt-hour (kWh) 1000 Kilo Watt-hour = 1 Mega Watt-hour (MWh) 1000 Mega Watt-hour = 1 Giga Watt-hour(GWh) 1000 Giga Watt-hour = 1 Tera Watt-hour (TWh).
active power	means the product of the components of the alternating current and the voltage that equate to true power which is measured in units of watts and standard multiples thereof, for example: 1000 Watt = 1 Kilo Watt (kW) 1000 Kilo Watt = 1 Mega Watt (MW) 1000 Mega Watt = 1 Giga Watt (GW) 1000 Giga Watt = 1 Tera Watt (TW).
adequacy	means the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.
aerial plate	means a number plate to aid the aerial observer to identify the transmission tower.
alternating current	means an electric current that reverses its direction of flow at periodic intervals, of 50 times per second.
ammeter	is an electrical instrument, with a scale usually graduated in amperes, placed in a circuit to measure the magnitude of electric current.
ampere (amp)	is a unit of measure of an electric current and is proportional to the quantity of electrons flowing through a conductor past a given point in one second.
ancillary service	means a service necessary to support the transmission of energy from supply sources to loads while maintaining reliable operation of the transmission system in accordance with Prudent Utility Practice and these services include voltage control, operating reserves, black start capability and frequency control.
Arc	is the discharge of electricity through gas occurring across a gap or set of electrodes.
Arcing	is the process of current flowing across a gap, such as fault current flowing across an insulator string that flashed over due to a lightning surge.
Asset Owner	means a person who owns the whole or part of the LITS or any facility connected to the LITS.
automated meter reading system	means a system capable of reading the data from a meter preparing and conditioning the data and transmitting the accumulated data from the meter location to a central data and accumulation device.
Automatic Generation Control	means the regulation of the power output of electric generators within a control area in response to changes in load, system frequency, and other factors to maintain the scheduled system frequency and interchanges with other control areas.

Automatic Voltage Regulator	means the continuously acting automatic equipment controlling the terminal voltage of a synchronous generating unit by comparing the actual terminal voltage with reference value and controlling by appropriate means the output of an exciter, depending on the deviations.
availability	is a measure of time a generation unit, transmission line or other facility is capable of delivering energy to the transmission system at the delivery point or of providing ancillary services to the transmission system.
availability declaration:	means a notice that declares the availability of the relevant facility.
availability factor	means a percentage representing the number of hours an equipment or unit is ready for or in service in a given period, compared to the number of hours in the period.
basic insulation level	means a design voltage level for electrical apparatus that refers to a short duration (1.2x50 microseconds) crest voltage - used to measure the ability of an insulation system to withstand high surge voltage.
black start capability	means the ability of a generating unit to start and synchronize to theLITS without using supply from the power system.
Large Consumer	means a customer that purchases or receives electric power or energy of the amount or level specified by the LERC or end users who consume more than a threshold number of kilowatt hours as defined by the regulations.
bus	is an electrical conductor which serves as a common connection for two or more electrical circuits and is used to interconnect equipment of the same voltage. A bus may be in the form of rigid bars or in the form of stranded conductor overhead cables held under tension.
capability	means the maximum load a generator, piece of equipment, substation, or system can carry under specified (standardized) conditions for a given time interval without exceeding approved limits.
capability curve	means a curve developed for generators showing the limits of reactive and active power that a generator can produce without overheating or becoming unstable.
capacity	means the rated continuous load-carrying ability, expressed in megawatts (MW) or megavoltamperes (MVA) of generation, transmission, or other electrical equipment.
capacity factor	means the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.
cascading outage	is the occurrence of an uncontrollable succession of outages, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it. The tendency of a local line fault to trigger problems elsewhere on the system and lead to a widespread power outage.
Check Meter	is a meter installed by the transmission customer which provides the source data for comparison with the Main Meter.
circuit	means a conductor or a system of conductors through which an electric current flow or is intended to flow.
circuit breaker	is a protective device located on a circuit to interrupt the flow of current at that particular point and used to disconnect from a power system which experiences an electrical fault or overload.

combined cycle	means the use of a combustion turbine and a steam turbine in an electrical generating plant so that the waste heat from the combustion cycle provides heat energy for the steam cycle to increase its thermal efficiency of the entire system.
combustion turbine	means a turbine that generates power from the combustion of a fuel.
commissioning test	means a test conducted on equipment that is being connected to the grid for the first time or after modification or major maintenance.
Committed Project Planning Data	means data relating to a proposed GCP development at the time that the GCP commits to a Connection Agreement or an Amended Connection Agreement.
compensation	means the use of devices like capacitors or voltage regulators to improve performance of an electric system with respect to some specified characteristic.
conductor	is a material through which electricity is transmitted, such as an electrical wire, or transmission or distribution line.
Connected Project Planning Data	means the data which replaces the estimated values that were assumed for planning purposes with validated actual values.
Connection Agreement	is an agreement between the TSO and a GCP that seeks connection of its facilities to the LITS and sets out the rights, obligations and liabilities of both parties.
Connection MOU	is an MOU between the TSO and the GCP required to be negotiated and signed prior to commencement of construction of the connection to the LITS.
connection point	is the point of physical linkage to or with the transmission network for the purpose of enabling the flow of electricity as the boundary between the transmission system and a facility or other equipment.
connection point drawing	means the drawings prepared for each Connection Point, which indicate the equipment layout, common protection and control, and auxiliaries at the Connection Point.
Connection Proposal	means the document required to be submitted to the TSO for the purpose of a new connection to the LITS.
constraints	means the physical and operational limitations on the transfer of electrical power through transmission facilities.
contingency	means the possibility of a fault or equipment failure in a power system.
Continuous Operation Range	means network frequency or voltage operating range, outside normal range of operation, within which no generating unit is allowed to disconnect and where power output restrictions may exist.
control action	means an action, like switching by which the Transmission System is operated.
control area	means an electric power system or a combination of electric power systems bounded by interconnection metering and telemetry, capable of controlling generation to maintain its interchange schedule with other such areas and contributing to frequency regulation of the interconnection.
control center	means the facility from which a power system is monitored and regulated where dispatchers use computerized displays to match generation with load and to respond to faults in the system.

control system	means the method of monitoring and controlling the operation of the power system or equipment including generating units connected to a transmission or distribution network.
control room	same meaning as in 'control center'.
Current Transformer (CT)	means an instrument transformer, with its primary winding connected with the conductor carrying the current to be measured, which gives an accurate low-current indication in its secondary winding of the high amperage current in its primary winding. The low-current output is used for relaying, metering and indication.
customer	means a person that contracts for an electricity service
demand	means the rate at which electric energy is delivered to or by the System or part of the System and is the sum of both active and reactive power, unless otherwise stated.
demand forecast	means predicted demand for electric power. A forecast may be short term (e.g., 15 minutes) for system operation purposes, long-term (e.g., five to 20 years) for generation planning purposes, or for any range in between. A forecast may include peak demand, energy, reactive power, or demand profile. A forecast may be made for total system demand, transmission loading, substation/feeder loading, individual customer demand, or appliance demand.
Demand GCP	Means a distribution company or large consumer or customer that has facilities or equipment directly connected to the LITS to offtake power and energy.
demand profile	is the hour-by-hour profiles of demand as at each Bulk Supply Point; demand management means the instructions by the TSO for the purposes of balancing the load with generation.
derogation	Means authorized directions from the LERC exempting or relieving a TSO or GCP from its obligation to comply with specific aspects of the provisions of the LEGC for a specified duration.
dispatch	means the operating control of an integrated electric system to (a) assign specific generating units and other sources of supply to meet the power demand as load rises or falls; (b) control operations and maintenance of high voltage lines, substations and equipment, including administration of safety procedures, (c) operate interconnections; (d) manage energy transactions with other interconnected control areas; and (e) curtail power demand to balance generations.
Dispatch Day	means the day assigned on a daily basis by the TSO for the forecast generation and dispatch of power and energy to meet demand.
dispatch instruction	means an instruction given by the Grid Company from its System Control Centre to the Generator's approved contact person or location to change the output, fuel or manner of operation of the Generation Unit.
Distribution Company	means a person licensed under the ELL to distribute and sell electricity without discrimination to consumers in an area or zone designated by the LERC.
Distribution GCP	means a distribution company with distribution network or facility connected to the LITS to offtake power and energy.
distribution network	means a system of electric lines and associated equipment (generally at nominal voltage levels of 36 kV or below) , which that Distribution

	.Company is licensed to use to distribute electricity for supply under its distribution license excluding public lighting assets.
disturbance	means an unplanned event that produces an abnormal system condition or any occurrence that adversely affects normal power flow in a system.
dynamic instability	means a condition that occurs when small undamped oscillations begin without any apparent cause because the Grid is operating too close to an unstable condition.
earthing	means a way of providing a low impedance connection between conductors and the earth by an earthing device which is in accordance with the requirements of the local safety instructions.
ECOWAS Energy Protocol	means the protocol signed by the Authority of the Heads of State and Governments of the ECOWAS on January 6, 2003, which establishes a legal framework in order to promote long term cooperation in the energy field based on complementarities and mutual benefits with a view to achieving increased investment in the energy sector and increased energy trade in the West Africa Sub-Region.
electrical diagram	means a schematic representation, using standard electrical symbols, which shows the connection of equipment or power system components to each other or to external circuits.
electrical energy loss	means the energy loss in an electric system, consisting of transmission, transformation, and distribution losses between sources of generation and ultimate consumer.
elements of the power system	includes generating units, transmission lines, transformers, circuit breakers and switches.
embedded generation	means production of electricity utilizing a generation facility that is electrically connected directly to a distribution system and for which the total output of the facility is distributed and utilised locally without any requirement for use of the national interconnected transmission system.
emergency	means any abnormal system condition that requires automatic or immediate manual action to prevent or limit loss of generation supply or transmission facilities that could adversely affect the reliability of the electric system.
Emergency Transfer Capability	means the overall capacity of interregional or international power lines, together with the associated electrical system facilities, to transfer power and energy from one electrical system to another under emergency conditions.
energize	is the action of connecting a component to a source of power by the movement of an isolator, breaker or switch enabling it to transfer active and reactive power.
energy storage	means the process for storing, or converting energy from one form to another, for later use.
Equipment Identification	means the system of numbering or nomenclature for the identification of equipment at the connection points in the LITS.
event	means an unscheduled or unplanned occurrence on, or relating to, a system including, faults, incidents and breakdowns.
event reporting	is the procedure set out for reporting events.
fault	is an event occurring on an electric system such as a short circuit, a broken wire, or an intermittent connection.
feeder	means an electrical supply line, either overhead or underground, which runs from the LITS Node. It is the start of a distribution circuit, usually less

	than 36000 volts, which carries power from the substation. Also, a line from a generating plant or an interchange point between a transmission system and a load or distribution system.
firm	means guaranteed or assured.
flicker	means a fast fluctuation in voltage leading to quick intermittent coming on, of an appliance and gives the impression of unstable visual sensation induced by a light stimulus with luminance or spectral distribution that fluctuates with light.
force majeure	means superior force that is unexpected or uncontrollable event and which upsets plans or releases a person from fulfilling an obligation.
forced outage	means removal of service of the temporary de-rating of, restriction of use of, or reduction in performance of, equipment other than those specified as a scheduled outage.
frequency	is the number of alternating current cycles per second (expressed in Hertz) at which a system is running.
frequency control	means the retention of the frequency on the power system within acceptable limits.
frequency regulation	means the automatic adjustment of active power output by a generation unit, initiated by free governor action in response to continuous minor fluctuations of frequency on the power system.
gas turbine	means a combustion turbine that converts energy of hot compressed gases (produced by burning fuel in compressed air) into mechanical energy that can be used to generate electricity.
generation company	means a wholesale supplier with electric generation facilities to produce power and energy.
generating unit	is an equipment or plant for producing energy from other forms of energy
generation (electricity):	is the process of producing electric energy from other forms of energy expressed in watthours (Wh).
generation facility	means a facility comprising of generating unit(s) and equipment for producing electric energy from other forms of energy expressed in watt-hours (Wh).
Generation GCP	means a generation company with generation facility(ies) connected to the LITS for production and injection of power and energy.
generation schedule	means a statement prepared by the TSO setting out which generating units are anticipated to be required to ensure, so far as practicable, that the integrity of the Transmission System, the security and quality of supply and that the generating units assigned are sufficient to meet demand at all times (to extent practicable) together with an appropriate margin of reserve.
governor control system	is the automatic control system which regulates the speed of the power turbine of a generating unit through the control of the rate of entry into the generating unit of the primary energy input (for example, steam, gas or water).
grid	means an interconnected network of transmission lines of the LITS including associated equipment for the transfer of electric energy between points of supply and points of demand.
Grid Code	means this code that contains the technical and operational rules of practice and standards of performance rules developed and approved by the LERC to facilitate the operations related to the bulk transmission of electricity within the LITS.

Grid Code Participant (GCP)	A Wholesale Supplier or VRPP operator, Transmission asset owner (NGC), Distribution Company or Large Consumer with facilities that are connected to the LITS as provided in sub-sections 1.3.2 and 1.3.3 of the LEGC.
harmonic	means a sinusoidal wave having a frequency that is an integral multiple of a fundamental frequency.
high voltage	is descriptive of transmission lines and electrical equipment with voltage levels greater than 36 kV.
imbalance	is a condition where the generation and interchange schedules do not match demand.
impedance	is a characteristic of an electric circuit that determines its hindrance to the flow of electricity and measured in ohms.
inadvertent interchange	means the difference between a control area's net actual interchange and net scheduled interchange.
Individual Harmonic Distortion (IHD)	is the ratio between RMS value of the individual harmonic content and the RMS value of the fundamental voltage expressed in percentage. $IHD = \sqrt{(Vi^2 / V_1^2)} * 100\ \%$ V_i = Voltage component of harmonic order i; V_1 = Voltage component of fundamental frequency (@50 HZ).
insulator	means a material usually a ceramic ,porcelain, elastic polymeric rubber, or fiberglass when used in the transmission line and is designed to support a conductor physically and to separate it electrically from other conductors and supporting material.
interchange	means electric power or energy that flows from one entity to another.
interchange schedule	consists of an agreement between the TSO and the GCP on the amount, start and end times, ramp rate, and degree of firmness for the purpose of an arrangement to transfer electric power.
Interconnected System	is a system consisting of two or more individual electric systems that normally operate in synchronism and that have connecting tie-lines.
interconnection transmission lines	means the linkage of transmission lines between two utilities, enabling power to be moved in either direction.
interruptible load	means load which can be automatically disconnected by the use of under frequency relay or other means.
inter-tripping	means a method in which operation of a protection equipment at one end of a circuit causes a signal to be transmitted to trip a circuit breaker at the remote end of the circuit.
island	means a portion of a power system or several power systems that is electrically separated from the interconnection due to the disconnection of transmission system equipment.
Isolating device	means a device which ensures the disconnection of equipment from the remainder of the network.
isolation	means the disconnection of equipment from the remainder of the network in which the equipment is situated by either of the methods specified in sub-section 11.6.2 of the LEGC.
Liberia Interconnected Transmission System (LITS)	means an interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or to other electric systems.

line voltage	means the voltage present between any two of the conductors in a three-phase system.
load	means the amount of power carried by a utility system or subsystem, or amount of power consumed by an electric device at a specified time.
load factor	is the ratio of the actual electrical energy produced/consumed to the possible maximum electrical energy that could be produced/consumed in any defined period.
load flow studies	means computer simulations of the transmission system, with representations of the complete electrical transmission system along with loads and different generation schedules to meet the loads and used by engineers to study various operating conditions and to plan future system additions to assure reliable service to customers.
load following	means an electric system's process of regulating its generation by selected generators to follow the changes in demand.
load forecasts	means predicted demand for electric power which may be short-term like for a duration of one hour for system operation purposes or long-term for five to twenty years for generation planning purposes.
load management	methods to reduce or reshape or redistribute electrical loads to match available resources designed to influence the timing and amount of electricity that customers may use and it generally attempts to shift loads from peak periods to low use periods.
load shedding	is the process of deliberately removing pre-selected loads from a power system, usually done automatically by relays, in order to maintain the integrity of the system under unusual conditions.
local safety instructions	means the safety instructions of the TSO or a GCP as applicable.
losses	means electric energy losses in the electric system which occur principally as energy transformation from kilowatt-hours (kWh) to waste heat in electrical conductors and apparatus.
low voltage	is descriptive of electricity supply lines and equipment with voltage levels up to 1000V (1KV).
Main Distribution Frame (MDF)	means an interface panel for process signals.
Main Meter	is the meter installed by the TSO which provides source data for the accounting and billing function for LITS supply and services.
maintenance outage	means the removal of equipment from service availability to perform work that can be deferred for a while, but requires the equipment be removed from service before the next planned outage.
Market Operation Rules (MOR)	means the rules for operation of the electricity wholesale (supply) market as provided for in regulation 50(3) of the ELR, as amended from time to time, and approved by the LERC.
major event/incident	means any forced outage, malfunction or fault of an equipment or apparatus that results in 10% or more customers losing electricity supply from the LITS.
medium voltage	is descriptive of electricity supply lines and equipment with voltage levels above 1000V (1KV) up to 36KV.
merit-order	is the ranking in order of which generating plant should be used, based on ascending order of price together with amount of electricity that will be generated.

merit-order dispatch	means the allocation of demand to individual generating units to effect the least cost production of electricity for customers. The process of determining the desired generation level for each of the generating units in a system in order to meet consumer demand at the lowest possible production cost given the operational constraints on the system.
meter	is a device for measuring and recording units of electrical quantities.
metering	is the method of applying devices to measure and record the amount and direction of electrical quantities with respect to time.
metering data	means the data associated with a metering point.
metering database	is the system for the storage of data for meters and associated equipment in the LITS to facilitate easy retrieval.
metering equipment	includes meters, time switches, measurement transformers ,metering protection and isolation equipment, circuitry and their associated data storage and data communications equipment and wiring which are part of the active energy and reactive energy measuring equipment at or related to a metering point.
metering facility	means a combination of metering equipment.
metering intervals	means the time between electricity meter consumption recordings.
metering information	means data related to a metering facility that is prescribed by the TSO for record in the metering register.
metering point	means a point in the LITS at which a meter and its accessories are physically located, where electrical energy is measured and defined.
Metering Register	has the meaning assigned to it under sub-section 13.9.1.
metering system	includes metering equipment, processes associated with metering, roles and activities related to metering.
Metering Site:	means overall metering location associated with metering a connection point, and includes main and back up metering points.
Metering Test Service Provider (MTSP):	means entity that has functions of monitoring, testing, inspecting and adjusting the metering equipment and metering systems of the generator.
Meter Test Station	means a certified test laboratory which has the technical and infrastructure capability to perform accuracy tests for meters and metering equipment.
multiple contingency	means the failure or outage of an element of the power system and the coincidental unexpected failure or outage of any other related element of the power system.
nameplate rating	means a manufacturer's guaranteed performance of an equipment in the power system under standardized conditions and is usually expressed in amperes, volts, kilovolt-amperes, kilowatts or other appropriate units usually indicated on a nameplate attached to the individual machine or device.
network	means the plant and equipment used to convey, and control the conveyance of, electricity to customers.
NITS node	see substation.
node	means a point in the LITS where active or reactive power or energy can be injected or withdrawn.
nominal voltage	means the voltage by which the system is designated and to which certain operating characteristics are related, and the voltage at which the system

	operates and is normally about 5 to 10 percent below the maximum system voltage for which system components are designed.
non-spinning reserve	means slow reserve.
N-1 contingency criterion	means that the system is sufficiently reliable if it is able to operate acceptably under any unplanned outage of equipment as the result of a single cause.
off-peak	means the hours or other periods defined by contract or other agreements or guide as the periods of lower electrical demand. Off- peak normally refers to a period of relatively low demand on an electric system and is typical to occur in the middle of the night.
on-peak	means the hours or other periods defined by contract or other agreements or guide as the periods of higher electrical demand. On- peak normally refers to a period of relatively high demand on an electric system.
open access	means the equal right or non-discriminatory provision to connect or use a system to transfer electrical energy provided established requirements are met.
operating criteria	means the fundamental principles of reliable interconnected systems operation.
operating procedures	means a set of policies, practices, or system adjustments that may be automatically or manually implemented by the TSO within a specified time frame to maintain the operational integrity of the interconnected electric systems.
operating reserve	means the additional megawatt output required from a generation unit or demand reduction which must be realizable in real time operation to contain and correct any potential power system frequency deviation to an acceptable level.
operating standards	means the established measurable criteria for determining the performance of obligation within a control area or a power system.
operational data	means the data required by the TSO for the purpose of satisfactorily operating, planning and managing the LITS.
operational planning	means planning through various time scales, the matching of Generation Output with forecast Demand together with a reserve of Generation to provide a Margin, taking into account Outages of certain Generation Units and of parts of the Transmission System carried out to achieve as far as possible, the required level of System Security.
outage	means a scheduled or unexpected period in a power system, during which a facility or component ceases to provide its full functioned capability and in relation to a generation unit, a total or partial reduction in availability such that the generation unit is unavailable to achieve its full registered megawatts capacity in accordance with its registered operating characteristics.
outage needs	means the time and periods specified by the GCP for planned and maintenance outage.
overload	means operation of equipment in excess of its normal, full load rating or operation of a conductor in excess of ampacity, which if continued for a sufficient length of time, would cause damage or overheating.
peak demand	means the maximum load during a specified period of time; performance standard: is a set of standards for the purpose of monitoring the performance of the TSO and the GCPs in the delivery of their services.

performance standard	means a set of standards for the purpose of monitoring the performance of the TSO and the GCPs in the delivery of their services.
planned outage	means the removal of the equipment from service availability for inspection or the general overhaul of a major equipment and is usually scheduled well in advance.
Point of Connection (PoC)	means the point on a public power supply system where the installation under consideration is or can be connected. *[Note: A supply system is considered as being public in relation to its use, and not its ownership].*
power factor	means the ratio of the active power to the reactive power at a metering point.
power flows	See 'load flow studies'.
power line carrier (PLC)	means power-line communication data carried on a conductor that is also used simultaneously for AC electric power transmission or distribution to consumers.
power pool	means two or more interconnected electric systems planned and operated to supply power for their combined demand requirements.
Power Purchase Agreement (PPA)	means a commercial agreement between a Generation GCP and a Demand GCP in which the Demand GCP agrees to purchase the electrical output of a Generating GCP and the Generation GCP agrees to provide the services from its plant.
Power Supply Agreement (PSA)	means a commercial agreement between the Transmission GCP and other GCP for the supply of electrical power and energy.
power system	means the interconnected system of generation units, transmission and distribution networks operated as an integrated arrangement for the supply of electricity.
power system stabilizer	means a device that injects a supplementary signal into the AVR (Automatic Voltage Regulator) in order to improve power system damping;
Preliminary Project Planning Data	means data relating to a proposed GCP development at the time that the applicant/proposer applies for a Connection Agreement or an Amended Connection Agreement.
primary reserve	means reserve that is provided automatically and immediately to correct drops in system frequency.
Prudent Utility Practice	means any generally accepted practice, method and act engaged in or approved by a significant portion of electric utility industry during a relevant time period or any practice, method or act that in the exercise of reasonable judgment in the light of facts known at the time of the decision, that could have been expected to accomplish the desired result at a reasonable cost, consistent with good business practices, reliability, efficiency, safety and expedition.
Public switched telephone network (PSTN)	means the aggregate of the worlds circuit-switched telephone networks that are operated by national, regional or local telephone operators.
Quick reserve	means spinning reserve and comprises of primary & secondary reserve (activated automatically), and tertiary and emergency reserve (activated manually) per Section 9.5 of the Code.
ramp rate	means the rate of change at which the power output of a generator can be increased or decreased (for example in MW/min).

rated power	means the rated installed power capacity of a generating unit that is connected to the network and whose output is continuously available to the network.
reactive energy	means the integral with respect to time of the instantaneous reactive power produced, flowing or supplied by an electric circuit during a time interval measured in units of VARH or standard multiples thereof
reactive power	means the product of voltage and current and the sine of the phase angle between them measured in units of volt-amperes reactive and standard multiples thereof.
reactive power capability curve	means a diagram, which shows the MW and MVar capability limits within which a generating unit will be expected to operate under steady state conditions.
reactor	means a device specifically arranged to be connected within the transmission system during periods of low load demand or low reactive power demand to counteract the natural capacitive effects of long transmission lines in generating excess reactive power and so correct any transmission voltage effects during these periods.
Regulations	means the Electricity Licensing Regulations issued by the LERC.
reliability	means the degree of performance of the elements of the electric power system that results in electricity being delivered to customers within accepted standards and in the amount desired. It is a measure of the ability of a power system to provide uninterrupted service, even while that system is under stress. Reliability may be measured by the frequency, duration, and magnitude of adverse effects on the electric supply.
remedial action scheme	means special protection schemes designed to automatically perform system protection functions other than the isolation of an electrical fault.
remote terminal unit	means a device installed in a substation for the purpose of collecting and transmitting codes and data to the Master Computer of SCADA/EMS, SCADA/DMS system.
renewable energy	means a type of electricity generated from an energy resource that is replaced rapidly by a natural process such as from the sun (e.g. solar PV, biomass), wind (e.g. wind power, wave power), earth's core (e.g. geothermal), or the moon (e.g. tidal).
Requesting safety coordinator	Refer to definition of 'safety coordinator'.
reserve	means an ancillary service that consists of a generation capacity that is available, or a load that can be interrupted by the Utility in the event of an unexpected outage of a scheduled plant.
reserve margin	means the difference between an electric utility's system capability and anticipated peak load during a specific period, measured either in megawatts or as a percentage of peak load.
reservoir elevation	means the level of the water stored behind a dam. Also can be the reservoir's elevation above sea level.
reservoir storage	means the volume of water in a reservoir at a given time.
safety coordinator	means a person appointed to be responsible in all matters concerning safety of personnel and equipment and shall be competent to carry out the functions set out to achieve safety on the LITS at all times as provided under section 11.4 and can either be a "Requesting Safety Coordinator" or an "Implementing Safety Coordinator.

safety precaution	means the isolation and grounding of equipment when work or testing is to be done on the LITS or GCP system.
safety procedures	means processes defined by safety rules.
safety key	means a key used for locking an earthing or Isolating device.
safety log	means the logbook in the relevant control room where safety precautions, instructions and incidents are logged.
safety rules	means the rules which ensures that persons working on Plant and/or apparatus to which the rules apply are safeguarded from hazards arising from the System.
scheduled Day	means a period in the Scheduling process from 00.00 hours to 24.00 hours in the same calendar day.
secondary reserve	means the capability of a generating unit to have its generated outputs adjusted frequently (e.g. by AGC) so that any system frequency variations can be corrected.
security	means the ability of the electric system to withstand sudden disturbances like electric short circuits or unanticipated loss of system facilities.
set point	means an analog or digital signal sent by the SCADA system to a VRPP facility representing the maximum renewable energy output required from that facility.
shunt capacitor	means an equipment connected to a network to generate reactive power.
shunt reactor	means an equipment connected to a network to absorb reactive power
significant incident	means every event or case where either or a combination of the following happens: (i) malfunctioning of equipment or apparatus connected to the transmission network; and (ii) a person or animal receives an electric shock, whether mild or serious or suffers an injury or burn, directly or indirectly due to electrical causes.
single contingency	includes the singular (a) sudden, unexpected failure or outage of a power system or of an element like generating unit, transmission line and transformer; or (b) removal from service of an element of the power system like generating unit, transmission line or transformer as part of the operation of a remedial action scheme, the occurrence of which shall not affect the normal operation of the LITS.
single line diagram	means a drawing of electrical circuits where three phase circuits are represented by a single line rather than three lines.
Slow reserve	means generating capacity that is not operating or synchronized to the system but which is available to serve demand within specific time of being requested as specified in sub-section 9.5.8 means non-spinning reserve.
spinning reserve	means the unloaded generation capacity, which is synchronized and ready to automatically serve additional demand without human intervention in order to arrest a drop of system frequency due to an instantaneous mismatch between generation and demand.
stability	means the ability of an electric system to maintain a state of equilibrium during normal and abnormal system conditions or disturbances.
static VAR compensation	means a controllable VAR supply, that consist of a complete system of static components like capacitors, reactors and solid-state switches

	combined in one device, to provide rapid and continuously controllable reactive compensation.
steady state stability	means the capability of an electric power system to maintain its initial condition after a small interruption or to reach a condition very close to the initial one when the disturbance is still present.
substation	means a facility at which two or more lines are switched for operational purposes and which may in addition have one or more transformers to enable some connected lines operate at different nominal voltages in relation to others.
Supervisory Control and Data Acquisition	means a computer system that allows an electric system operator to remotely monitor and control elements of an electric system.
surge	means a transient variation of current, voltage, or power flow in an electric circuit or across an electric system.
switchgear	includes the combination of various switching and interrupting devices used in a power system like disconnecting switches circuit breakers, and automatic circuit reclosers.
synchronize	means the process of connecting two previously separated alternating current apparatuses after matching frequency, voltage, phase angles like paralleling a generator to the electric system.
system disturbance	means any disturbance that results in localized or widespread loss of load or resulting in one or more of the following phenomena: system instability, cascading outages, formation of islands, or undesirable voltage or frequency.
System Emergency Condition	means a partial shutdown or total shutdown or any other physical operational condition or occurrence on the power system which is (a) imminently likely to endanger life or property; or (b) imminently likely to impair the: (i) ETU's ability to discharge its obligation; or (ii) safety and reliability of the power system.
System Protection Dependability (D_p)	means a measure of the ability of protection to initiate successful tripping of circuit-breakers which are associated with a faulty item of apparatus. It is calculated using the formula: $D_p = 1 - F_N/F_{tot}$ Where: F_{tot} = Total number of system faults F_N = Number of system faults where there was a failure to trip a circuit breaker
tertiary reserve	means quick reserve that can be manually instructed by the TSO to replace secondary reserve, and to balance load and VRPP forecast errors.
test procedure	means a procedure that specifies the switching sequence and proposed timing of the switching sequence, including other activities deemed necessary and appropriate in carrying out the test.
tie-line	means a circuit connecting two or more control areas or systems of an electric system.
time error	means an accumulated time difference between control area system time and the time standard and is caused by a deviation in Interconnection frequency from 50.0 Hz.
time error correction	means the offset to the interconnection's scheduled frequency to correct for the time error accumulated on an electric clock.

Total Harmonic Distortion (THD)	means the ratio of the RMS voltage of the harmonic content to the RMS value of the fundamental voltage, expressed in percent. $THD = \sqrt{[\sum (Vi^2 / V_1^2)]} * 100\ \%$ Vi = Voltage component of harmonic order i; V_1 = Voltage component of fundamental frequency (50 HZ).
transfer capability	means the amount of power, that can be transmitted between one system and another and which power flow and stability studies can determine under various outage, system loading and system operating conditions.
transformer	means a device that consists of a magnetic core on which there are two or more windings which can be used to transfer electrical energy from one circuit to another by magnetic induction, usually between circuits of different voltages.
transient stability	means the ability of an electric power system to maintain synchronism between its parts when subjected to a disturbance of a specified severity and to regain a state of equilibrium following that disturbance OR the ability of the system to experience a sudden change in generation, load or system characteristics without a prolonged loss of synchronism.
transmission network	means the electric system consisting of (major part or the system as a whole) lines and cables, having design voltage of 66kV and above, operated by the TSO and managed by the Transmission GCP to transmit energy from a generating station to a substation or to another generating station or inter-substations or to any interconnection system including apparatus, equipment and metering systems owned by the Transmission GCP and used for transmission of electrical energy.
Transmission GCP	means a person mandated and licensed under the ELL to own transmission assets and provide transmission services without discrimination to customers within the LITS.
transmission system	means an interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or to other electric systems.
Transmission System Operator (TSO)	means a neutral operator licensed under the ELL responsible for maintaining instantaneous balance of the LITS by controlling the dispatch of generating units to ensure that loads match resources available to the system and is effected in a safe, reliable, economic and non-discriminatory manner.
turbine	means a machine to generate rotary mechanical power from the energy of a stream of fluid like water, steam, or hot gas.
Under-Frequency Load Shedding	means the automatic tripping of customer load by means of one or more relays set to trip at specific under-frequencies which during a sudden mismatch between Generation and customer Load attempts to prevent system shutdown.
unit commitment	means the process of determining which generator will be brought on-line to meet load or provide ancillary services for the next generation schedule
Unrestricted Operation Range	means normal network frequency or voltage operating range during which no generating unit is allowed to disconnect and where there is no technical restriction with regard to the delivery of active power or reactive power.
VAR	means a single unit of reactive power.

Variable Renewable Power Plant (VRPP)	means renewable power plant with continuously varying power output following the availability of primary energy without any storage (Wind and solar PV farms.
voltage	means the electronic force or electric potential between two points that gives rise to the flow of electricity.
voltage collapse	means an event that occurs when an electric system does not have adequate reactive support to maintain voltage stability and which may result in the outage of the components of the power and the interruption in service to customers.
voltage control	means the control of transmission voltage within acceptable limits through adjustments in generator reactive output and transformer taps, and by switching.
voltage dip	means a sudden reduction of the voltage to a value between 90% and 100% of the nominal voltage followed by a voltage recovery after a short period of time.
voltage droop	means the relationship between Voltage and Reactive Power, specified in percent, for use in the Voltage Droop Control and which value represents the change in Voltage which will cause a Generator's site to move from 0 MVAr exchange to full Reactive Power exchange at the Connection Point.
voltage droop control	means a method of controlling the reactive power exchange from a GCP's site at the Connection Point, depending on the voltage, voltage vroop and voltage target settings.
voltage instability	means a condition that results in Grid voltages that is beyond the level where voltage control equipment can return them to the normal level
voltage stability	means the condition of an electric system in which the sustained voltage level is controllable and within predetermined limits.
VRPP Operator	means an operator of a VRPP seeking connection to or already connected to the LITS.
Watt (Electric)	means the electrical measuring unit for active power.
Watt-hour (Wh)	means the unit of electrical energy equal to one (1) watt of power supplied to, or taken from, an electric circuit steadily for 1 hour.
wheeling	means the use of the facilities of one transmission system to transmit power and energy from one power system to another.
wholesale electricity market	means an electricity market established by market operation rules for bulk trading of electricity, ancillary services and any other related electricity supply product or service.
wholesale electricity trading	includes electricity sales, purchase and settlements in the Wholesale Electricity Market between a wholesale supplier and a distribution company or large consumer.
wholesale supplier	means a person licensed under the ELL to install and operate a facility to produce electricity or to procure electricity for sale in bulk to a large consumer or to a distribution company for distribution and sale to consumers.

PART G: TECHNICAL SCHEDULES

Part G, Technical Schedules, contains detailed technical information relevant for the implementation of the LEGC to guide the operation of the LITS.

Technical Schedule TS–A: AFLS Philosophy

Introduction

1. Power system frequency is controlled mainly by the generation. Small frequency excursions occur continually as generation is controlled to match changing loads. The frequency is stable when generation and load match. Frequency is normally controlled by the following:
   (a) generator governors;
   (b) automatic generation control (AGC); and
   (c) System operators/Dispatchers.

2. When these actions fail, the system is in danger of a total blackout and a final safety net is the Automatic Frequency Load Shedding (AFLS) scheme.

Justification

3. The intent of the AFLS Program is to provide a last resort system preservation measure during severe frequency declines that can result from an extreme disturbance or a condition where load substantially exceeds generation. An AFLS program can minimize the risk of total or partial system collapse, prevent damage to generation and transmission facilities, provide for equitable load shedding, and improve the overall reliability of the power system.

Philosophy

4. An Automatic Frequency Load Shedding (AFLS) program shall be developed, coordinated, and documented by the TSO. All Distribution Companies and large consumers are obligated to participate in the AFLS program, in accordance with good utility practice.

5. The AFLS Program shall be coordinated between all GCPs and with interconnected utilities, as necessary. The AFLS Program shall also be coordinated with generation protection, any tie-line tripping schemes, etc.

6. Loads shed during AFLS operations shall not be restored except with the approval of the TSO.

7. The AFLS Program shall be in steps, set to drop predetermined blocks of load at discreet frequency steps and for each step, the following shall be defined:
   (a) the frequency and/or rate of frequency decay settings and time delays;
   (b) the substation or location of loads to be shed; and
   (c) the estimated magnitude of loads/percentage of load to be shed for both peak and off-peak periods.

8. The AFLS program shall be determined by the TSO following consultations with relevant GCPs and published as the Demand Management Guidelines in the System Operations Manual by **November 1st** each calendar year, to cover the immediately following twelve-month period.

9. The TSO shall ensure that, as far as is practicable, the burden of load shedding is fairly distributed among GCPs.

10. The AFLS program shall be reviewed annually or as and when necessary, by the TSO.

Technical Schedule TS–B: Capability and Availability Declaration

1. Capability and Availability Declarations shall contain the following information:
    (a) The average active power expected to be available for each hour during the following day (including start time and date);
    (b) Estimated initial conditions (time required for notice to synchronize within the Technical Limits and Plant Performance Characteristics), last on or off time;
    (c) Generating Unit run-up rates in MW for each level of warmth (cold, warm or hot starts);
    (d) Unit run-down rates;
    (e) The reactive power capability of each unit;
    (f) Minimum load for each Unit; and
    (g) Any maintenance which is planned during the period that could reasonably affect the available power.
2. Definitions
    (a) Cold Start: More than 96 hours since the last shutdown
    (b) Warm Start: 8 hours or up to 96 hours since the last shutdown
    (c) Hot Start: Less than 8 hours since the last shutdown

Technical Schedule TS – C: [Not Used]

Technical Schedule TS – D: Detailed Planning Data

Generating Unit and Generating Plant Data

1. The following additional information shall be provided for the **generating units** at each generating plant:
    (a) Generating Unit Manufacturer;
    (b) Rated power factor (over-excited and under-excited);
    (c) De-rated capacity (MW) on a monthly basis if applicable;
    (d) Additional capacity (MW) obtainable from the generating unit in excess of net declared capability;
    (e) Generator performance and efficiency data and curves;
    (f) Minimum stable loading (MW);
    (g) Reactive power capability curve;
    (h) Stator armature resistance;
    (i) Direct axis synchronous, transient and sub-transient reactances;
    (j) Quadrature axis synchronous, transient and sub-transient reactances;
    (k) Direct axis transient and sub-transient time constants;
    (l) Quadrature axis transient and sub-transient time constants;
    (m) Turbine and generating unit inertia constant (MWsec/MVA);
    (n) Rated field current (A) at rated MW and MVar output and at rated terminal voltage; and
    (o) Short circuit and open circuit characteristic curves.

2. The following information for **step-up transformers** shall be provided for each generating unit:
    (a) Rated MVA;
    (b) Rated frequency (Hz);
    (c) Rated voltage for both primary and secondary (kV);
    (d) Voltage ratio;
    (e) Winding connection and vector group;
    (f) Positive sequence resistance (at maximum, minimum and nominal tap);
    (g) Positive sequence reactance (at maximum, minimum and nominal tap);
    (h) Zero sequence reactance;
    (i) Magnetizing curve;
    (j) Tap changer range, step size; and type (on load or off load); and
    (k) Transformer test certificates from which actual technical detail can be extracted as required are to be supplied on reasonable request.

3. The following **excitation control system parameters** shall be provided for each generating unit:
    (a) Voltage regulator model name;
    (b) DC gain of excitation loop;
    (c) Rated field voltage;
    (d) Maximum field voltage;
    (e) Minimum field voltage;
    (f) Maximum rate of change of field voltage (rising and falling)
    (g) Functional description and block diagram showing transfer function of individual elements of the excitation system and the automatic voltage regulator;
    (h) Dynamic characteristics of over excitation limiter; and
    (i) Dynamic characteristics of under excitation limiter

4. The following information shall be provided for **Power System Stabilizers (PSS)**:

(a) Functional description and block diagram showing transfer function of individual elements of the PSS;
(b) Report on methodology in deriving the PSS setting, including simulation results and tuning procedures;
(c) Commissioning tests or other filed results

5. The following **speed governing system parameters** shall be provided for each generating unit:
(a) Governor dead band - Maximum setting, normal setting, minimum setting;
(b) Time constant of steam or fuel governor valve or water column inertia;
(c) Governor valve opening limits;
(d) Governor valve rate limits;
(e) Time constant of turbine; Governor block diagram showing transfer function of individual elements including acceleration sensitive elements in accordance with IEEE Standard Models;
(f) Detailed description of setting calculation for each of the governor system functions; and
(g) Documents describing the performance of the overall governor system and each governor function for which a setting is derived

6. The following plant **flexibility performance data** shall be submitted for each generating unit:
(a) rate of loading from a cold start-up condition;
(b) rate of loading from a warm start-up condition;
(c) rate of loading from a hot start-up condition;
(d) block load following synchronization;
(e) time from minimum stable load to full load (minutes)
(f) rate of load reduction from normal rated MW;
(g) regulating range;
(h) load rejection capability while still synchronized and able to supply load;
(i) power required for unit auxiliaries

System Data
7. The TSO and each GCP shall exchange information, including details of physical and electrical layouts, parameter, specifications and functional description and settings of generating unit protection and other data needed for power system studies.

8. Each GCP shall provide additional planning data that may be requested by the TSO.
[Note: All data to be provided shall be in per unit magnitude with MVA base specified. Generating unit and generating unit's step-up transformer data shall be provided in rated MVA capacity base]

Detailed Planning Data for Variable Renewable Power Plants (VRPPs)
A Generation GCP operating a VRPP shall provide the following sets of information and data to the TSO:
General
9. Name of VRPP module:

10. No. and capacity of VRPP Units (MW):

11. Ratings of all major Equipment:
(a) VRPP Unit Transformers (MVA)
(b) VRPP module Grid Transformers (MVA)

(c) Auxiliary Transformers (MVA)
(d) Cables
(e) Additional reactive Equipment (e.g. STATCOM / SVC / shunt elements)

12. Single Line Diagram of VRPP module and switchyard.

13. Relaying and metering diagram.
14. Neutral Grounding of VRPP Units.

15. Voltage Control methodology (e.g. utilizing VRPP Units / STATCOM / SVC / shunt elements etc.) 8. Earthing arrangements with earth resistance values.

B. Protection and Metering

16. Full description including settings for all relays and protection systems installed on the VRPP module, including but not limited to, those on the VRPP Unit, Generating Unit Transformer, Auxiliary Transformer, VRPP module Grid Transformer and cable networks

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17. Full description including settings for all relays installed on all outgoing circuits from VRPP module substation switchyard, tie circuit breakers, incoming circuit breakers.

18. Full description of inter-tripping of Breakers at the Connection Point(s) with the Transmission System.

19. Most probable fault clearance time for electrical faults on the GCP's system.

20. Full description of operational and commercial metering schemes.

C. Switchyard

21. In relation to
    (a) interconnecting transformers between High Voltage Transmission System and the PPM MV system and
    (b) transformers on individual units:
        (i) Rated MVA
        (ii) Voltage Ratio
        (iii) Vector Group
        (iv) Positive sequence reactance (maximum, minimum, normal Tap(% on MVA)
        (v) Positive sequence resistance (maximum, minimum, normal Tap (% on MVA)
        (vi) Zero sequence reactance (% on MVA)
        (vii)Tap changer Range (+ % to - %) and steps
        (viii) Type of Tap changer (off-load/on-load)

22. In relation to switchgear including circuit breakers and isolators in all areas on of the VRPP module and at the Connection Point(s):
    (a) Rated Voltage (KV)
    (b) Type of Breaker (MOCB/ABCB/SF6)
    (c) Rated short circuit breaking current (kA) 3 Phase
    (d) Rated short circuit breaking current (kA) 1 Phase
    (e) Rated short circuit making current (kA) 3 Phase
    (f) Rated short circuit making current (kA) 1 Phase
    (g) Provisions of auto reclosing with details.

23. Lightning Arresters: Provide technical data.

24. Communication- Details of PLC Equipment installed at connection point(s).

25. Basic Insulation Level (kVp).
    (a) Busbar.
    (b) Switchgear.
    (c) Transformer Bushings.
    (d) Transformer windings.

26. Parameters of VRPP Units:
    (a) Rated terminal voltage (KV)
    (b) Rated MVA
    (c) Rated MW
    (d) VRPP Unit Capability Chart (MW/MVAr at terminals)

27. Parameters of VRPP module
    (a) SCADA details
    (b) Communication details
    (c) Control point details and location / contact details
    (d) Description of Voltage Control / Reactive Power Control methodology and associated Equipment

28. VRPP module Study reports/Model
    (a) Short circuit report
    (b) Reactive capability load flow report
    (c) Voltage Control / Reactive Power Control system performance report
    (d) Fault Ride Through report
    (e) Harmonic studies report
    (f) Dynamic model of VRPP module

29. Plant Performance data
    (a) Daily demand profile (last year) - Peak and average in time marked 30 minutes throughout the day.
    (b) Daily demand profile (forecast) - In time marked 30 minutes throughout the day.
    (c) Units generated (MWh)
    (d) Units consumed in auxiliaries (MWh)
    (e) Units supplied from system to auxiliary Load
    (f) Seasonal generation

30. Operational Parameters
    (a) Minimum notice required for Synchronizing a VRPP module
    (b) Minnimum time between Synchronizing different VRPP Units in a Power Station
    (c) The minimum block load requirements on Synchronizing
    (d) Maximum VRPP module loading rate
    (e) Maximum VRPP module de-loading rate
    (f) Minimum on-load time
    (g) Minimum off-load time
    (h) Minimum load
    (i) Any staffing constraints (e.g. only day and evening shifts are employed so no overnight operation)

Technical Schedule TS – E: LITS Security Requirement

1.0 Criteria for Normal System Conditions

1.1 Normal conditions are considered to exist if system voltages, line and equipment loadings are within normal limits and an emergency does not exist on the system or externally.

1.2 Criteria used to define Operating Security Limits for the normal system conditions are summarized below and must satisfy the conditions in paragraph 4.0.

(a) A permanent three-phase fault on any generation, transmission line, transformer, or bus section excluding those bus sections contained in (e), cleared in normal time, with due regard to reclosing facilities;
(b) Simultaneous permanent phase to ground faults on different phases on each of two adjacent transmission circuits on a multiple transmission circuit tower, cleared in normal time, with due regard to reclosing facilities;
(c) A permanent phase to ground fault on any generator, transmission circuit, transformer, or bus section with delayed clearing and with due regard to reclosing facilities;
(d) Loss of any element without a fault; and
(e) A permanent phase to ground fault (between current transformers) on a circuit breaker, cleared in normal time, and with due regard to reclosing facilities.

2.0 Criteria for Emergency System Conditions

2.1 Emergency conditions are considered to exit when observance of Normal Operation Limits would require load cuts or restriction in interconnection transactions during capacity or energy emergencies on the system or externally.

2.2 Capacity or energy emergency exists when firm loads may have to be cut due to insufficient power or energy is available in the area.

2.3 Criteria used to define Emergency Security Limits are summarized below and must satisfy the conditions in paragraph 4.0.

(a) A permanent three-phase fault on any generation, transmission circuit, transformer, or bus section, cleared in normal time and with due regard to reclosing facilities.
(b) Loss of any element without a fault.

3.0 Criteria for Areas Not Affecting Interconnections

3.1 Portions of the network where instability will not significantly affect the interconnected systems may be operating within Security Limits based on the following criteria and must satisfy the conditions in paragraph 4.0.

(a) Loss of any element without a fault.
(b) A normally cleared phase-to-phase to ground fault on any generator, transmission circuit, transformer or bus section, with due regard to re-closure.

4. Operating Limits

4.1 The system must be stable with all un-faulted elements remaining in service except those associated with normal fault clearance and generation rejection if employed.

4.2 The post-contingency steady-state loading of system elements must be within their 15-minute Limited Time Rating unless a pre-planned course of action exists to return the loading to continuous rating within shorter time period. Where a pre-planned course of action exists, the post-contingency steady-state loading must not exceed the five-minute Limited Time Rating on any system element.

4.3 The system must be able to withstand manual energization of the faulted element without prior readjustment of generation levels unless specific instructions to the contrary are provided. Such instructions will be embodied in Operating Security Limits and will normally apply only under specified conditions of loading in instances where post-contingency conditions would present a radical departure from the normal system configuration.

4.4 The post-contingency voltage levels must be within acceptable limits.

Technical Schedule TS – F: Frequency Limits

1. The LITS frequency shall be maintained as follows:
    (a) Between 49.8 to 50.2 Hz under Normal State of operation;
    (b) Between 49.5 to 50.5 Hz for a period not exceeding ten (10) minutes under Alert State;
    (c) Between 49.0 to 51.0 Hz for a period not exceeding thirty (30) minutes under Emergency State.

2. A generating unit must be operable within the frequency range of 48.75 Hz to 51.25 Hz without automatically disconnecting from the LITS.

Technical Schedule TS – G: [Not Used]

Technical Schedule TS–H: Accuracy Classes of Metering Equipment

Connection Capacity	< 50 MVA	> 50MVA	International Interconnections
CT	0.2S / 0.5(1)	0.2S	0.2 S
VT	0.5	0.2	0.2
Active Energy Meters	0.2S / 0.5(1)	0.2S	0.2 S
Reactive Energy Meters	2	2	2

(1) For new connections and replacements made after the date of approval of the LEGC, the higher accuracy class shall be used

Technical Schedule TS – I: [Not Used]

Technical Schedule TS – J: [Not Used]

Technical Schedule TS–K: LITS Performance Benchmarks

1. Benchmarks for system performance and reliability indices shall be determined by the LERC on the basis of computations of the 3-year record of historical operational performance data submitted by the TSO.

2. The LERC shall, in consultations with the TSO and the relevant GCPs, determine the benchmarks for the system performance and reliability indices defined and specified under Section 12 and Technical Schedule TS – R of the LEGC in consideration of the following:

    (a) historical performance trends,
    (b) committed reliability improvement projects,
    (c) system performance requirements,
    (d) industry and international standards and
    (e) other considerations.

3. The benchmarks shall be defined and become effective, not later than six months following the establishment of the LEGC.

4. The performance and reliability benchmarks shall be reviewed annually by the LERC.

Technical Schedule TS–L: Limits for Operating Parameters

The following indices and limits shall be measured or determined and used in the monitoring and reporting of the performance and reliability of the LITS:

1. LITS frequency shall be maintained as follows:
    (a) Between 49.8 to 50.2 Hz at all times, under Normal State of operation;
    (b) Between 49.5 to 50.5 Hz for a period not exceeding ten minutes under Single Contingency or Alert State of operation; and
    (c) Between 49.0 to 51.0 Hz for a period not exceeding thirty minutes under Emergency State.

2. LITS voltage magnitudes shall be kept within the following limits:
    (a) ±5% of the nominal voltage at all times under **Normal State**;
    (b) ±10% of the nominal voltage under Single Contingency or **Alert State** for a period not exceeding 10 minutes;
    (c) ±10% of the nominal voltage under **Emergency State** for a period not exceeding 30 minutes.

3. All Demand GCPs of power shall maintain their power factor at values not less than 0.90 at all times.

4. Imbalance in phase voltage magnitude shall not exceed 3%.

5. Phase displacement between voltages shall be within the limits stated in the System Operations Manual of the TSO.

6. The maximum permissible voltage flicker limits shall be in accordance with IEC/TR3 61000-3-7 standard (or IEEE Standard 519- 1992 as alternative).

7. The maximum permissible harmonic limits shall be in accordance with IEC/TR3 61000-3-7 standard (or IEEE Standard 519- 1992 as alternative).

8. All generating units shall be operable between power factors of 0.85 lagging and 0.95 leading.

Technical Schedule TS–M: Minimum data requirements for transmission to SCADA system

The SCADA system shall be used for storage, display and processing of operational real time data. All Transmission GCPs and other GCPs shall make available outputs of their respective installed operational equipment to the data acquisition system or as specified in the Connection Agreement.

1. State of plant/equipment SCADA Data (Digital Inputs)

A Transmission GCP and other GCPs shall provide the status information for both real time and recording purposes in relation to the status of each equipment or plant in respect of the indications provided as follows:

(a) Generating unit (On/Off, if available);
(b) Generation unit circuit breaker (Open/close/undefined, if available);
(c) Circuit breaker in switchyard (open/close/undefined);
(d) Disconnector (open/close); and
(e) Position of tap changer.

2. Operational data (analog inputs)

A Transmission GCP and other GCPs shall provide operational information for both real time and recording purposes in relation to each equipment of plant in respect of indications and measured quantities as follows:

(a) Bus-bar voltage (V);
(b) Active and reactive power of incoming and outgoing feeders (W/VAr) (if available);
(c) Generating outputs (W/VAr);
(d) Frequency (Hz); and
(e) Current (A).

3. Accumulator inputs;

(a) Generation outputs (Wh, VArh) (if available);
(b) Energy transmitted in incoming and outgoing feeders (Wh/VArh);

4. Control Outputs including the following:

(a) Circuit breaker in switchyard (open/close);
(b) Feeder Circuit breaker (open/close);
(c) Motorized disconnector (open/close);
(d) Position of tap changer; and
(e) Any other important alarm signals specified by the TSO.

5. **Other requirements** of data acquisition and transmitting equipment (if necessary) shall be clearly described in the Connection Agreement.

Technical Schedule TS – N: [Not Used]

Technical Schedule TS–O: Operating Reserve Policy

1. The TSO shall, in consultation with the GCPs, specify the Operating Reserve Policy, including its allocation of the permissible mix of Quick Reserve and Slow Reserve, and the procedure for applying operating reserve in practice, and the limitations, if any, upon the amount of interruptible load which may be included.

2. The TSO shall submit the Operating Reserve Policy to the LERC for approval.

3. In developing the Operating Reserve Policy, due consideration shall be taken of relevant factors, including, but not limited to the following:

    (a) the cost of providing operating reserve at any point in time;
    (b) the magnitude and number of the largest generation in-feeds to the LITS at that time, including in-feeds over interconnections and also over single transmission feeders (which may be single or double circuit) within the LITS;
    (c) ambient weather conditions, insofar as they may affect (directly or indirectly) generating unit and/or transmission system reliability;
    (d) the predicted frequency drop on loss of the largest credible trip as determined through simulation using a dynamic model of the LITS;
    (e) constraints imposed by agreements in place with externally interconnected parties;
    (f) historical availability and reliability performance of individual generating units;
    (g) notified risk to the reliability of individual generating units; and
    (h) imbalance power requirements resulting from –
        (i) uncertainties of demand and VRPPs' forecasts; and
        (ii) continuous variation of demand and VRPPs output during a dispatch period which impose uncertain load following requirements.

4. Unless proven to be technically impossible, or the economic burden imposed on the dispatch cost is excessive, the precise methodology for allocating reserve shall be defined by the TSO and agreed with LERC, and must be in-line with the following principles:

    (a) **Primary Reserve:** the TSO shall ensure that enough Primary Reserve is available to maintain system frequency within acceptable limits, following a contingency such as a unit trip or a sudden surge in Load, without any Under-Frequency Load Shedding. The requirement on the TSO is to keep the frequency above 48.75 Hz following all credible single contingency losses. The TSO shall ensure that the same volume of Negative Primary Reserve is available. Those generating units that are contracted for Primary Reserve are also required to provide the same capacity for Negative Primary Reserve for high frequencies.
    (b) **Secondary Reserve:** sufficient Secondary Reserve shall be carried to ensure that any decay in Primary Reserve is replaced. The same volume of Negative Secondary Reserve shall be carried; however, this may come from other sources.
    (c) **Tertiary Reserve**: the TSO must ensure that sufficient Tertiary Reserve is available to restore Primary and Secondary Reserve following a contingency or to compensate the maximum residual load variability value within any 1-hour interval (maximum difference between instantaneous value of Load or residual Load and one hour average value) minus the allocated Secondary Reserve. The same volume of

Negative Tertiary Reserve shall be carried; however this may come from other sources.

(d) **Emergency Reserve**: the TSO must ensure that sufficient Emergency Reserve is available for compensating the worst-case credible multiple contingency loss (e.g. simultaneous outage of two large gas turbine Generating Units).

(e) **Slow Reserve:** The TSO must ensure that sufficient Slow Reserve is available to restore Tertiary Reserve plus Emergency Reserve following a contingency and to compensate for the worst-case imbalance error resulting from day-ahead forecast errors of the available generation and Load. Slow reserve should be procured on an hour-by-hour basis. It should predominantly be procured from hydro power plants, operating under water management and gas turbine Generating Units that operate under fuel management.

(f) Operating Reserve shall be considered the effective use of capacity in an emergency and shall be dispersed throughout the system taking into account the time required to be effective, transmission limitations, and local area requirements.

5. The TSO shall, in consultation with the other GCPs, review probable contingencies frequently to determine the adequacy of Operating Reserve Policy and maintain it permanently under review.

6. On an annual basis, the TSO shall submit to the LERC an amended version for approval, taking into consideration the previous year's frequency recovery performance.

7. Record keeping: The TSO shall keep records of significant alterations to the Operating Reserve Policy.

Technical Schedule TS–P: Power Factor and Reactive Power Limits

1. Distribution GCPs and all other Demand GCPSs off-taking power from the LITS shall maintain their power factor at values not less than 0.90.

2. All generating units shall be operable between power factors of 0.85 lagging and 0.95 leading.

Technical Schedule TS – Q:[Not Used]

Technical Schedule TS–R: LITS Performance Report

Information in Performance Report

A LITS Performance Report prepared by the TSO shall, in the least, provide information relating to the performance in relation to the following:

1. System Efficiency Performance Indices

(a) Maximum System Demand
(b) Total energy received
(c) Total energy supplied
(d) Net total energy dispatched
(e) Average power dispatched
(f) Load Factor (%)
(g) Transmission losses (%)
(h) System Capacity Factor (%)
(i) Utilization Factor (%)
(j) Equipment Loading reporting > 85% of rated capacity, time of occurrence & duration

2. Availability

(a) Availability Factor for a line segment (%)
(b) Availability Factor for group of transmission line segments (%)
(c) Equivalent Availability Factor for a line segment (%)
(d) Equivalent Availability Factor for a group of line segments (%)

3. Reliability

(a) System Time error
(b) System Average Interruption Duration Index
(c) System Average Interruption Frequency Index
(d) System Minutes Lost
(e) Index of Transmission Reliability
(f) Transmission line faults/100km of circuit line.

4. Quality

Index	Normal State	Alert State	Emergency State
Frequency deviations (a) No. of occurrences (b) Total duration of incidents (c) Maximum continuous period (d) Max Value/Time/Date (e) Min Value/Time/Date			
Voltage profile (a) No. of occurrences (b) Total duration of incidents (c) Maximum continuous period (d) Maximum Value/Time/Date (e) Minimum Value/Time/Date			

5. Events reporting

(a) Planned outages - Time/Date/Duration
(b) Forced Majeure conditions
(c) Generation capacity shortage outages - Time/Date/Duration/Amount/Causes

Technical Schedule TS–S: Standard Planning Data

Historical Energy and Power Demand

1. A GCP shall provide its actual monthly energy and demand consumption at each Connection Point for the immediate past year.

2. A GCP shall also provide the hourly load profiles for a typical Weekday, Saturday, Sunday and holiday.

Energy and Power Demand Forecast

3. The GCP shall provide its energy and power demand forecast at each Connection Point for five (5) successive years. Where the GCP is connected to the LITS at more than one Connection Point, the demand data shall also include the coincident peak active demand at each connection point.

4. The forecast data for the first year shall include monthly forecast for energy and power demand, while the remaining four years shall include only one annual energy and power demand forecast.

5. The GCP shall provide the TSO with forecast hourly load profiles for typical Weekday, Saturday and Sunday and holiday.

6. Distribution GCPs shall provide the net values of energy and power demand forecast for the distribution system at each Connection Point, after any deductions to reflect the output of embedded generating plants.

7. Generation GCPs shall submit to the TSO the projected energy and power to be generated by each generating plant.

[NB: Energy and power demand forecast shall be accompanied by a short description setting out the basis for the forecast]

Generating Unit Data

8. Each Generation GCP shall provide the TSO with data relating to its generating units, including
   (a) a brief description of the configuration of the generation facilities,
   (b) power station name and location,
   (c) type of facilities (combined cycle, gas turbine, hydro, etc), number for each type,
   (d) Approximate period of construction,
   (e) Commissioning Date, and
   (f) single line diagram.

9. The following information shall be provided for generating units of each generating plant:
   (a) Rated capacity (MVA and MW);
   (b) Rated voltage (kV);
   (c) Maximum available output in MW;
   (d) Minimum stable load (MW)
   (e) Type of generating unit and expected running mode(s);
   (f) Direct axis transient reactance (% on MVA rating);
   (g) Direct axis sub-transient reactance (% on MVA rating);
   (h) Frequency Response Table;
   (i) Reactive Power capability (MVAr) in the range 0.95 leading and 0.85 lagging;

(j) Rated capacity, voltage and impedance of the generating unit's step-up transformer;
(k) Short Circuit Ratio (% on MVA rating); and
(l) Auxiliary Power requirement.

10. For Hydropower plant the following additional information is required:
    (a) Submerged Area - Furnish information on area of villages submerged, forestland, agricultural land etc.;
    (b) Operating Head (In Mtr) – Maximum, Minimum, and Average;
    (c) Turbine type and capacity;
    (d) Annual Generation: expected water flow, expected Energy, annual load factor; and
    (e) Step up voltage for connection in kV.

System Data for GCPs

11. Each GCP shall provide the electrical diagrams and connection point drawings of the GCP's System and the Connection Point. The diagrams and drawings shall indicate the quantities, ratings and operating parameters of the following:
    (a) Equipment (e.g. Generating units, transformers, circuit breakers, motors and drives, etc);
    (b) Electrical circuits (e.g. Overhead lines and underground cables);
    (c) Substation bus arrangements;
    (d) Grounding arrangements;
    (e) Phasing arrangements; and
    (f) Switching facilities.

12. The GCP shall provide the values of the following circuit parameters of overhead lines and/or underground cables from the GCP substation to the connection point with the LITS:
    (a) Rated and operating voltage (kV);
    (b) Positive sequence resistance and reactance;
    (c) Positive sequence shunt susceptance;
    (d) Zero sequence resistance and reactance; and
    (e) Zero sequence susceptance.

13. If the GCP is connected to the LITS through a transformer, the following data for the power transformer shall be provided:
    (a) Rated MVA;
    (b) Rated voltages, HV, LV, Tertiary (kV);
    (c) Winding arrangement;
    (d) Positive sequence resistance and reactance (at maximum, minimum and nominal tap);
    (e) Zero sequence reactance for three-winding core transformer;
    (f) Tap changer range, step size and type (on-load or off-load); and
    (g) Basic lightning impulse insulation level (kV).

14. The GCP shall provide the following information for the switchgear, including circuit breakers and disconnect switches at the substation of the GCP:
    (a) Rated voltage (kV);
    (b) Rated current (A);
    (c) Rated symmetrical RMS short circuit current (kA); and
    (d) Basic lightning impulse insulation level (kV).

15. The GCP shall provide the details of its system grounding. This shall include the rated capacity and impedances of the grounding equipment.

16. The GCP shall provide the data on reactive power compensation equipment at the connection point and/or at the substation of the GCP. This shall include the following information:
    (a) rated capacity (MVar)
    (b) rated voltage (kV);
    (c) type (e.g. shunt capacitor, shunt reactor, static var compensator, etc);
    (d) resistance/reactance/susceptance of all components of the compensation device; and
    (e) operation and control details (fixed or switched, automatic or manual)

17. If a significant portion of the GCP's demand may be supplied from alternative connection point(s), the relevant information on the demand transfer capability shall be provided by the GCP, including the:
    (a) alternative connection point;
    (b) demand normally supplied from each alternative connection point;
    (c) demand which may be transferred from or to each alternative connection point; and
    (d) control (manual or automatic) arrangements for transfer including the time required to implement the transfer for forced outage and planned maintenance conditions.

18. If a distribution or GCP system has embedded generating plants, the short circuit contribution of the embedded generating plants shall be provided by the Distribution GCP or the Demand GCP. The short circuit currents shall be calculated in accordance with the IEC Standards or their equivalent national standards.

General Information

19. For each new connection from a Distribution GCP or otherDemand GCP, the following information is required:
    (a) load build-up curve (in the case of a new connection);
    (b) supply date start (start of load build-up);
    (c) load type (residential, commercial, factory, etc);
    (d) annual load factor;
    (e) power factor;
    (f) special requirements (e.g. Quality of supply); and
    (g) other information required to enable the TSO to provide a GCP with an appropriate supply.

Standard Planning Data for VRPPs

General:

20. Site:
    (a) Furnish location map to scale showing roads, Railway lines, Transmission lines, Rivers, and reservoirs if any.
    (b) Environmental (State whether forest, lands mining clearance areas are affected).

21. Site Map: (To scale) Showing area required for VRPP module, main Plant, buildings and location of VRPP Units.

22. Approximate period of construction.

23. Estimated Plant Load Factor.

24. Estimated Annual Generation.

Connection:

25. Connection Point: Furnish Single Line Diagram of the proposed connection with the system.

26. Step up voltage for connection in kV

Station Capacity:

27. Total VRPP module capacity (MW).

28. Ancillary Services provided - State the total installed capacity (in MW) of VRPP Units, and the total export capacity (in MW) at the Connection Point

29. No. of VRPP Units and Unit size MW & State whether development will be carried out in phases and if so, furnish details.

30. VRPP module and VRPP Unit Data:
    (a) Generator (Unit data):
        (i) Type
        (ii) Rating (MVA)
        (iii) Terminal Voltage (kV)
        (iv) Rated Power Factor
        (v) Frequency Response Table (where applicable)
        (vi) Reactive Power capability chart (MW/MVAr) at the VRPP Unit Terminals.
    (b) VRPP (module data):
        (i) Module capability chart (MW/MVAr) at the Connection Point
        (ii) Grid Transformer(s)
            - Rated Capacity (MVA)
            - Voltage Ratio (HV/LV)
            - Tap change range (+% to - %)
            - On-load or off-load tap change
            - Percentage Impedance (Positive Sequence at Full load).

Optional Planning Data: (For submission on request by Transmission GCP)

General:

31. Detailed Project report.

32. Status Report:
    (a) Land
    (b) Fuel type
    (c) Environmental clearance
    (d) Rehabilitation of displaced persons.

33. Approval by Liberia Electricity Regulatory Commission (LERC)

34. Financial tie-up in place.

35. Connection Agreement and Use of System Agreement in place

Connection:

36. Report of studies of parallel operation with Transmission System:
    (a) Load flow studies (including Reactive Power capability)
    (b) Stability studies (Fault Ride Through)

(c) Short Circuit studies

37. Proposed connection with Transmission System:
    (a) Voltage
    (b) Number of circuits
    (c) Connection Point

Technical Schedule TS–T: Timetable for Data & Information Submissions

Ref section/ sub-section	Responsible player	Description of submission	Deadline
4.2.1	GCPs	Non-compliance List of affected equipment to TSO for compilation and subsequent preparation of compliance plans.	3 months after commencement of the LEGC
4.2.5	TSO	Presentation of compiled Compliance Plans to GCAC and LERC	9 months after commencement of the LEGC
4.6.3	Transmission GCP / TSO	Negotiation of new contracts or amendment of existing contracts to conform with LEGC	One year (12 months) after commencement of the LEGC
5.4 (e)	GCAC	Analysis of any major grid disturbance	Within 14 calendar days after occurrence
5.5.8	TSO	Quarterly report on LITS performance to GCAC and LERC	14 days after the end of the quarter
5.5.10	GCAC	Semi-annual report on GCAC activities	6 weeks after the end of the period
5.6.6	TSO/GCP	Views and comments on LEGC revision proposal submitted to GCAC	3 months after receipt of proposal
5.6.11	GCAC	Notification of stakeholders on LERC approved revisions to the LEGC	1 week upon receipt of LERC approval
5.7.4	Affected GCPs	Comments/responses to lodged complaint by a complainant	30 days after receipt of complaint
5.8.3	TSO	Referral to GCAC of provisional action taken by TSO on an unforeseen occurrence	Within 14 days after taking the provisional action
6.4.5(d)	GCAC	Publication of minutes of GCAC meeting	10 working days after the meeting
7.3.2	TSO	Submission of initial 5-year GDP for approval by LERC	18 months after coming into force of LEGC
7.6.1	GCPs	Standard Planning Data (for Grid planning)	July 1st each year
7.6.3	GCPs	Detailed Planning Data (for Grid planning data)	Within 30 days upon TSO request
8.15.2	TSO / Transmission GCP	Notification of applicant on status of connection application	Within 60 days from the date of submission of the completed application
8.15.9	GCPs	Detailed planning data as part of connection proposal	Within 30 days after the signing of Connection MOU

8.15.14	TSO	Lodgment of Connection Agreement or Amended Connection Agreement with LERC	30 days after execution
Ref Section/ sub-section	**Responsible player**	**Description of submission**	**Deadline**
8.18.16	Generation GCP	Restoration of protection which was bypassed by agreement to normal settings	Within One (1) day after the bypass
8.21.9	GCPs	Additional measured quantities made available at connection point RTU	Within seven (7) days upon TSO notification
8.21.11	TSO/GCPs	Verification of measured quantities & indications for functionality of RTU	Once every three (3) years
8.24.4	TSO	Response to statement of readiness to connect	14 days after receipt of the statement
8.24.12	GCP	Design information of new or replacement equipment to TSO	Four (4) months prior to the planned commissioning date
8.24.13	TSO	Solicitation and compilation of GCP comments on newly proposed parameter settings	20 days after receipt of design parameter information from GCP
8.24.15	GCP	Commissioning program including test procedures for new or replacement equipment	Three 3 months prior to commencement of commissioning
8.24.16	TSO/Transmis sion GCP	Notification of GCP on decision of commissioning program	15 working days after receipt of the advice of readiness to commission
8.25.9	Transmission GCP/other relevant GCP	Revised electrical diagram of a LITS node in respect of connected equipment	One (1) month prior to addition or change of equipment
8.28.2	GCP	Notice of intention to inspect a LITS facility not owned by that GCP	At least two (2) days' notice
8.28.8	GCP	Inspection report to TSO/Transmission GCP after exercising right of entry	Seven (7) days after first entry
8.28.16	GCP's Testing officer	Report on any relevant tests carried out upon a GCP's request	Not exceeding two (2) weeks after the test
8.27.3 (c)	Generation GCP	Report on remedial actions undertaken to correct detected problems	Monthly interval report
8.31.1	GCP	Notification of intention to disconnect facility from the LITS permanently	Six (6) months prior notice
9.14.7	TSO	Notification of load shedding incident	60 minutes after action
9.15.4	TSO	Review and update of LITS Restoration Plan	At least annually

9.16.8 (b)	GCP	Written notification of TSO on removal of facility or equipment from service	Within 24 hours
9.16.14	GCP	Submission of outage needs for the next three years to TSO	15th June each year
9.16.18	TSO	Circulation of Initial Outage Plan for the next year and Provisional Outage Plan for a further two years	August 15th each year
Ref section/ sub-section	**Responsible player**	**Description of submission**	**Deadline**
9.16.20	TSO	Issue of the Committed Outage Plan for the next year	December 1st each year
9.16.22	GCP	Outage request for each month	30 days prior to start date of planned work
9.16.30	TSO	Quarterly report on outages, disputes etc.	15 days after the quarter
9.17.5	GCP	Request for carrying out proposed test	14 days before the proposed date of test
9.18.1	TSO	Periodic test of generating unit to assess performance	At least 12 months interval
9.18.2	TSO	Request for carrying out annual test of generating unit	14 days prior notice to the proposed test date
9.23.4	TSO	Monthly report on LITS operations	Within 15 days of the succeeding month
9.24.2	GCP	Notification through report of a forced outage, fault or Significant Incident	Within 24 hours of occurrence
9.24.2 (a)	Generation GCP	Reporting of loss of output, tripping and loss of governor control of a generating unit	Within 15 minutes of event occurring
9.24.2 (b)	Demand GCP	Reporting of (i) loss of major load and (ii) reconnection of major load	(i) Within 15 minutes of event occurring and (ii)15 minutes advance notice
9.24.2 (c)	International Transmission GCP	Tie line incident	As determined in Interconnection Agreement
9.24.6	TSO	Notification of forced outage, fault or Significant Incident to LITS equipment	Within 24 hours after occurrence of incident
9.24.15 (b)	TSO	Preliminary report on Significant Incident investigation	Within 3 days of occurrence of incident
9.24.15 (c)	TSO	Final report on Significant Incident investigation	Within 3 months of occurrence
9.24.19	TSO	Joint investigation of Significant Incident report to LERC	Within 10 days after receipt of report
10.6.3	GCP	Forecast hourly load profiles for each day of the next two weeks	One (1) week in advance

10.6.5 (a)	TSO	Hourly day-ahead dispatch schedule	As determined by MOR
10.6.5 (b)	TSO	Days 2-7 ahead load forecasts	As determined by MOR
10.6.5 (c)	TSO	Weekly demand forecast for 4 weeks ahead	As determined by MOR
10.6.5 (d)	TSO	Monthly demand forecast for 12 months ahead	As determined by MOR
10.9.1	Generation GCP	Dispatch Day generation data	One day ahead of Scheduled day
Ref Section/ sub-section	**Responsible player**	**Description of submission**	**Deadline**
10.9.5 (a)	Demand GCP	Dispatch Day hourly demand forecast	One (1) day ahead of scheduled day
10.13.2	Generation GCP	Generation unit capability and availability declaration data	At 10:00h each preceding day
10.13.4	Demand GCP	Requirements for power, energy, voltage and reactive power compensation, and system or network constraints	At 10:00h each preceding day
10.15.1	TSO	Issuing of Generation schedule for the next day	At 15:00h each day
12.7.4	TSO	LITS Reliability & Performance (i) Quarterly Report (ii) Annual Report	 1 month after quarter 2 months after end of the year
12.7.12	TSO	System overload report with relief plans	2 months after end of the year
13.11.6	GCP/TSO	Notification of routine testing of Main or Check meter	Seven (7) days in advance notice
14.6.1	GCP	Records of meter commissioning to TSO	Seven (7) days upon request
14.11.1	TSO	Reporting requirements: – (i) Daily (ii) Monthly iii) Annual Report	 (i) Mid-day of following day (ii) One week after end of the month (iii) Two months after end of the year.
14.11.3	TSO	System performance report for previous week	Monday of every week
TS-A (Par 8)	TSO	AFLS program determination for the succeeding year and publication of the Demand Management Guidelines in the System Operations Manual	November 1st of the preceding year

Technical Schedule TS – U: [Not Used]

Technical Schedule TS – V: Voltage Limits

1. LITS voltage magnitudes shall be kept within the following limits:
   (a) ±5% of the nominal voltage at all times under **Normal State**;
   (b) ±10% of the nominal voltage under **Alert State** for a period not exceeding 10 minutes;
   (c) ±10% of the nominal voltage under **Emergency State** for a period not exceeding 30 minutes.

2. Imbalance in phase voltage magnitude shall not exceed 3%.

3. Phase displacement between voltages shall be within the limits stated in the System Operations Manual of the TSO.

4. The maximum permissible voltage flicker limits shall be in accordance with IEC/TR3 61000-3-7 standard (or IEEE Standard 519- 1992 as alternative).

5. The maximum permissible harmonic limits shall be in accordance with IEC/TR3 61000-3-7 standard (or IEEE Standard 519- 1992 as alternative).

Technical Schedule TS – W: [Not Used]

Technical Schedule TS–X: Additional Post-Dispatch Information

1. The TSO shall provide the following minimum operational information in near real-time and as historic data in relation to each generating unit at each generating station:

Item no.	Data description	Format	Size	Unit
1.	Unit high limit	Real	999,99	MW
2.	Unit high low	Real	999,99	MW
3.	Unit AGC mode CER/BLO	Character 3		
4.	Unit AGC status AUT/OFF/MAN	Character 3		
5.	Unit set-point	Real	99,99	MW
6	AGC pulse	Real	9,9	
7.	Unit sent out	Real	999,99	MW
8.	Unit auxiliary	Real	999,99	MW
9.	Unit contract	Integer	999	MW
10.	Unit spinning	Integer	999	
11.	32-bit flag on AGC settings	Integer	32 bits	

2. The TSO shall provide the following minimum operational information in near real-time in relation to the overall dispatch performance:

Item no.	Data description	Format	Size	Unit
1.	ACE (Area Control Error)	Real	999,99	MW
2.	Average ACE previous hour	Real	999,99	MW
3.	HZ system frequency	Real	999,99	MW
4.	Frequency distribution current hour	Real	999,99	MW
5.	Frequency distribution previous hour	Real	99,99	MW
6	System total generation	Integer	99999	MW
7.	Control area total actual interchange	Integer	999,99	MW
8.	Control area total scheduled interchange	Integer	99999	MW
9.	System operating reserve	Integer	99999	MW
10.	System sent out	Integer	99999	MW
11.	System spinning reserve	Integer	99999	MW
12.	AGC regulating up	Integer	99999	MW
13.	AGC regulating down	Integer	99999	MW
14.	AGC regulating up assist	Integer	99999	MW
15.	AGC regulating down assist	Integer	99999	MW
16.	AGC regulating up emergency	Integer	99999	MW
17.	AGC regulating down emergency	Integer	99999	MW
18.	AGC mode	Character	TLBC /CFC	
19.	AGC status	Character	ON/ OFF	
20.	Area control error output	Real	999,99	MW
21.	System transmission losses	Real	999,99	MW
22.	Cross Border tie-line A	Integer	99999	MW
23.	Cross Border tie-line B	Integer	99999	MW
24.	AGC performance indicators			

PART H: APPENDICES

Part H, the Appendices, contains supplementary information or additional details of information that provide further clarification of specific provisions in certain Sections of the LEGC.

APPENDIX A: Connection Application Information

A.1 – Identification Information *(Apply to all applicant GCPs)*

1. Name of Applicant GCP:
2. Address:
3. Contact person:
4. Phone:
5. Fax:
6. Email:

A.2 – General Information *(Apply to all applicant GCPs)*

1. Project description:

(a) Name of project
(b) Scope of Activities/Production type
(c) Expectation output/Production capacity
(d) Projected beginning date of construction
(e) Projected operation date
(f) Current connection point
(g) Proposed connection point
(h) Proposed voltage level and number of connecting circuits
(i) Proposed transmission network connection date

2. Map and schemes:

(a) Provide a 1:50000 topographic map, with the location of Applicant's Project marked with an "X", connection point and related part of transmission network.
(b) Provide a plan of the site (1:200 or 1:500) indicating the proposed location for transmission station compound, generating units, transformers, site buildings, connection point...

3. Legal documentation:

Legal documentation including copy of the following:
(a) decision of establishment
(b) business registration
(c) investment license
(d) operational licenses
(e) EPA Permit
(f) any other legal licenses required

A.3 – Demand data/Information *(Apply to an applicant for Demand GCP)*

1. Power and energy requirements

(a) Active power (MW)
(b) Reactive power (MVAr)
(c) Energy per day/month/year (kWh)

2. Measured and forecast demand data

(a) **Measured demand data:** The existing Demand GCP is required to provide daily load curves of all days in the latest year with clear specification of –

(i) Active and reactive power received from TNO network;
(ii) Active and reactive power self - produced (if existing).
(iii) Monthly energy consumption and production of the latest years.

(b) **5 years forecast of demand:** The existing Demand GCP is required to provide:

(i) daily load curve forecast in peak day and peak-off day of every month for each of the 5 succeeding years from the official date of operation indicating separately the forecast MW and MVar received from the LITS and from self-supply; and
(ii) Monthly energy consumption for 5 next years with clear specification of which to expected from relevant GCP's transmission network and amount from self-supply.

(c) **The document on which above forecasts are based (if existing)**

3. Technical data of Demand GCP's network/system

(a) Electrical schemes: A Demand GCP is required to provide information on electrical schemes required for the connection site only as follows:

(i) System layout
(ii) Single line diagram including the following indications:
- ✓ Busbar arrangements
- ✓ Electrical circuits (overhead line, underground cable, transformers);
- ✓ Phase arrangements;
- ✓ Earthing arrangements;
- ✓ Switching facilities;
- ✓ Operating voltages;
- ✓ Protection configurations;
- ✓ Transmission network connection point; and
- ✓ Arrangements of reactive compensation equipment.

[NB: Any intended modification or/and future extension must be clearly specified.

(b) Switching equipment: A Demand GCP shall provide characteristics information on its switching equipment (breaker. disconnector) of all power circuits related to the connection point including the following:

(i) Rated and Operating voltage.
(ii) Rated current (A)
(iii) Rated 3-phased short circuits breaking current (kA)
(iv) Rated 1-phased short circuits breaking current (kA).
(v) Rated 3-phased load breaking current (kA)
(vi) Rated 1-phased load breaking current (kA)
(vii) Rated peak 3-phased short circuit making current (kA)

(viii) Rated peak 1-phased short circuit making current (kA)
(ix) Basic insulating level - BIL (kV)

(c) Transformers: The following characteristics for Demand GCP's transformers shall be provided:

(i) Rated voltage and winding arrangement
(ii) Rated MVA of each winding.
(iii) Tapped winding, tap changer type (on load or off load), tap change
(iv) range (number of tap and tap changer step size).
(v) Tap change cycle time
(vi) Earthing arrangement (neutral earthing resistance and reactance)
(vii) Saturation curve
(viii) Positive sequence resistance and reactance of transformer at
(ix) nominal, minimum and maximum tap (R+jX in % on rating MVA
(x) of transformer). For three windings transformer, where there are
(xi) external connections to all three windings, the resistance and
(xii) reactance between each pair of windings is required, measured with the third set of terminals open - circuit
(xiii) Zero-sequence resistance and reactance of transformer at nominal,
(xiv) minimum and maximum tap (Ω)
(xv) Basic insulation level (KV)

(d) Reactive compensation equipment (capacitors/shunts): Information to be provided by Demand GCP include:

(i) Type of equipment (fixed or variable), capacitive and/or inductive
(ii) rating or its operating range in MVAr.
(iii) Resistance / reactance, recharging/discharging current
(iv) For controlled capacitor/shunt, please provide details of control
(v) logic, controlled data such as voltage, load, switched or automatic,
(vi) operating time and other setting.

(e) VT) and CT: Information to be provided by Demand GCP include:

(i) Rated Ratio
(ii) Testing Certificates in accordance with the Metering Sub-code

(f) Protection and Control system: Information to be provided by Demand GCP include:

(i) Protection configurations
(ii) Proposed setting values
(iii) Fault clearing time of main and backup protection
(iv) Auto - re-closer cycles (if available)

(v) Control management and data communication

(g) Transmission lines and cables related to power connection point): Information to be provided by Demand GCP include:

(i) Resistance / reactance / capacitor
(ii) Rated and maximum loading current

4. Short circuit data: Information to be provided by Demand GCP shall include –

(a) The three-phase short circuit current (in-feed at the instant of fault and after sub-transient fault current contribution has substantially decayed) from GCP's system at connection point
(b) Zero sequence resistance and reactance values of GCP's system seen from the connection point.
(c) Voltage value before the fault consistent with the maximum fault current.
(d) Negative sequence resistance and reactance values of GCP's system seen from the connection point.
(e) Zero sequence resistance and reactance values of the Pi equivalent scheme of GCP's system (if existing).

5. Reserve requirement: Demand GCP that is supplied from two or more power resources, must clearly specify

(a) Type of reserve power resource
(b) Reserve capacity requirement (in MW and MVAr)

6. Load characteristics

(a) Information to be provided by Demand GCP shall include:

(i) Characteristic of the load
(ii) Power factor
(iii) Voltage sensitivity MW/kV, MVAr/kV
(iv) Frequency sensitivity MW/Hz, MVAr/Hz
(v) Maximum and average phase unbalance %
(vi) Maximum harmonic content
(vii) Long-term and short-term flicker severity
(viii) Load fluctuation

(b) Demand GCP with capacity requirement from 5 MW up at connection point is required to provide following data:

(i) Change rate of load (kW/s and kVAr/s) both increasing and decreasing.
(ii) The shortest repetitive time interval between load fluctuations (in seconds);
(iii) The magnitude of the largest step changes in power demand (kW, kVAr).

7. Any other requirements for power quality

A.4 – Power Plant Data/Information *(Apply to an applicant for Generation GCP)*

1. Plant description

(a) Name of power plant
(b) Location
(c) Type of plant (hydropower, thermal power, VRPP – Wind or Solar PV etc.)
(d) Number of generating units and rated capacity
(e) Estimated energy generation (MWh/month or year)
(f) Proposed export capacity (MW) into the LITS
(g) Proposed commercial operation time
(h) Proposed voltage level of connection point (kV)

2. Electrical scheme: A Generation GCP is required to provide information on electrical schemes required for the connection site only as follows

(a) System layout
(b) Single line diagram including the following indications:
- ✓ Busbar arrangement;
- ✓ Electrical circuits (power transmission line, cable, transformers);
- ✓ Phase arrangements;
- ✓ Earthing arrangements;
- ✓ Switching facilities;
- ✓ Operating voltages;
- ✓ Protective configurations;
- ✓ Transmission network connection point;
- ✓ Arrangements of reactive compensation equipment.

[NB: Any intended modification or/and future extension must be clearly specified.]

3. Generator Operating Characteristics:

(a) Parameter ratings - For each individual unit, fill in the following
(i) Unit number (#)
(ii) Rated capacity (MW)
(iii) Generator Rating (MVA)
(iv) Generating station auxiliary load (MW)
(v) Generating station auxiliary load (MVAr)
(vi) Terminal Voltage (kV)
(vii) Active Power range (MW-MW)
(viii) Reactive power generation at rated active power (MVAr)
(ix) Reactive power received at rated active power (MVAr)
(x) Short-circuit ratio
(xi) Rated stator current (A)
(xii) Rated rotor current at rated output (rated MW, rated power factor, rated terminal voltage) and rated speed of rotor (A)
(xiii) Rated rotor voltage (kV)

(b) Operating Characteristics - For each individual unit, fill in the following:

(i) Operation range of generating unit including thermal and exciter limits
(ii) Open circuit magnetization curve
(iii) Short-circuit characteristic
(iv) Zero-power factor curve
(v) Voltage curve
(vi) Time to synchronize from warm (h)
(vii) Time to synchronize from cold (h)
(viii) Minimum operation time
(ix) Minimum stop time
(x) Normal loading rate, MW/min
(xi) □ Normal de-loading rate, MW/min
(xii) Type of start-up fuel
(xiii) Ability to changing fuels on load
(xiv) Available modes
(xv) Time to change modes on load
(xvi) Control range for secondary frequency regulation system (SFRS) operation (MW)
(xvii) Other relevant operating characteristics

(c) Provide details of reserve capability of the generating unit in different operating modes.

(d) For thermal power plant, provide a functional block diagram of the main plant components, showing boilers, alternators, any heat or steam supplies.

4. Technical specifications

(a) For each generating unit the GCP shall provide [in per unit]

(i) Parameters Symbol and value
(ii) Direct axis synchronous reactance X_d
(iii) Direct axis transient reactance X'_d
(iv) Direct axis sub-transient reactance unsaturated X''_d
(v) Quadrature axis synchronous reactance X_q
(vi) Quadrature axis transient reactance unsaturated X'_q
(vii) Quadrature axis sub-transient reactance X''_q
(viii) Negative sequence reactance X_2
(ix) Zero sequence reactance X_o
(x) Stator resistance R_a
(xi) Stator leakage reactance X_L
(xii) Poiter reactance X_p
(xiii) Generator time constants symbol and value
(xiv) Direct axis open circuit transient T_{do}'(s)
(xv) Direct axis open circuit sub-transient T_{do}''(s)
(xvi) Quadrature axis open circuit transient T_{qo}'(s)

(xvii) Quadrature axis open circuit sub-transient T_{qo}''(s)
(xviii) Direct axis short-circuit transient Td'(s)
(xix) Direct axis short-circuit sub-transient Td''(s)
(xx) Quadrature axis short-circuit transient Tq'(s)
(xxi) Quadrature axis short-circuit sub-transient Tq''(s)

(b) Turbine generator inertia constant for entire rotating mass (MW-sec/MVA)*

5. Excitation system
The GCP shall provide data relating to excitation system and PSS in Laplace-domain control block diagram in accordance with IEEE standard excitation models (or as otherwise agreed with Transmission GCP) completely specifying all the time constants and gains.

6. Speed Governor system and stabilizer system
The GCP shall provide Laplace-domain control block diagram in accordance with IEEE standard (or as otherwise agreed with Transmission GCP) completely specifying all the time constants and gains.

7. Control and protection system
The GCP shall provide detailed information for control and protection system of the
Generating unit and plant.

8. Black start
The GCP shall provide information about black start system, if available.

9. Environmental impact
The GCP shall provide all information relating with gas emission (for thermal Power Plant) parameter values as follows:

(a) CO_2 gas:
(i) tonnes CO_2/tonnes fuel
(ii) CO_2 removal efficiency

(b) SO_2 gas:
(i) tonnes SO_2/tonnes fuel
(ii) SO_2 removal efficiency

(c) NOx gas:
(i) tonnes NOx/exported MWh curve

10. Pumped-storage power plant
The GCP shall provide following data:
(a) Reservoir capacity (MWh pumping)

(b) Maximum pumping capacity (MW)
(c) Minimum pumping capacity (MW)
(d) Maximum generating capacity (MW)
(e) Minimal generating capacity (MW)
(f) Efficiency (generating/pumping ratio) in %

11. Wind turbine generating station

The GCP shall provide following data:

(a) Type of turbine (fixed or variable speed);
(b) Manufacturer details on technical specifications and operating characteristics with particular reference to flicker and harmonic performance;
(c) Seasonal operation regimes of generation: seasonal or continues etc;
(d) List the anticipated maximum export level into the LITS' transmission network for each calendar month (MW);
(e) Typical daily generation curve of the month of maximum export;
(f) Details of expected rapid or frequent variations in output, including magnitude, maximum change rate, frequency and duration.

12. Forecast availability

(a) Expected maintenance requirement: specify weeks/year
(b) Availability (excluding expected scheduled maintenance requirements)

Availability Time %	Reason Available	Exported MW
(i) Full availability		
(ii) Partial availability		
(iii) Forced outage probability		
(iv) Total 100%		

(c) Energy Limitations
(d) Daily generation (GWh)
(e) Weekly generation (GWh)
(f) Monthly generation (GWh)
(g) Yearly generation (GWh)

[NB: A Hydropower plant shall provide expected generation (GWh) for each month in the year supported with reservoir regulation documentation.]

13. Technical data for electrical equipment at connection point

(a) Switching equipment: A Generation GCP shall provide characteristics information on its switching equipment (breakers. disconnector) of all power circuits related to the connection point including the following –

(i) Rated and operating voltage (kV)
(ii) Rated current (A)
(iii) Rated 3-phased short circuits breaking current (kA)
(iv) Rated 1-phased short circuits breaking current (kA).
(v) Rated 3-phased load breaking current (kA)
(vi) Rated 1-phased load breaking current (kA)

(vii) Rated peak 3-phased short circuit making current (kA)
(viii) Rated peak 1-phased short circuit making current (kA)
(ix) Basic insulating level - BIL (kV)

(b) Transformers: The following characteristics for a Generation GCP's transformers shall be provided –

(i) Rated voltage and winding arrangement
(ii) Rated MVA of each winding
(iii) Tapped winding, tap changer type (on load or off load), tap change range (number of tap and tap changer step size)
(iv) Tap change cycle time
(v) Earthing arrangement (neutral earthing resistance and reactance) saturation curve
(vi) Positive sequence resistance and reactance of transformer at nominal, minimum and maximum tap (R+jX in % on rating MVA of transformer). [NB: For three windings transformer, where there are external connections to all three windings, the resistance and reactance between each pair of windings is required, measured with the third set of terminals open circuit
(vii) Zero-sequence resistance and reactance of transformer at nominal, minimum and maximum tap (Ω)
(viii) Basic insulation level (KV)

(c) Reactive compensation equipment (capacitors/shunts): Information to be provided by a Generation GCP include:

(i) Type of equipment
- (fixed or variable),
- capacitive and/or inductive rating or
- its operating range in MVAr.

(ii) Resistance / reactance, recharging/discharging current
(iii) For controlled capacitor/shunt, also provide details of control logic, controlled data such as voltage, load, switched or automatic, operating time and other setting.

(d) VT and CT: Information to be provided by a Generation GCP include:

(i) Rated Ratio
(ii) Testing Certificates in accordance with the Measuring Sub-code

(e) Protection and Control system: Information to be provided by a Generation GCP include:

(i) Protection configurations
(ii) Proposed setting values
(iii) Fault clearing time of main and backup protection
(iv) Auto re-closer cycles (if available)
(v) Control management and data communication

(f) Transmission lines and cables related to power connection point

Information to be provided by a Generation GCP include:

(i) Resistance / reactance / capacitor

(ii) Rated and maximum loading current

14. Generation GCP's own consumption

The GCP shall provide following load forecast data for its own consumption:

(a) Maximum and minimum demand forecast

(b) Power energy requirement

(c) Load characteristic (*refer to Section A.3*)

APPENDIX B: Certification Test for Metering Equipment

B.1. Introduction

This Appendix B sets out those tests and checks that shall be performed by a manufacturer or a Meter Test Station to the meters and metering equipment prior to certification of compliance with the Metering Sub-code of the LEGC.

B.2. Measurement Transformers

B.2.1 Current transformer (CT)

2.1.1 The following tests shall be conducted in compliance with IEC 60044-1:

(a) Verification of marking and polarity wiring
(b) Impulse withstand test
(c) Power frequency voltage withstand test
(d) Interturn over-voltage test (injection 1 Amp on secondary)
(e) Partial discharge in accordance with IEC 60270-2000
(f) Short time over current test
(g) Limits of error test

B.2.2 Voltage Transformer (VT)

2.2.1 The following tests shall be conducted in compliance with IEC 60044-2

(a) Verification of marking and polarity wiring
(b) Impulse withstand test
(c) Power frequency voltage withstand test
(d) Partial discharge in accordance with IEC 60270-2000
(e) Induced over-voltage test by injecting 234V at 150c/s on secondary winding for 40 seconds
(f) Limits of error test

B.2.3 Combined VT/CT

2.3.1 The following type tests and routine tests shall be conducted according to IEC 60044-3 for a combined VT/CT type measurement transformer –

(a) Short time over-current test
(b) Temperature rise test
(c) Lightning Impulse test
(d) Switching Impulse test
(e) Wet Test for outdoor transformer
(f) Short CCT withstand capability on PT
(g) Limits of error test
(h) Measurement of the radio interference voltage

2.3.2 The following routine tests shall be conducted according to IEC 60044-3 for a combined VT/CT type measurement transformer:

(i) Verification of terminal marking.
(ii) Power frequency withstand test on the primary.
(iii) Partial discharge measurement for PT in accordance with IEC 60270 – 2000.
(iv) Power frequency withstand test on secondary.

(v) Power frequency withstand test between sections.
(vi) Inter-turn over-voltage test for CT.
(vii)Limits of error test.

B.3. Meters

B.3.1 Type tests

3.1.1 In accordance with the standards mentioned in this Code, samples of all meters shall satisfactorily fulfil the requirements of type tests.

3.1.2 The type tests required to be carried out are as listed in Table AP-B1 below:

Table AP-B1: Required Type Tests for Meters

Nr	**Tests**	**Electro-mechanical meters**	**Electronic meters**
1.	***Test of insulation properties***		
	Impulse voltage tests	X	X
	AC voltage tests	X	X
2.	***Tests of accuracy requirements***		
	Test of meter constant	X	X
	Test of starting condition	X	X
	Test of no-load condition	X	X
	Test of influence quantities	X	X
	Repeatability of error test	X	X
3.	***Tests of electrical requirements***		
	Test of power consumption	X	X
	Test of influence of supply voltage	X	X
	Test influence of short-time over-currents	X	X
	Test of influence of self-heating	X	X
	Test of influence of heating	X	X
	Test of immunity to earth fault	X	X
4.	***Test for electromagnetic compatibility (EMC)***		
	Radio interference suppression Fast transient burst		X
	test Damped oscillatory waves immunity test		X
	Test of immunity to conducted disturbances		X
	induced by radio-frequency fields		X
	Test of immunity to electrostatic discharges		X
	Surge immunity test		X
5.	***Tests of the effect of the climatic environments***		
	Dry heat test	X	X
	Cold test	X	X
	Damp heat, cyclic test	X	X
	Solar radiation test	X	X
6.	***Mechanical Tests***		
	Vibration test	X	X
	Shock test	X	X
	Spring hammer test	X	X
	Tests of protection against penetration of dust and	X	X
	water	X	X
	Test of resistance to heat and fire		

B.3.2 Routine tests

3.2.1 Upon supply, all meters are required to fulfill requirements of routine test comprising the following tests:

(a) A.C High Voltage Test
(b) Test of Meter Constant
(c) Test of Starting Condition
(d) Test of No-Load Condition
(e) Test of Influence Quantities

B.3.3 Acceptance tests

3.3.1 The following tests shall be conducted for meter samples for the purpose of Acceptance Test Certification:

(a) Test of Starting Condition
(b) Test of No-Load Condition
(c) Test of Power Consumption
(d) Voltage Variation Test
(e) Frequency Variation Test
(f) Test of Influence Quantities
(g) Repeatability of Error Test
(h) Power Frequency and Impulse Voltage Withstand Tests

3.3.2 Samples of meters shall be selected from the lot (batch) using the Single Plan Method provided in Table AP-B2:

Table AP-B2: Single Plan Method sample selection

Batch Size	Sample Size	Criterion	
		Acceptance	Rejection
1-50	All	No	No
51-150	13	0	1
151-500	50	1	2
501-1200	80	2	3

APPENDIX C: Metering Equipment Sealing Procedure

C.1. Sealing Procedure at the Laboratory

1.1 Every meter cover shall be sealed after certification at the laboratory by the Meter Test Officer. For Maximum Demand (MD) meter, the meter terminal cover shall also be sealed.

1.2 The Meter Test Station shall keep records of the seals fixed on meters certified by the Station.

C.2. Sealing Procedure at the Point of Installation

2.1 Every meter terminal cover shall be sealed after installation at the customer premises in the case of 1-phase and 3-phase meters.

2.2 For MD meters, the terminal cover test terminal block, CT terminal, VT terminals, voltage fuse holders, meter boxes/cubicle shall be sealed by the meter installer.

2.3 The sealing procedure described in Sections C.2.1 and C.2.2 above shall be witnessed by the representative of the customer.

2.4 A certificate duly signed by the meter installer and the customer, or his representative shall be issued by both parties

2.5 For meters at the wholesale electricity trading points, a copy of the certificate shall be forwarded to the Market Operator for update of the records.

2.6 The sealing certificate shall contain the following information: -

(a) Present seal serial number,
(b) Previous seal serial number
(c) Date of sealing
(d) Purpose of sealing
(e) Meter serial number
(f) Name of the Installer
(g) Name and signatures of Meter Installer
(h) Name and signature of Customer or his representative.

C.3. Sealing Procedure at the Point of Maintenance, Recalibration, Inspection etc.

3.1 Breaking of seals shall be done in the presence of the customer or his representative for any of the following purposes:

(a) Maintenance
(b) Recalibration
(c) Inspection
(d) Site testing

3.2 All the sealable points where seals were broken for any of the purposes in sub-section C.3.3.1 shall be resealed in the presence of the customer, or his representative and an updated seal certificate issued.

3.3 For meters at the wholesale electricity trading points procedure as in the PPA or PSA shall be followed.

3.4 A sealing certificate for this purpose shall contain information listed under sub-section C.3.2.6.

C.4 Seal Specifications

The specifications for seals shall be as specified in Table AP-C1

Table AP-C1: Specification for Seals

Feature	Specification
Type	Compressible or non-compressible type
Material	Plastic with embossed serial number
Temperature Range	To withstand operating temperature of up to 70°C
Color	Any color
Wire Dimension	Not more than 2.5mm^2 cross-sectional area
Average Break Strength	Reasonably large break strength

C.5 Sealing Points

Recommended sealing points for every metering system shall be the following:

(a) Meter cover
(b) Meter terminal cover
(c) Meter battery cover
(d) Test terminal cover
(e) Voltage fuses & Links
(f) CTs and VTs terminals
(g) Associated circuits, and
(h) Metering box or cubicles