

## **FOREWORD**

The Sudan Grid Code establishes the basic rules, requirements, procedures, and standards that govern the operation, maintenance, and development of the high-voltage backbone Transmission System in Sudan. The Grid Code identifies and recognizes the responsibilities and obligations of three (3) key independent functional groups, namely (a) Grid Owner, (b) System Operator, and (c) Market Operator. These functional groups and all Users of the Grid must comply with all the provisions of the Grid Code. The Grid Code is intended to be used with the Market Rules of the Electricity Market to ensure the safe, reliable, and efficient operation of the Grid.

The Grid Code was prepared using a functional rather than an organizational format so that it will remain robust and require minimum changes as the Sudan electric power industry is transformed to its new organizational structure.

The safe, reliable, and efficient operation of the Grid requires the cooperation of all industry participants. It is important that all Grid Users follow the instructions and orders of the System Operator to ensure the reliable operation of the Grid. The System Operator will work closely with the Market Operator to dispatch the generation schedule and provide the necessary support in satisfying the technical and operational requirements of real-time control of the Grid.

The policies and decisions of the Grid Owner, System Operator, and Market Operator on matters involving the operation, maintenance, and development of the Grid will affect all industry participants and end-users. It is important, therefore, that all affected parties have a voice in making decisions and policies involving the operation, maintenance, and development of the Grid. The Grid Code provides this mechanism through the Grid Management Committee (GMC), which will relieve the Electricity Regulatory Authority (ERA) from the tedious task of monitoring the day-to-day operation of the Grid.

The Sudan Grid Code (SGC) is organized into nine (9) Chapters. These are:

Chapter 1. Grid Code General Conditions

Chapter 2. Grid Management

Chapter 3. Performance Standards for Transmission

Chapter 4. Safety Code

Chapter 5. Connection Code

Chapter 6. Planning Code

Chapter 7. Operation Code

Chapter 8. Interchange Scheduling and Dispatch Code

Chapter 9. Metering Code

Chapter 1 of the SGC cites the legal and regulatory framework for the promulgation and enforcement of the Sudan Grid Code. It also specifies the general provisions that apply to all the other Chapters of the Grid Code and contains articles on definition of terms and abbreviations used in the Grid Code.

Chapter 2 of the SGC specifies the guidelines for Grid Management, the procedure for dispute resolution, the required operational reports, and the process for Grid Code enforcement and revision.

Chapter 3 of the SGC specifies the performance standards for the transmission of electricity that applies to the Grid Owner and the System Operator to ensure power quality and the efficiency and reliability of the Grid. The safety standards for the protection of personnel in the work environment are also included in this Chapter.

Chapter 4 of the SGC specifies the financial capability standards in the generation and transmission sectors to safeguard against the risk of financial non-performance, ensure the affordability of electric power supply, and to protect the public interest.

Chapter 5 of the SGC specifies the procedures and requirements to be complied with by any User who seeking connection or modification of existing connection to the Grid. It also specifies the minimum technical, design, and operational criteria in the Grid.

Chapter 6 of the SGC specifies the technical criteria and procedures to be applied by the Grid Owner in planning the development or reinforcement of the Grid and to be taken into account by Users in planning the expansion of their own Systems.

Chapter 7 of the SGC establishes the rules and procedures to be followed by the Grid Owner, System Operator, and all Users to ensure the safe and reliable operation of the Grid.

Chapter 8 of the SGC establishes the rules, procedures and requirements for generation Scheduling for real-time dispatch and control in order to compensate for imbalances in Active Power and to provide the Ancillary Services that are required to ensure power quality and the reliability and Security of the Grid.

Chapter 9 of the SGC specifies the technical requirements pertaining to the measurement of electrical quantities associated with the transactions for the supply of electricity.

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## **Chapter 1 Grid Code General Conditions**

### **1.1 Purpose and scope**

#### **1.1.1 Purpose**

- (a) To cite the legal and regulatory framework for the promulgation and enforcement of the Sudan Grid Code;
- (b) To specify the general rules pertaining to data and notices that apply to all Chapters of the Grid Code;
- (c) To specify the rules for interpreting the provisions of the Grid Code; and
- (d) To define the common and significant terms and abbreviations used in the Grid Code.

#### **1.1.2 Scope of Application**

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) The Market Operator;
- (d) Generators;
- (e) Distributors;
- (f) Suppliers; and
- (g) Any other entity with a User System connected to the Grid.

### **1.2 Authority and Applicability**

#### **1.2.1 Authority**

The Act provides the Electricity Regulatory Authority (ERA) the authority to promulgate the Sudan Grid Code.

#### **1.2.2 Applicability**

1.2.2.1 The Sudan Grid Code applies to the national Grid .

1.2.2.2 The ERA shall promulgate the rules and regulations that will apply to



the small Grids, which are not connected to the national Grid.

## **1.3 Enforcement and suspension of provisions**

### **1.3.1 Enforcement**

1.3.1.1 The Act assigns to the ERA the responsibility of enforcing the Grid Code.

1.3.1.2 The ERA shall establish the Grid Management Committee (GMC) to monitor Grid Code compliance at the operations level and to submit regular and special reports pertaining to Grid operations.

1.3.1.3 The (GMC) shall also initiate an enforcement process for any perceived violations of Grid Code provisions and recommend to the ERA the appropriate fines and penalties for such violations.

### **1.3.2 Suspension of Provisions**

Any provision of the Grid Code may be suspended, in whole or in part, when the Grid is not operating in the Normal State or pursuant to any directive given by the ERA or the appropriate government agency.

## **1.4 Data, Notices, and Confidentiality**

### **1.4.1 Data and Notices**

1.4.1.1 The submission of any data under the Grid Code shall be done through electronic format or any suitable format agreed upon by the concerned parties.

1.4.1.2 Written notices under the Grid Code shall be served either by hand delivery, registered first-class mail, or facsimile transfer.

### **1.4.2 Confidentiality**

1.4.2.1 All data submitted by any Grid User to the Grid Owner, System Operator or Market Operator in compliance with the data requirements of the Grid Code, shall be treated by the Grid Owner, System Operator, or Market Operator as confidential. These include data requirements for connection to the Grid and those that are required in the planning, operation, and maintenance of the Grid.

1.4.2.2 Aggregate data shall be made available by the Grid Owner or the System Operator when requested by a User. These data shall be used only for

the purpose specified in the request and shall be treated by the User as confidential.

## **1.5 Construction of References**

### **1.5.1 References**

Unless the context otherwise requires, any reference to a particular Chapter, Article, Section, Subsection, or Appendix of the Grid Code shall be applicable only to that Chapter, Article, Section, Subsection, or Appendix to which the reference is made.

### **1.5.2 Cross-References**

A cross-reference to another document shall not in any way impose any condition or modify the material contained in the document where such cross-reference is made.

### **1.5.3 Definitions**

When a word or phrase that is defined in the Definitions Article is more particularly defined in another Article, Section, or Subsection of the Grid Code, the particular definition in that Article, Section, or Subsection shall prevail if there is any inconsistency.

### **1.5.4 Foreword, Table of Contents, and Titles**

The Table of Contents was added for the convenience of the users of the Grid Code. The Table of Contents, the Foreword, and the titles of the Chapters, Articles, and Sections shall not be considered in interpreting the Grid Code provisions.

### **1.5.5 Mandatory Provisions**

The word “shall” refers to a rule, procedure, requirement, or any provision of the Grid Code that requires mandatory compliance.

### **1.5.6 Singularity and Plurality**

In the interpretation of any Grid Code provision, the singular shall include the

plural and vice versa, unless otherwise specified.

### **1.5.7 Gender**

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

### **1.5.8 “Include” and “Including”**

The use of the word “include” or “including” to cite an enumeration shall not impose any restriction on the generality of the preceding words.

### **1.5.9 “Written” and “In Writing”**

The words “written” and “in writing” refer to the hardcopy of a document that is generally produced by typing, printing, or other methods of reproducing words in a legible format.

### **1.5.10 Repealing Clause**

All existing rules and regulations, orders, resolutions, and other similar issuances, or parts thereof, which are inconsistent with the provisions of the Sudan Grid Code are hereby repealed or modified accordingly.

## **1.6 Definitions**

In the Grid Code the following words and phrases shall, unless more particularly defined in an Article, Section, or Subsection of the Grid Code, have the following meanings:

#### **Accountable Manager :**

A person who has been duly authorized by the Grid Owner (or a User) to sign the Fixed Asset Boundary Documents on behalf of the Grid Owner (or the User).

#### **Active Energy :**

The integral of the Active Power with respect to time, measured in Watt-hour (Wh) or multiples thereof. Unless otherwise qualified, the term “Energy”

refers to Active Energy.

**Active Power :**

The time average of the instantaneous power over one period of the electrical wave, measured in Watts (W) or multiples thereof. For AC circuits or Systems, it is the product of the root-mean-square (RMS) or effective value of the voltage and the RMS value of the in-phase component of the current. In a three-phase System, it is the sum of the Active Power of the individual phases.

**Administrative Loss :**

The component of System Loss that refers to the Energy used in the proper operation of the Grid ( *e.g.* station service) that is not classified as Technical Loss or Non-technical Loss.

**Adverse Weather :**

A weather condition that results in abnormally high rate of Forced Outages for exposed Components while such condition persists, but does not qualify as a Major Storm Disaster. An Adverse Weather condition can be defined for a particular System by selecting the proper values and combinations of the weather conditions reported by the Weather Bureau including thunderstorm, wind velocity, precipitation, and temperature.

**Alert Warning :**

A notice issued by the System Operator, including Yellow Alert, Blue Alert, and Red Alert, to notify the Grid Users that an alert state exists.

**Amended Connection Agreement :**

An agreement between a User and the Grid Owner (or the Distributor), which specifies the terms and conditions pertaining to the renovation or modification of the User System or Equipment at an existing Connection Point in the Grid (or the Distribution System).

**Ancillary Service :**

Support services such as Frequency Regulating and Contingency Reserves, Reactive Power support, and Black Start capability which are necessary to support the transmission capacity and Energy that are essential in maintaining Power Quality and the Reliability and Security of the Grid.

**Apparent Power :**

The product of the root-mean-square (RMS) or effective value of the current and the root-mean-square value of the voltage. For AC circuits or systems, it

is the square root of the sum of the squares of the Active Power and Reactive Power, measured in volt-ampere (VA) or multiples thereof.

**Asset Transfer Date :**

Such date as may be appointed by the Secretary of the Energy Committee (EC) by order of the Act for the transfer of the Grid Owner's assets to Users or vice versa.

**Automatic Generation Control (AGC) :**

The regulation of the power output of Generating Units within a prescribed area in response to a change in system Frequency, interconnection loading, or the relation of these to each other, so as to maintain the System Frequency or the established interchange with other areas within the predetermined limits or both.

**Automatic Load shedding(ALSH) :**

The process of automatically and deliberately removing pre-selected Loads from a power System in response to an abnormal condition in order to maintain the integrity of the System.

**Availability :**

The long-term average fraction of time that a Component or System is in service and satisfactorily performing its intended function. Also, the steady-state probability that a Component or System is in service.

**Average Assets :**

The average of the assets at the beginning and end of the period.

**Average Collection Period :**

The ratio of average receivables to daily sales.

**Average Inventory :**

The average of the inventory at the beginning and end of the period.

**Average Receivables :**

The average of the accounts receivable at the beginning and end of the period.

**Average Sales :**

The average of the sales at the beginning and end of the period.

**Backup Protection :**

A form of protection that operates independently of the specified Components in the primary protective System. It may duplicate the primary protection or may be intended to operate only if the primary protection fails or is temporarily out of service.

**Backup Reserve :**

Refers to a Generating Unit that has Fast Start capability and can Synchronize with the Grid to provide its declared capacity for a minimum period of eight (8) hours. Also called Cold Standby Reserve.

**Balanced Three-Phase Voltages :**

Three sinusoidal voltages with equal frequency and magnitude and displaced from each other in phase by an angle of 120 degrees.

**Black Start :**

The process of recovery from Total System Blackout using a Generating Unit with the capability to start and synchronize with the System without an external power supply.

**Blue Alert :**

A notice issued by the System Operator when a tropical disturbance is expected to make a landfall within 24 hours.

**Business Day** . Any day on which banks are open for business.

**Capability and Availability Declaration :**

Refers to the data submitted by the Generator for its Scheduled Generating Unit, which is used by the Market Operator in preparing the day-ahead Generation Schedule. It includes declaration of capability and availability, Generation Scheduling and Dispatch Parameters, and Price Data.

**Central Dispatch :**

The process of issuing direct instructions to the electric power system participants by the System Operator to achieve an economic operation while maintaining Power Quality, Stability, and the Reliability and Security of the Grid.

**Circuit Breaker :**

A mechanical switching device, which is capable of making, carrying, and breaking current under normal circuit conditions and also capable of making,

carrying for a specified time, and breaking current under specified abnormal circuit conditions, such as a short circuit.

**Committed Project Planning Data :**

The data pertaining to a User Development once the offer for a Connection Agreement or an Amended Connection Agreement is accepted.

**Completion Date :**

The date, specified in the Connection Agreement or Amended Connection Agreement, when the User Development is scheduled to be completed and be ready for connection to the Grid.

**Component :**

A piece of Equipment, a line or circuit, a section of line or circuit, or a group of items, which is viewed as a unit for a specific purpose.

**Connected Project Planning Data :**

The data which replaces the estimated values that were assumed for planning purposes, with validated actual values and updated estimates for the future and by updated forecasts, in the case of forecast data.

**Connection Agreement :**

An agreement between a User and the Grid Owner (or the Distributor), which specifies the terms and conditions pertaining to the connection of the User System or Equipment to a new Connection Point in the Grid (or the Distribution System).

**Connection Point :**

The point of connection of the User System or Equipment to the Grid (for Users of the Grid) or to the Distribution System (for Users of the Distribution System).

**Connection Point Drawings :**

The drawings prepared for each Connection Point, which indicate the equipment layout, common protection and control, and auxiliaries at the Connection Point.

**Constrained Generation Schedule :**

The Generation Schedule prepared by the Market Operator after considering operational constraints, including the Grid constraints, changes in Generating Unit Declared Data and parameters, and changes in forecasted data.

**Contingency Reserve :**

Generating Capacity that is intended to take care of the loss of the largest Synchronized Generating Unit or the power import from a single Grid interconnection, whichever is larger. Contingency Reserve includes Spinning Reserve and Backup Reserve.

**Control Center :**

A facility used for monitoring and controlling the operation of the Grid, Distribution System, or a User System.

**Critical Loading :**

Refers to the condition when the loading of transmission lines or substation Equipment is between 80 percent and 100 percent of the continuous rating.

**Customer :**

Any person/entity supplied with electric service under a contract with a Distributor or Supplier.

**Customer Demand Management :**

The reduction in the Supply of Electricity to a Customer or the disconnection of a Customer in a manner agreed upon for commercial purposes, between a Customer and its Generator, Distributor, or Supplier.

**Customer Self-Generating Plant:**

A customer with one or more Generating Units not subject to Central Dispatch, to the extent that it operates exclusively to supply all or part of its own electricity requirements, and does not export electrical power using the Distribution System.

**Days in Inventory :**

The ratio of average inventory to cost of goods sold per day.

**Debt-Equity Ratio :**

The ratio of long-term debt to total long-term capital.

**Debt Ratio :**

The ratio of total liabilities to total assets.



**Declared Data :**

The data provided by the Generator in accordance with the latest/current Generating Unit parameters.

**Declared Net Capability :**

The Capability of a Generating Unit as declared by the Generator net of station service.

**Degradation of the Grid:**

A condition resulting from a User Development or a Grid expansion project that has a Material Effect on the Grid or the System of other Users and which can be verified through Grid Impact Studies.

**Demand :**

The Active Power and/or Reactive Power at a given instant or averaged over a specified interval of time, that is actually delivered or is expected to be delivered by an electrical Equipment or supply System. It is expressed in Watts (W) and/or VARs and multiples thereof.

**Demand Control :**

The reduction in Demand for the control of the Frequency when the Grid is in an Emergency State. This includes Automatic Load Shedding, Manual Load Shedding,, demand reduction upon instruction by the System Operator, demand disconnection initiated by Users, Customer Demand Management, and Voluntary Load Curtailment.

**Demand Control Imminent Warning :**

A warning from the System Operator, not preceded by any other warning, which is issued when a Demand Reduction is expected within the next 30 minutes.

**Demand Forecast :**

The projected Demand and Active Energy related to a Connection Point in the Grid.

**Energy Committee (EC):**

The government agency created pursuant to the Act which is provided with the additional mandate under the Act of supervising the restructuring of the electricity industry, developing policies and procedures, formulating and implementing programs, and promoting a system of incentives that will encourage private sector investments and reforms in the electricity industry

and ensuring an adequate and reliable supply of electricity.

**Detailed Planning Data:**

Additional data, which the Grid Owner requires, for the conduct of a more accurate Grid planning study.

**Disconnection:**

The opening of an electrical circuit to isolate an electrical System or Equipment from a power source.

**Dispatch :**

The process of apportioning the total Demand of the Grid through the issuance of Dispatch Instructions to the Scheduled Generating Units and the Generating Units providing Ancillary Services in order to achieve the operational requirements of balancing Demand with generation that will ensure the Security of the Grid.

**Dispatch Instruction :**

Refers to the instruction issued by the System Operator to the Generators with Scheduled Generating Units and the Generators whose Generating Units will provide Ancillary Services to implement the final Generation Schedule in real time.

**Dispute Resolution Panel :**

A panel appointed by the (GMC) to deal with specific disputes relating to violations of the provisions of the Grid Code (or Distribution Code).

**Distribution Code :**

The set of rules, requirements, procedures, and standards governing Distribution Utilities and Users of Distribution System in the operation, maintenance and development of the Distribution System. It also defines and establishes the relationship of the Distribution System with the facilities or installations of the parties connected thereto.

**Distribution of Electricity :**

The conveyance of electric power by a Distribution Utility through its Distribution System.

**Distribution System :**

The system of wires and associated facilities belonging to a franchised

Distribution Utility, extending between the delivery points on the transmission, sub-transmission system, or Generating Plant connection and the point of connection to the premises of the End-User.

**Distribution Utility :**

An Electric Cooperative, private corporation, government-owned utility, or existing local government unit that has an exclusive franchise to operate a Distribution System.

**Distributor** . Has the same meaning as Distribution Utility.

**Dynamic Instability :**

A condition that occurs when small undamped oscillations begin without any apparent cause because the Grid is operating too close to an unstable condition.

**Earth Fault Factor :**

The ratio of the highest RMS phase-to-ground power Frequency voltage on a sound phase, at a selected location, during a fault to ground affecting one or more phases, to the RMS phase-to-ground power Frequency voltage that would be obtained at the selected location with the fault removed.

**Electric Cooperative :**

A cooperative or corporation authorized to provide electric Services, within the framework of the national rural electrification plan.

**Electrical Diagram :**

A schematic representation, using standard electrical symbols, which shows the connection of Equipment or power System Components to each other or to external circuits.

**Embedded Generating Plant :**

A Generating Plant that is connected to a Distribution System or the System of any User and has no direct connection to the Grid.

**Embedded Generating Unit :**

A Generating unit within an Embedded Generating Plant.

**Embedded Generator :**

A person or entity that generates electricity using an Embedded Generating Plant.

**Emergency State :**

The Grid operating condition when a Multiple Outage Contingency has occurred without resulting in Total System Blackout and any of the following conditions is present: (a) generation deficiency exists; (b) Grid transmission voltages are outside the limits of 0.90 and 1.10; or (c) the loading level of any transmission line or substation Equipment is above 110 percent of its continuous rating.

**End-User :**

A person or entity that requires the supply and delivery of electricity for its own use.

**Energy.**

Unless otherwise qualified, refers to the Active Energy.

**The Electricity Regulatory Authority (ERA) :**

The independent, quasi-judicial regulatory body created, which is mandated to promote competition, encourage market development, ensure customer choice, and penalize abuse of market power in the restructured electricity industry and among other functions, to promulgate and enforce the Sudan Grid Code.

**Equipment :**

All apparatus, machines, conductors, etc. used as part of, or in connection with, an electrical installation.

**Equipment Identification :**

The System of numbering or nomenclature for the identification of Equipment at the Connection Points in the Grid.

**Event :**

An unscheduled or unplanned occurrence of an abrupt change or disturbance in a power System due to fault, Equipment Outage, or Adverse Weather Condition.

**Expected Energy Not Supplied (EENS) ;**

The expected Energy curtailment due to generating capacity Outages in the specified period.

**Extra High Voltage (EHV) :**

A voltage level exceeding 220 kV up to 500 kV.

**Fast Start .**

The capability of a Generating Unit or Generating Plant to start and synchronize with the Grid within 15 minutes.

**Fault Clearance Time :**

The time interval from fault inception until the end of the arc extinction by the Circuit Breaker.

**Fault Level :**

The expected current, expressed in kA or in MVA, that will flow into a short circuit at a specified point in the Grid or System.

**Financial Current Ratio :**

The ratio of current assets to current liabilities.

**Financial Efficiency Ratio :**

A financial indicator that measures the productivity in the entity's use of its assets.

**Financial Year :**

The same as the calendar year.

**Fixed Asset Boundary Document :**

A document containing information and which defines the operational responsibilities for the Equipment at the Connection Point.

**Flicker :**

The impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

**Forced Outage :**

An Outage that results from emergency conditions directly associated with a Component, requiring that it be taken out of service immediately, either automatically or as soon as switching operations can be performed. Also, an Outage caused by human error or the improper operation of Equipment.

**Franchise Area :**

A geographical area assigned or granted to a Distributor for the Distribution of Electricity.

**Frequency :**

The number of complete cycles of a sinusoidal current or voltage per unit time, usually measured in cycles per second or Hertz.

**Frequency Control :**

A strategy used by the System Operator to maintain the Frequency of the Grid within the limits prescribed by the Grid Code by the timely use of Frequency Regulating Reserve, Contingency Reserve, and Demand Control.

**Frequency Regulating Reserve :**

Refers to a Generating Unit that assists in Frequency Control by providing automatic Primary and/or Secondary Frequency response.

**Frequency Variation :**

The deviation of the fundamental System Frequency from its nominal value.

**Generating Plant:**

A facility, consisting of one or more Generating Units, where electric Energy is produced from some other form of Energy by means of a suitable apparatus.

**Generating Unit:**

A conversion apparatus including auxiliaries and associated Equipment, functioning as a single unit, which is used to produce electric Energy from some other form of Energy.

**Generation Company :**

Any person or entity authorized by the ERA to operate a facility used in the Generation of Electricity.

**Generation of Electricity :**

The production of electricity by a Generation Company.

**Generation Schedule :**

Refers to the schedule that indicates the hourly output of the Scheduled Generating Units and the list of Generating Units that will provide Ancillary Services for the next Schedule Day.

**Generation Scheduling and Dispatch Parameters :**

Refers to the technical data pertaining to the Scheduled Generating Units,

which are taken into account in the preparation of the Generation Schedule.

**Generator :**

Has the same meaning as Generation Company.

**Good Industry Practice:**

The practices and methods not specified in specific standards but are generally accepted by the power industry to be sound and which ensure the safe and reliable planning, operation, and maintenance of a power System.

**Grid :**

The high voltage backbone System of interconnected transmission lines, substations, and related facilities for the purpose of conveyance of bulk power. Also known as the Transmission System.

**Grid Code :**

The set of rules, requirements, procedures, and standards to ensure the safe, reliable, secured and efficient operation, maintenance, and development of the high voltage backbone Transmission System and its related facilities.

**Grid Impact Studies :**

A set of technical studies which are used to assess the possible effects of a proposed expansion, reinforcement, or modification of the Grid or a User Development and to evaluate Significant Incidents.

**Grid Owner :**

The party that owns the high voltage backbone Transmission System and is responsible for maintaining adequate Grid capacity in accordance with the provisions of the Grid Code.

**Grounding :**

A conducting connection by which an electrical circuit or Equipment is connected to earth or to some conducting body of relatively large extent that serves as ground.

**Harmonics :**

Sinusoidal voltages and currents having frequencies that are integral multiples of the fundamental frequency.

**High Voltage (HV) :**

A voltage level exceeding 34.5 kV up to 220 kV.

**IEC Standard .**

The international standard for electro-technical Equipment approved and published by the International Electrotechnical Commission.

**Imminent Overloading :**

Refers to the condition when the loading of transmission lines or substation Equipment is above 100 percent up to 110 percent of the continuous rating.

**Implementing Safety Coordinator :**

The Safety Coordinator assigned by the Grid Owner (or the User) to establish the requested Safety Precautions in the User System (or the Grid).

**Interest Cover :**

The ratio of earnings before interest and taxes plus depreciation to interest plus principal payments made during the year.

**Interruption :**

The loss of service to a Customer or a group of Customers or other facilities. An Interruption is the result of one or more Component Outages.

**Interruption Duration :**

The period from the initiation of an Interruption up to the time when electric service is restored.

**Island Grid :**

A Generating Plant or a group of Generating Plants and its associated load, which is isolated from the rest of the Grid but is capable of generating and maintaining a stable supply of electricity to the Customers within the isolated area.

**Isolation :**

The electrical separation of a part or Component from the rest of the electrical System to ensure safety when that part or Component is to be maintained or when electric service is not required.

**Large Customer :**

A Customer with a demand of at least one (1) MW, or the threshold value specified by the **ERA**.



**Large Generator :**

A Generation Company whose generating facility at the Connection Point has an aggregate capacity in excess of 20 MW.

**Leverage Ratio :**

A financial indicator that measures how an entity is heavily in debt.

**Liquidity Ratio :**

A financial indicator that measures the ability of an entity to satisfy its short-term obligations as they become due.

**Load :**

An entity or an electrical Equipment that consumes electrical Energy.

**Load Factor:**

The ratio of the total Energy delivered during a given period to the product of the maximum Demand and the number of hours during the same period.

**Load Reduction :**

The condition in which a Scheduled Generating Unit has reduced or is not delivering electrical power to the System to which it is Synchronized.

**Local Safety Instructions :**

A set of instructions regarding the Safety Precautions on HV or EHV Equipment to ensure the safety of personnel carrying out work or testing on the Grid or the User System.

**Long Duration Voltage Variation :**

A variation of the RMS value of the voltage from nominal voltage for a time greater than one (1) minute.

**Long Term Flicker Severity :**

A value derived from twelve (12) successive measurements of Short Term Flicker Severity over a two-hour period. It is calculated as the cube root of the mean sum of the cubes of twelve (12) individual measurements.

**Loss of Load Probability (LOLP):**

The expected number of days in a specified period in which the daily peak Demand will exceed the available generating capacity.

**Low Voltage:**

A voltage level not exceeding 1000 volts.

**Maintenance Program :**

A set of schedules, which are coordinated by the Grid Owner and the System Operator, specifying planned maintenance for Equipment in the Grid or in any User System.

**Major Storm Disaster :**

A weather condition wherein the design limits of Equipment or Components are exceeded, and which results in extensive mechanical fatigue to Equipment, widespread customer Interruption, and unusually long service restoration time.

**Manual Load Shedding (MLSH) :**

The process of manually and deliberately removing pre-selected Loads from a power System, in response to an abnormal condition, and in order to maintain the integrity of the System.

**Market Operator :**

An independent group, with equitable representation from the electric power industry participants, whose task includes the operation and administration of the Wholesale Electricity Spot Market in accordance with the Market Rules.

**Material Effect :**

A condition that has resulted or is expected to result in problems involving Power Quality, System Reliability, System Loss, and safety. Such condition may require extensive work, modification, or replacement of Equipment in the Grid or the User System.

**Medium Voltage (MV) :**

A voltage level exceeding one (1) kV up to 34.5 kV.

**Merit Order Table:**

Refers to the list showing the offer prices and the corresponding capacity of the Scheduled Generating Units arranged in a manner such that the lowest offer price is at the top of the list.

**Minimum Stable Loading :**

The minimum Demand that a Generating Unit can safely maintain for an indefinite period of time.

**Modification :**

Any actual or proposed replacement, renovation, or construction in the Grid or the User System that may have a Material Effect on the Grid or the System of any User.

**Momentary Average Interruption Frequency Index (MAIFI):**

The total number of momentary customer power Interruptions within a given period divided by the total number of customers served within the same period.

**Momentary Interruption :**

An Interruption whose duration is limited to the period required to restore service by automatic or supervisory controlled switching operations or by manual switching at a location where an operator is immediately available.

**Multiple Outage Contingency :**

An Event caused by the failure of two or more Components of the Grid including Generating Units, transmission lines, and transformers.

**Negative Sequence Unbalance Factor :**

The ratio of the magnitude of the negative sequence component of the voltages to the magnitude of the positive sequence component of the voltages, expressed in percent.

**Net Profit Margin :**

The ratio of net profit after taxes to sales.

**Non-Technical Loss :**

The component of System Loss that is not related to the physical characteristics and functions of the electrical System, and is caused primarily by human error, whether intentional or not. Non-Technical Loss includes the Energy lost due to the tampering of meters and erroneous meter reading.

**Normal State :**

The Grid operating condition when the System Frequency, voltage, and transmission line and equipment loading are within their normal operating limits, the Operating Margin is sufficient, and the Grid configuration is such that any fault current can be interrupted and the faulted equipment isolated from the Grid.

**Notice to Synchronize:**

The notice given by the System Operator to a Generator requiring a Generating Unit to Synchronize with the Grid.

**Operating Margin :**

The margin of generation over the total Demand plus losses that is necessary for ensuring Power Quality and the Security of the Grid. Operating Margin is the sum of the Frequency Regulating Reserve and the Contingency Reserve.

**Operating Program :**

A periodic program prepared by the Grid Owner and the System Operator based on data submitted by Generators and Users which specifies the expected Availability and aggregate capability of generation to meet forecasted Demand.

**Outage :**

The state of a Component when it is not available to perform its intended function due to some event directly associated with that Component. An Outage may or may not cause an Interruption of service to Customers.

**Outage Duration :**

The period from the initiation of the Outage until the affected Component or its replacement becomes available to perform its intended function.

**Over voltage :**

A Long Duration Voltage Variation where the RMS value of the voltage is greater than or equal to 110 percent of the nominal voltage.

**Partial System Blackout :**

The condition when a part of the Grid is isolated from the rest of the Grid and all generation in that part of the Grid has Shutdown.

**Planned Activity Notice :**

A notice issued by a User to the Grid Owner and the System Operator for any planned activity, such as a planned Shutdown or Scheduled Maintenance of its Equipment, at least seven (7) days prior to the actual Shutdown or maintenance.

**Point of Grounding:**

The point on the Grid or the User System at which Grounding can be established for safety purposes.

**Point of Isolation :**

The point on the Grid or the User System at which Isolation can be established for safety purposes.

**Power Development Program (PDP) :**

The indicative plan for managing Demand through energy-efficient programs and for the upgrading, expansion, rehabilitation, repair, and maintenance of power generation and transmission facilities, formulated and updated periodically by the ERA in coordination with Generators, the Grid Owner, System Operator, and Distribution Utilities.

**Power Factor :**

The ratio of Active Power to Apparent Power.

**Power Line Carrier (PLC) :**

A communication Equipment used for transmitting data signals through the use of power transmission lines.

**Power Quality :**

The quality of the voltage, including its frequency and resulting current, that are measured in the Grid, Distribution System, or any User System.

**Preliminary Project Planning Data :**

The data relating to a proposed User Development at the time the User applies for a Connection Agreement or an Amended Connection Agreement.

**Primary Response :**

The automatic response of a Generating Unit to Frequency changes, released increasingly from zero to five seconds from the time of Frequency change, and which is fully available for the next 25 seconds.

**Profitability Ratio :**

A financial indicator that measures the entity's return on its investments.

**Protective Device:**

A protective relay or a group of protective relays and/or logic elements designed to perform a specified protection function.

**Pumped Storage Plant:**

A hydro-electric Generating Plant which normally generates electric Energy during periods of relatively high System Demand by utilizing water which has been pumped into a storage reservoir usually during periods of relatively low System Demand.

**Quick Ratio :**

The ratio of current assets less inventory to current liabilities.

**Reactive Energy:**

The integral of the reactive power with respect to time, measured in VARh or multiples thereof.

**Reactive Power:**

The component of electrical power representing the alternating exchange of stored Energy (inductive or capacitive) between sources and loads or between two systems, measured in VAR or multiples thereof. For AC circuits or systems, it is the product of the RMS value of the voltage and the RMS value of the quadrature component of the alternating current. In a three-phase system, it is the sum of the Reactive Power of the individual phases.

**Reactive Power Capability Curve:**

A diagram which shows the Reactive Power capability limit versus the Real Power within which a Generating Unit is expected to operate under normal conditions.

**Red Alert :**

An alert issued by the System Operator when the Grid Contingency Reserve is zero, a generation deficiency exists, or there is Critical Loading or Imminent Overloading of transmission lines or Equipment.

**Red Alert Warning:**

A warning issued by the System Operator to Users regarding a planned Demand reduction following the declaration of a Red Alert.

**Registered Data:**

Data submitted by a User to the Grid Owner at the time of connection of the User System to the Grid.

**Reliability:**

The probability that a System or Component will perform a required task or mission for a specified time in a specified environment. It is the ability of a power System to continuously provide service to its Customers.

**Requesting Safety Coordinator :**

The Safety Coordinator assigned by the Grid Owner (or the User) when it requests that Safety Precautions be established in the User System (or the Grid).

**Return on Assets (ROA) :**

The ratio of net profits after taxes to average total assets.

**Return on Investment (ROI) :**

The most common name given by analysts to return on assets.

**Safety Coordinator :**

A person designated and authorized by the Grid Owner (or the User) to be responsible for the coordination of Safety Precautions at the Connection Point when work or testing is to be carried out on a System which requires the provision of Safety Precautions for HV or EHV Equipment.

**Safety Log :**

A chronological record of messages relating to safety coordination sent and received by each Safety Coordinator.

**Safety Precautions :**

Refers to the Isolation and Grounding of HV or EHV Equipment when work or testing is to be done on the Grid or User System.

**Safety Rules :**

The rules that seek to safeguard personnel working on the Grid (or User System) from the hazards arising from the Equipment or the Grid (or User System).

**Safety Tag :**

A label conveying a warning against possible interference or intervention as defined in the safety clearance and tagging procedures.

**Sales-to-Assets Ratio :**

The ratio of sales to average total assets.

**Schedule Day :**

The period from 00:00H to 24:00H each day.

**Scheduled Generating Plant :**

A Generating Plant whose Generating Units are subject to Central Dispatch by the System Operator.

**Scheduled Generating Unit :**

A Generating Unit within a Scheduled Generating Plant.

**Scheduled Maintenance :**

The Outage of a Component or Equipment due to maintenance, which is coordinated by the Grid Owner and the System Operator or User, as the case may be.

**Scheduling :**

The process of matching the offers to supply Energy and provide Ancillary Services with the bids to buy Energy and the operational support required by the Grid, to prepare the Generation Schedule, which takes into account the operational constraints in the Grid.

**Secondary Response :**

The automatic response to Frequency which is fully available 25 seconds from the time of Frequency change to take over from the Primary Response, and which is sustainable for at least 30 minutes.

**Security :**

The continuous operation of a power system in the Normal State, ensuring safe and adequate supply of power to End-Users, even when some parts or Components of the System are on Outage.

**Security Red Alert :**

A notice issued by the System Operator when peace and order problems exist, which may affect Grid operations.

**Short Duration Voltage Variation:**

A variation of the RMS value of the voltage from its nominal value for a time greater than one-half cycle of the power frequency but not exceeding one minute.



**Short Term Flicker Severity:**

A measure of the visual severity of Flicker derived from a time-series output of a Flicker meter over a ten-minute period.

**Shutdown :**

The condition of the Equipment when it is de-energized or disconnected from the System.

**Significant Incident :**

An Event on the Grid, a Distribution System, or the System of any User that has a serious or widespread effect on the Grid, the Distribution System, and/or the User System.

**Significant Incident Notice:**

A notice issued by the System Operator or any User if a Significant Incident has transpired on the Grid or the System of the User, as the case may be.

**Single Outage Contingency:**

An Event caused by the failure of one Component of the Grid including a Generating Unit, transmission line, or a transformer.

**Site :**

Refers to a substation or switchyard in the Grid or the User System where the Connection Point is situated.

**Small Generator :**

A Generation Company whose generating facility at the Connection Point has an aggregate capacity of 20 MW or below.

**Spinning Reserve:**

The component of Contingency Reserve which is Synchronized to the Grid and ready to take on Load. Also called Hot Standby Reserve.

**Spot Market :**

Has the same meaning as the Electricity Market.

**Stability :**

The ability of the dynamic Components of the power System to return to a normal or stable operating point after being subjected to some form of change

or disturbance.

**Standard Planning Data :**

The general data required by the Grid Owner as part of the application for a Connection Agreement or Amended Connection Agreement.

**Start-Up :**

The process of bringing a Generating Unit from Shutdown to synchronous speed.

**Supervisory Control and Data Acquisition (SCADA) :**

A system of remote control and telemetry used to monitor and control a power System.

**Supplier :**

Any person or entity authorized by the **ERA** to sell, broker, market, or aggregate electricity to the End-users.

**Supply of Electricity:**

The sale of electricity by a party other than a Generator or a Distributor in the Franchise Area of a Distribution Utility using the wires of the Distribution Utility concerned.

**Sustained Interruption:**

Any Interruption that is not classified as a Momentary Interruption.

**Synchronized :**

The state when connected Generating Units and/or interconnected AC Systems operate at the same frequency and where the phase angle displacements between their voltages vary about a stable operating point.

**System :**

Refers to the Grid or Distribution System or any User System. Also a group of Components connected or associated in a fixed configuration to perform a specified function.

**System Loss :**

The total Energy injected into the Grid (or the Distribution System) minus the total Energy delivered to Distributors and End-Users. In the Grid Code, it is the Energy injected into the Grid by Generating Plants, plus (or minus) the Energy transported through Grid interconnections minus the total Energy delivered to Distributors and End-Users. In the Distribution Code, it is the

Energy received from the Grid plus internally generated Energy by Embedded Generating Plants, plus (or minus) the Energy transported by other Distributors minus the total Energy delivered to End-Users.

**System Operator :**

The party responsible for generation Dispatch, the provision of Ancillary Services, and operation and control to ensure safety, Power Quality, Stability, Reliability, and the Security of the Grid.

**System Test :**

The set of tests which involve simulating conditions or the controlled application of unusual or extreme conditions that may have an impact on the Grid or the User System.

**System Test Coordinator :**

A person who is appointed as the chairman of the System Test Group.

**System Test Group :**

A group established for the purpose of coordinating the System Test to be carried out on the Grid or the User System.

**System Test Procedure:**

A procedure that specifies the switching sequence and proposed timing of the switching sequence, including other activities deemed necessary and appropriate by the System Test Group in carrying out the System Test.

**System Test Proponent :**

Refers to the Grid Owner or the User who plans to undertake a System Test and who submits a System Test Request to the System Operator.

**System Test Program :**

A program prepared by the System Test Group, which contains the plan for carrying out the System Test, the System Test Procedure, including the manner in which the System Test is to be monitored, the allocation of costs among the affected parties, and other matters that the System Test Group had deemed appropriate and necessary.

**System Test Report :**

A report prepared by the Test Proponent at the conclusion of a System Test for submission to the System Operator, the Grid Owner (if it is not the System

Test Proponent), the affected Users, and the members of the System Test Group.

**System Test Request :**

A notice submitted by the System Test Proponent to the System Operator indicating the purpose, nature, and procedures for carrying out the proposed System Test.

**Technical Loss :**

The component of System Loss that is inherent in the physical delivery of electric Energy. It includes conductor loss, transformer core loss, and technical errors in meters.

**Test and Commissioning :**

Putting into service a System or Equipment that has passed all required tests to show that the System or Equipment was erected and connected in the proper manner and can be expected to work satisfactorily.

**Total Demand Distortion (TDD) :**

The ratio of the root-mean-square value of the harmonic content to the root-mean-square value of the rated or maximum demand fundamental quantity, expressed in percent.

**Total Harmonic Distortion (THD) :**

The ratio of the root-mean-square value of the harmonic content to the root-mean-square value of the fundamental quantity, expressed in percent.

**Total System Blackout :**

The condition when all generation in the Grid has ceased, the entire System has Shutdown, and the System Operator must implement a Black Start to restore the Grid to its Normal State.

**Transformer :**

An electrical device or Equipment that converts voltage and current from one level to another.

**Transient Instability :**

A condition that occurs when undamped oscillations between parts of the Grid result in Grid separation. Such Grid disturbances may occur after a fault and the loss of Generating Units and/or transmission lines.

**Transient Voltages :**

High-frequency Over voltages caused by lightning, switching of capacitor banks or cables, current chopping, arcing ground faults, ferroresonance, and other related phenomena.

**Transmission Development Plan (TDP) :**

The program for expansion, reinforcement, and rehabilitation of the Transmission System which is prepared by the Grid Owner and submitted to the EC.

**Transmission of Electricity :**

Refers to the conveyance of electricity through the Grid.

**Transmission System :**

Has the same meaning as Grid.

**Unconstrained Generation Schedule :**

The Generation Schedule without considering any operational constraints such as the Grid constraints, changes in Generating Unit Declared Data and parameters, and changes in forecasted data.

**Under frequency Relay (UFR) :**

An electrical relay that operates when the System Frequency decreases to a preset value.

**Under voltage :**

A Long Duration Voltage Variation where the RMS value of the voltage is less than or equal to 90 percent of the nominal voltage.

**User :**

A person or entity that uses the Grid or Distribution System and related facilities. Also, a person or entity to whom the Grid Code or Distribution Code applies.

**User Development :**

The System or Equipment to be connected to the Grid or to be modified, including the relevant proposed new connections and/or modifications within the User System that requires a Connection Agreement or an Amended Connection Agreement.

**User System :**

Refers to a System owned or operated by a User of the Grid or Distribution System.

**Voltage :**

The electromotive force or electric potential difference between two points, which causes the flow of electric current in an electric circuit.

**Voltage Control :**

The strategy used by the System Operator, Distributors, or User to maintain the voltage of the Grid, Distribution System, or the User System within the limits prescribed by the Grid Code or the Distribution Code.

**Voltage Dip :**

Has the same meaning as Voltage Sag.

**Voltage Fluctuation :**

The systematic variations of the voltage envelope or random amplitude changes where the RMS value of the voltage is between 90 percent and 110 percent of the nominal value.

**Voltage Instability :**

A condition that results in Grid voltages that are below the level where voltage control Equipment can return them to the normal level. In many cases, the problem is compounded by excessive Reactive Power loss.

**Voltage Reduction :**

The method used to temporarily decrease Demand by a reduction of the System voltage.

**Voltage Sag :**

A Short Duration Voltage Variation where the RMS value of the voltage decreases to between 10 percent and 90 percent of the nominal value.

**Voltage Swell :**

A Short Duration Voltage Variation where the RMS value of the voltage increases to between 110 percent and 180 percent of the nominal value.

**Voltage Unbalance :**

In the Grid Code, it refers to the Negative Sequence Unbalance Factor or the

Zero Sequence Unbalance Factor. In the Distribution System, it refers to the maximum deviation from the average of the three phase voltages divided by the average of the three phase voltages, expressed in percent.

**Voltage Variation :**

The deviation of the root-mean-square (RMS) value of the voltage from its nominal value, expressed in percent.

**Voluntary Load Curtailment (VLC) :**

The agreed self-reduction of Demand by identified industrial End-Users to assist in Frequency Control when generation deficiency exists.

**Weather Disturbance Alert :**

A notice issued by the System Operator when a weather disturbance has entered the Sudan area of responsibility.

**Weather Disturbance Monitoring :**

The tracking of weather disturbances.

**Market Rules :**

The rules that govern the administration and operation of the Electricity Market.

**Wheeling Charge:**

Refers to the tariff paid for the conveyance of electric Power and Energy through the Grid or a Distribution System.

**Yellow Alert :**

A notice issued by the System Operator when the Contingency Reserve is less than the capacity of the largest Synchronized Generating Unit or power import from a single interconnection, whichever is higher.

**Zero Sequence Unbalance Factor :**

The ratio of the magnitude of the zero sequence component of the voltages to the magnitude of the positive sequence component of the voltages, expressed in percent.

## 1.7 Abbreviations

<b>A</b>	Ampere .
<b>AC</b>	Alternating Current .
<b>AGC</b>	Automatic Generation Control .
<b>ALSH</b>	Automatic Load Shedding.
<b>DC</b>	Direct Current .
<b>EBIT</b>	Earnings Before Interest and Taxes .
<b>EC</b>	Energy Committee .
<b>ERA</b>	Electricity Regularity Authority .
<b>EENS</b>	Expected Energy Not Supplied .
<b>EHV</b>	Extra High Voltage.
<b>GW</b>	Gigawatt .
<b>GWh</b>	Gigawatt-hour .
<b>HV</b>	High Voltage .
<b>IDMAS</b>	Integrated Disturbance Monitoring and Analysis System .
<b>IEC</b>	International Electrotechnical Commission .
<b>IED</b>	Intelligent Electronic Devices.
<b>IEEE</b>	Institute of Electrical and Electronics Engineers .
<b>IFRS</b>	International Financial Report Standard .
<b>ISO</b>	International Standards Organization
<b>IRR</b>	Implementing Rules and Regulations
<b>KW</b>	Kilo watt
<b>kWH</b>	Kilo watt-hour
<b>kVARH</b>	Kilo var-hour
<b>LOLP</b>	Loss-of-Load Probability
<b>LV</b>	Low Voltage
<b>MAIFI</b>	Momentary Average Interruption Frequency Index
<b>MLSH</b>	Manual Load Shedding
<b>MV</b>	Medium Voltage
<b>MVA</b>	Megavolt-ampere
<b>MVAR</b>	Mega var
<b>MVARh</b>	Mega var-hour
<b>MW</b>	Megawatt
<b>MWH</b>	Megawatt-hour
<b>NSUF</b>	Negative Sequence Unbalance Factor
<b>OSHS</b>	occupational Safety and Health Standards
<b>PABX</b>	Private Automated Branch Exchange



<b>PDP</b>	Power Development Program
<b>PLC</b>	Power Line Carrier
<b>PRC</b>	Professional Regulations Commission
<b>RISSP</b>	Record of Inter-System Safety Precautions
<b>RMS</b>	Root-mean-square
<b>ROA</b>	Return on Assets
<b>ROI</b>	Return on Investment
<b>RTU</b>	Remote Terminal Unit
<b>SCADA</b>	Supervisory Control and Data Acquisition
<b>SEIN</b>	Standard Equipment Identification Number
<b>SPUG</b>	Small Power Utility Group
<b>TDD</b>	Total Demand Distortion
<b>TDP</b>	Transmission Development Plan
<b>THD</b>	Total Harmonic Distortion
<b>UFR</b>	Under frequency Relay
<b>V</b>	Volts
<b>VA</b>	Volt-Ampere
<b>VAR</b>	Volt-Ampere Reactive
<b>VLC</b>	Voluntary Load Curtailment
<b>W</b>	Watt
<b>Wh</b>	Watt-hour
<b>ZSUF</b>	Zero Sequence Unbalance Factor

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## Chapter 2 Grid Management

### 2.1 Purpose and scope

#### 2.1.1 Purpose

- (a) To facilitate the monitoring of compliance with the Grid Code at the operations level;
- (b) To ensure that all Users of the Grid are represented in reviewing and making recommendations pertaining to connection, operation, maintenance, and development of the Grid; and
- (c) To specify the processes for the settlement of disputes, enforcement, and revision of the Grid Code.

#### 2.1.2 Scope of Application

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) The Market Operator;
- (d) Generators;
- (e) Distributors;
- (f) Suppliers; and
- (g) Any other entity with a User System connected to the Grid.

### 2.2 GRID MANAGEMENT COMMITTEE

#### 2.2.1 Functions of the Grid Management Committee

There shall be established a Grid Management Committee (GMC) which shall carry out the following functions:

- (a) Monitor the implementation of the Grid Code;
- (b) Monitor, evaluate, and make recommendations on Grid operations;
- (c) Review and recommend standards, procedures, and requirements for Grid connection, operation, maintenance, and development;
- (d) Coordinate Grid Code dispute resolution and make appropriate recommendations to the **ERA**;

- (e) Initiate the Grid Code enforcement process and make recommendations to the **ERA**;
- (f) Initiate and coordinate revisions of the Grid Code and make recommendations to the **ERA**; and
- (g) Prepare regular and special reports for submission to the **ERA**, or as required by the appropriate government agency, or when requested by a Grid User.

## **2.2.2 Membership of the GMC**

2.2.2.1 The GMC shall be composed of the following members who shall be appointed by the **ERA**:

- (a) One (1) member nominated by the System Operator;
- (b) One (1) member nominated by the Grid Owner;
- (c) One (1) member nominated by the Market Operator;
- (d) Three (3) members nominated by Large Generators;
- (e) One (1) member nominated by Small Generators;
- (f) Three (3) members nominated by private and local government Distributors;

2.2.2.2 In addition to the regular members, there shall be two representatives, one each from **ERA** and EC, to provide guidance on government policy and regulatory frameworks and directions. The government representatives shall not participate in any GMC decision-making and in the formulation of recommendations to the **ERA**.

2.2.2.3 The **ERA** shall issue the guidelines and procedures for the nomination and selection of the GMC members.

2.2.2.4 The Chairman of the GMC shall be selected by the **ERA** from a list of three (3) members nominated by the GMC. The first Chairman of the GMC, however, shall be the member nominated either by the Grid Owner or the System Operator.

2.2.2.5 The members of the GMC shall have sufficient technical background and experience to fully understand and evaluate the technical aspects of Grid operation, planning, and development.

## **2.2.3 Terms of Office of the GMC Members**

2.2.3.1 All members of the GMC shall have a term of three (3) years and shall be allowed only one re-appointment.

2.2.3.2 For the first appointees to the GMC, the Chairman shall hold office for

three (3) years, seven (7) members shall hold office for two (2) years, and the remaining members shall hold office for one (1) year. The **ERA** shall determine the terms of office of the initial GMC members.

2.2.3.3 Appointment to any future vacancy shall be only for the remaining term of the predecessor.

## **2.2.4 GMC Support Staff and Operating Cost**

2.2.4.1 The Grid Owner and the System Operator shall fund the operations of the GMC and its subcommittees, including a permanent support staff, and recover the costs from Grid service charges. The **ERA** shall issue the guidelines pertaining to the budget of the GMC.

2.2.4.2 The GMC shall prepare and submit the budget requirements for the following year to the Grid Owner and the System Operator by September of the current year. Honor area of GMC members and subcommittee members, if any, shall be included in the operating cost of the GMC.

2.2.4.3 The salaries of all GMC members and all subcommittee members shall be the responsibility of their respective employers or sponsoring organizations.

## **2.2.5 GMC Rules and Procedures**

2.2.5.1 The GMC shall establish and publish its own rules and procedures relating to the conduct of its business. These include:

- (a) Administration and operation of the Committee;
- (b) Establishment and operation of GMC subcommittees;
- (c) Evaluation of Grid operations reports;
- (d) Coordination of dispute resolution process;
- (e) Monitoring of Grid Code enforcement;
- (f) Revision of Grid Code provisions;
- (g) Review of the Transmission Development Plan;
- (h) Review of major Grid reinforcement and expansion projects; and
- (i) Coordination with the Energy Committee.

2.2.5.2 The rules and procedures of the GMC shall be approved by the **ERA**.

2.2.5.3 The GMC is expected to decide issues based on consensus rather than by simple majority voting.

## **2.3 GRID MANAGEMENT SUBCOMMITTEES**

### **2.3.1 Grid Planning Subcommittee**

2.3.1.1 The GMC shall establish a permanent Grid Planning Subcommittee with the following functions:

- (a) Review and revision of Grid planning procedures and standards;
- (b) Evaluation and making recommendations on the Transmission Development Plan; and
- (c) Evaluation and making recommendations on proposed major Grid reinforcement and expansion projects.

2.3.1.2 The chairman and members of the Grid Planning Subcommittee shall be appointed by the GMC.

2.3.1.3 The members of the Grid Planning Subcommittee shall have sufficient technical background and experience in Grid planning.

### **2.3.2 Grid Operations Subcommittee**

2.3.2.1 The GMC shall establish a permanent Grid Operations Subcommittee with the following functions:

- (a) Review and revision of Grid operations procedures and standards;
- (b) Evaluation and making recommendations on Grid operations reports; and
- (c) Evaluation and making recommendations on Significant Incidents.

2.3.2.2 The chairman and members of the Grid Operations Subcommittee shall be appointed by the GMC.

2.3.2.3 The members of the Grid Operations Subcommittee shall have sufficient technical background and experience in Grid operations.

### **2.3.3 Grid Reliability and Protection Subcommittee**

2.3.3.1 The GMC shall establish a permanent Grid Reliability and Protection Subcommittee with the following functions:

- (a) Review and revision of Grid reliability and protection procedures and standards;
- (b) Evaluation and making recommendations on Grid reliability reports; and
- (c) Evaluation and making recommendations on significant Grid events or incidents caused by the failure of protection.

2.3.3.2 The chairman and members of the Grid Reliability and Protection Subcommittee shall be appointed by the GMC.

2.3.3.3 The members of the Grid Reliability and Protection Subcommittee shall have sufficient technical background and experience in Grid reliability

and protection.

### **2.3.4 Other Grid Subcommittees**

The GMC may establish other subcommittees as necessary.

## **2.4 GRID CODE DISPUTE RESOLUTION**

### **2.4.1 Grid Code Disputes**

Disputes will arise from time to time regarding how the Grid Code is being administered and interpreted. The Grid Code dispute resolution process outlined in this Article applies to the System Operator, Grid Owner, Market Operator, and all Users of the Grid with respect to the provisions of the Grid Code. It does not apply to disputes related to billing and commercial transactions that are handled according to the Market Rules of the Electricity Market.

### **2.4.2 Grid Code Dispute Resolution Process**

The Grid Code dispute resolution process shall include the following steps:

- (a) When a dispute arises between parties which is not resolved informally, one of the parties shall, if he/she wishes, register the dispute in writing to the GMC and the other party or parties;
- (b) The parties shall meet to discuss and attempt to resolve the dispute within a period to be prescribed by the GMC. If resolved, the resolution shall be documented and a written record provided to all parties and to the GMC;
- (c) If the dispute is not resolved, a committee of representatives from both parties shall be formed by the GMC to discuss and attempt to resolve the dispute within a period to be prescribed by the GMC. If resolved, the resolution shall be documented and a written record provided to all parties and the GMC; and
- (d) If the dispute is not resolved at stage (c), the committee of representatives shall refer the dispute to the GMC for appropriate action. The GMC shall either create an independent Grid Code Dispute Resolution Panel or refer the matter directly to the **ERA** for resolution.

### **2.4.3 Grid Code Dispute Resolution Panel**

2.4.3.1 The Grid Code Dispute Resolution Panel shall consist of three (3) or five (5) persons. The Panel shall include members who have the technical

background to understand the technical merits and implications of the disputing parties' arguments.

2.4.3.2 The Panel shall hold meetings, within a period to be prescribed by the GMC, to hear the contending parties and to receive documents supporting their positions. The proceedings and recommendations of the Panel shall be documented and provided to both parties and the GMC.

2.4.3.3 The GMC shall submit a report regarding the dispute, including any recommendations, to the **ERA** who shall render the final ruling on the matter.

#### **2.4.4 Cost of Dispute Resolution**

The cost of the dispute resolution process shall be shared in one of the following ways:

(a) If the dispute is resolved, part of the resolution shall include an allocation of the cost of the process; and

(b) If the dispute is not resolved ( *e.g.* , the dispute is dropped or becomes a legal action), the parties shall share equally the cost of the dispute resolution process.

### **2.5 GRID CODE ENFORCEMENT AND REVISION PROCESS**

#### **2.5.1 Enforcement Process**

2.5.1.1 Any party who has evidence that any other party has violated or is violating any provision of the Grid Code may file a complaint to the GMC who shall initiate an enforcement process. The GMC may initiate the enforcement process even if no complaint has been filed but it has information on possible Grid Code violations. The **ERA** may also direct the GMC to begin the enforcement process.

2.5.1.2 The steps of the enforcement process are as follows:

(a) The GMC shall send a written notice to the offending party with the specifics of the alleged violation and the recommended course of action needed to correct the alleged violation;

(b) The offending party shall respond in writing, within 30 days from receipt of the notice from the GMC, its reaction to the alleged violation and to state whether or not it shall comply with the course of action recommended by the GMC;

(c) If the GMC is satisfied with the response, it shall make a report, including the recommended course of action, to the **ERA** who shall render the final



decision on the matter; and

(d) If the GMC is not satisfied with the response, it shall document the charges against the offending party and submit a report, including the recommended course of action, fines, and penalties, to the **ERA**.

## **2.5.2 Fines and Penalties**

To effectively enforce the Grid Code, the **ERA** shall impose the fines or penalties prescribed by the Act for any non-compliance with or breach of any provision of the Grid Code.

## **2.5.3 Unforeseen Circumstances**

2.5.3.1 If an emergency situation arises which the provisions of the Grid Code have not foreseen, the System Operator shall, to the extent reasonably practicable, consult promptly all affected Users in an effort to reach agreement as to what should be done.

2.5.3.2 If an agreement is reached, the System Operator shall promptly refer the matter, including the agreement, to the GMC for review and to make the appropriate recommendations to the **ERA**.

2.5.3.3 If an agreement is not reached, the System Operator shall decide what is to be done if the Security of the Grid is at stake. In such a case, all Users shall comply with all instructions issued by the System Operator to the extent that such instructions are consistent with the technical characteristics of the User's system as registered under the Grid Code. The System Operator shall be

answerable to the GMC and the **ERA** for unjustified unilateral actions or measures it has taken against any User.

## **2.5.4 Grid Code Revision Process**

2.5.4.1 Any party who has a proposal to revise any provision of the Grid Code shall submit the proposed revision, including the supporting arguments and data, to the GMC or to the appropriate GMC subcommittee who shall evaluate the proposal.

2.5.4.2 If the GMC or the appropriate GMC Subcommittee agrees with the proposed revision, it shall make the appropriate recommendations to the **ERA**.

2.5.4.3 If the GMC or the appropriate GMC Subcommittee disagrees with the proposed revision, it shall submit a report, including the justifications why it

disagrees with the proposed revision, to the **ERA**.

2.5.4.4 The **ERA** shall render the final decision on any matter pertaining to Grid Code revision.

## **2.6 GRID MANAGEMENT REPORTS**

### **2.6.1 Quarterly and Annual Reports**

2.6.1.1 The GMC shall submit to the **ERA** four (4) quarterly reports before the end of the month immediately following the quarter.

2.6.1.2 The GMC shall submit to the **ERA** an annual report for the previous year by the end of March of the current year.

### **2.6.2 Significant Incident Reports**

2.6.2.1 Within one (1) week following a Significant Incident in the Grid or a User System, the System Operator shall submit to the GMC and the **ERA** a report detailing the sequence of events and other relevant information pertaining to the incident. The report shall describe the cause of the Significant Incident and the amount and duration of the resulting power interruptions.

2.6.2.2 Within one (1) month following the receipt of the System Operator's report on the Significant Incident, the GMC shall validate the report and make recommendations to the **ERA**. In cases where any User has violated any provision of the Grid Code, the GMC may recommend to the **ERA** sanctions as part of the Significant Incident report.

### **2.6.3 Special Reports**

The GMC shall prepare special reports as ordered by the **ERA** or any appropriate government agency, or at the request of any User, or as it deems necessary. Special Reports prepared at the request of any User shall be at the expense of the User.

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## **Chapter 3 Performance Standards for Transmission**

### **3.1 Purpose and scope**

#### **3.1.1 Purpose**

- (a) To ensure the quality of electric power in the Grid;
- (b) To ensure that the Grid will be operated in a safe and efficient manner and with a high degree of reliability; and
- (c) To specify safety standards for the protection of personnel in the work environment.

#### **3.1.2 Scope of Application**

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) Generators;
- (d) Distributors; and
- (e) Any other entity with a User System connected to the Grid.

### **3.2 POWER QUALITY STANDARDS**

#### **3.2.1 Power Quality Problems**

3.2.1.1 For the purpose of this Article, Power Quality shall be defined as the quality of the voltage, including its frequency and the resulting current, that are measured in the Grid during normal conditions.

3.2.1.2 A Power Quality problem exists when at least one of the following conditions is present and significantly affects the normal operation of the System:

- (a) The System Frequency has deviated from the nominal value of 50 Hz;
- (b) Voltage magnitudes are outside their allowable range of variation;

- (c) Harmonic Frequencies are present in the System;
- (d) There is imbalance in the magnitude of the phase voltages;
- (e) The phase displacement between the voltages is not equal to 120 degrees;
- (f) Voltage Fluctuations cause Flicker that is outside the allowable Flicker Severity limits; or
- (g) High-frequency Over voltages are present in the Grid.

### **3.2.2 Frequency Variations**

3.2.2.1 The nominal fundamental frequency shall be 50 Hz.

3.2.2.2 The control of System frequency shall be the responsibility of the System Operator. The System Operator shall maintain the fundamental frequency within the limits of 49.5Hz and 50.5Hz during normal conditions.

### **3.2.3 Voltage Variations**

3.2.3.1 For the purpose of this Section, Voltage Variation shall be defined as the deviation of the root-mean-square (RMS) value of the voltage from its nominal value, expressed in percent. Voltage Variation will either be of short duration or long duration.

3.2.3.2 A Short Duration Voltage Variation shall be defined as a variation of the RMS value of the voltage from nominal voltage for a time greater than one-half cycle of the power frequency but not exceeding one minute. A Short Duration Voltage Variation is a Voltage Swell if the RMS value of the voltage increases to between 110 percent and 180 percent of the nominal value. A Short Duration Voltage Variation is a Voltage Sag (or Voltage Dip) if the RMS value of the voltage decreases to between 10 percent and 90 percent of the nominal value.

3.2.3.3 A Long Duration Voltage Variation shall be defined as a variation of the RMS value of the voltage from nominal voltage for a time greater than one minute. A Long Duration Voltage Variation is an Under voltage if the RMS value of the voltage is less than or equal to 90 percent of the nominal voltage. A Long Duration Voltage Variation is an Overvoltage if the RMS value of the voltage is greater than or equal to 110 percent of the nominal value.

3.2.3.4 The Grid Owner and the System Operator shall ensure that the Long Duration Voltage Variations result in RMS values of the voltages that are greater than 95 percent but less than 105 percent of the nominal voltage at any Connection Point during normal conditions.

### 3.2.4 Harmonics

3.2.4.1 For the purpose of this Section, Harmonics shall be defined as sinusoidal voltages and currents having frequencies that are integral multiples of the fundamental frequency.

3.2.4.2 The Total Harmonic Distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent.

3.2.4.3 The Total Demand Distortion (TDD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the rated or maximum fundamental quantity, expressed in percent.

3.2.4.4 The Total Harmonic Distortion of the voltage and the Total Demand Distortion of the current at any Connection Point shall not exceed the limits given in Tables 3.1 and 3.2, respectively.

**T ABLE 3.1**  
**MAXIMUM H ARMONIC V OLTAGE D ISTORTION F ACTORS**

<b>Harmonic Voltage Distortion</b>			
<b>Voltage Level</b>	<b>THD*</b>	<b>Individual</b>	
		<b>Odd</b>	<b>Even</b>
500kV	1.5%	1.0%	0.5%
110kV–220kV	2.5%	1.5%	1.0%
66kV	3.0%	2.0%	1.0%

\* Total Harmonic Distortion.

**T ABLE 3.2**  
**MAXIMUM H ARMONIC C URRENT D ISTORTION F ACTORS**

<b>Harmonic Current Distortion</b>			
<b>Voltage Level</b>	<b>THD*</b>	<b>Individual</b>	
		<b>Odd</b>	<b>Even</b>
500kV	1.5%	1.0%	0.5%
110kV–220kV	2.5%	1.5%	1.0%
66kV	3.0%	2.0%	1.0%

\* Total Harmonic Distortion.

### **3.2.5 Voltage Unbalance**

3.2.5.1 For the purpose of this Section, the Negative Sequence Unbalance Factor shall be defined as the ratio of the magnitude of the negative sequence component of the voltages to the magnitude of the positive sequence component of the voltages, expressed in percent.

3.2.5.2 For the purpose of this section, the Zero Sequence Unbalance Factor shall be defined as the ratio of the magnitude of the zero sequence component of the voltages to the magnitude of the positive sequence component of the voltages, expressed in percent.

3.2.5.3 The maximum Negative Sequence Unbalance Factor at the Connection Point of any User shall not exceed one (1) percent during normal operating conditions.

3.2.5.4 The maximum Zero Sequence Unbalance Factor at the Connection Point of any User shall not exceed one (1) percent during normal operating conditions.

### **3.2.6 Voltage Fluctuation and Flicker Severity**

3.2.6.1 For the purpose of this Section, Voltage Fluctuations shall be defined as systematic variations of the voltage envelope or random amplitude changes where the RMS value of the voltage is between 90 percent and 110 percent of the nominal voltage.

3.2.6.2 For the purpose of this Section, Flicker shall be defined as the impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

3.2.6.3 In the assessment of the disturbance caused by a Flicker source with a short duty cycle, the Short Term Flicker Severity shall be computed over a 10-minute period.

3.2.6.4 In the assessment of the disturbance caused by a Flicker source with a long and variable duty cycle, the Long Term Flicker Severity shall be derived from the Short Term Flicker Severity levels.

3.2.6.5 The Voltage Fluctuation at any Connection Point with a fluctuating demand shall not exceed one percent (1%) of the nominal voltage for every step change, which may occur repetitively. Any large Voltage Fluctuation other than a step change may be allowed up to a level of three percent (3%) provided that this does not constitute a risk to the Grid or to the System of any User.

3.2.6.6 The Flicker Severity at any Connection Point in the Grid shall not exceed the values given in Table 3.3.

**TABLE 3.3**  
**MAXIMUM FLICKER SEVERITY**

	Short Term	Long Term
110 kV and above	0.8 unit	0.6 unit
Below 110 kV	1.0 unit	0.8 unit

### 3.2.7 Transient Voltage Variations

3.2.7.1 For the purpose of this Section, Transient Voltages shall be defined as the high-frequency Over voltages that are generally shorter in duration compared to the Short Duration Voltage Variations.

3.2.7.2 Infrequent short-duration peaks may be permitted to exceed the levels specified in Section 3.2.4 for harmonic distortions provided that such increases do not compromise service to other End-users or cause damage to any Grid equipment.

3.2.7.3 Infrequent short-duration peaks with a maximum value of two (2) percent may be permitted for Voltage Unbalance, subject to the terms of the Connection Agreement or Amended Connection Agreement.

## 3.3 RELIABILITY STANDARDS

### 3.3.1 Criteria for Establishing Transmission Reliability Standards

3.3.1.1 The **ERA** shall impose a uniform system of recording and reporting of Grid reliability performance.

3.3.1.2 The same reliability indices shall be imposed on all Grids. However, the numerical levels of performance (or targets) shall be unique to each Grid and shall be based initially on the particular Grid's historical performance.

3.3.1.3 Each Grid shall be evaluated annually to compare its actual performance with the targets.



### **3.3.2 Transmission Reliability Indices**

3.3.2.1 The **ERA** shall prescribe a reliability index that will measure the total number of sustained power interruptions in the Grid.

3.3.2.2 The **ERA** shall prescribe a reliability index that will measure the total duration of sustained power interruptions in the Grid.

3.3.2.3 After due notice and hearing, the **ERA** may impose other indices that will monitor the reliability performance of the Grid.

### **3.3.3 Inclusions and Exclusions of Interruption Events**

3.3.3.1 A power Interruption shall include any Outage in the Grid 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 Grid User or a group of Users.

3.3.3.2 The following events shall be excluded in the calculation of the reliability indices:

- (a) Outages that occur outside the Grid;
- (b) Outages due to generation deficit;
- (c) Planned Outages where the Users have been notified at least seven (7) days prior to the loss of power;
- (d) Outages that are initiated by the System Operator or Market Operator during the occurrence of Significant Incidents or the failure of their facilities;
- (e) Outages caused by Adverse Weather or Major Storm Disasters which result in the declaration by the government of a state of calamity; and
- (f) Outages due to other events that the **ERA** shall approve after due notice and hearing.

### **3.3.4 Submission of Transmission Reliability Reports and Performance Targets**

3.3.4.1 The Grid Owner and the System Operator shall submit every three (3) months the monthly Interruption reports for each Grid using the standard format prescribed by the **ERA**.

3.3.4.2 The **ERA** shall set the performance targets for each Grid after due notice and hearing.

## **3.4 SYSTEM LOSS STANDARDS**

### **3.4.1 System Loss Classifications**

3.4.1.1 System Loss shall be classified into three categories: Technical Loss, Non-Technical Loss, and Administrative Loss.

3.4.1.2 The Technical Loss shall be the aggregate of conductor loss, the core loss in transformers, and any loss due to technical metering error.

3.4.1.3 The Non-Technical Loss shall be the aggregate of the Energy loss due to meter-reading errors and meter tampering.

3.4.1.4 The Administrative Loss shall include the Energy that is required for the proper operation of the Grid.

### **3.4.2 System Loss Cap**

3.4.2.1 The **ERA** shall, after due notice and hearing, prescribe a cap on the System Loss that can be passed on by the Grid Owner to the Grid Users. The cap shall be applied to the aggregate of the Technical and Non-Technical Losses.

3.4.2.2 The Grid Owner shall submit to **ERA** an application for the approval of its Administrative Loss. The allowance for Administrative Loss shall be approved by the **ERA**, after due notice and hearing, based on connected essential load.

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## CHAPTER 4 SAFETY CODE

### 4.1 Purpose and Scope

#### 4.1.1 Purpose

- (a) To specify the rules and standards for measure of performance for personal safety that shall be applied to the Grid Owner and System Operator.
- (b) To ensure a safe work environment for their employees .
- (c) To protect every workman against the dangers of injures ,illness or death through safe and healthful conditions .
- (d) To ensure that all provisions of these safety rules are not violate at all times .

#### 4.1.2 Scope of Application

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator; and
- (c) Generators.
- (d) Distributors;
- (e) Suppliers; and
- (f) Any other entity with a User System connected to the Grid.

### 4.2 Adoption of PRC AND OSHS

4.2.1 The Grid Owner and the System Operator shall develop, operate, and maintain the Grid in a safe manner and shall always ensure a safe work environment for their employees. In this regard, the **ERA** adopts the (SGC) Part 1 and Part 2 set by Professional Regulations Commission(PRC) and the occupational Safety and Health Standards (OSHS) set by the Bureau of Working Conditions of the Department of labor and Employment .

4.2.1.2 The (SGC) Part 1 and Part 2 govern the safety requirements for electrical installation, operation, and maintenance. Part 1of the (SGC) pertains to the wiring System in the premises of End Users. Part 2 covers electrical Equipment and associated work practices employed by the electric utility. Compliance with these codes is mandatory. Hence, the Grid Owner

and the System Operator shall at all times ensure that all provisions of these safety codes are not violated.

3.5.1.3 The OSHS aims to protect every workingman against the dangers of injury, sickness, or death through safe and healthful working conditions.

#### **4.2.1 Measurement of Performance for Personnel Safety**

Safety Standards specifies the rules for the measurement of performance for personnel safety that shall be applied to the Grid Owner and the System Operator. The pertinent portions of this rule are reproduced as follows:

(a) Exposure to work injuries shall be measured by the total number of hours of employment of all employees in each establishment or reporting unit.

(b) Employee-hours of exposure for calculating work injury rates are intended to be the actual hours worked. When actual hours are not available, estimated hours may be used.

(c) The Disabling Injury/Illness Frequency Rate shall be based upon the total number of deaths, permanent total, permanent partial, and temporary total disabilities, which occur during the period covered by the rate. The rate relates those injuries/illnesses to the employee-hours worked during the period and expresses the number of such injuries in terms of a million man-hour units.

(d) The Disabling Injury/Illness Severity Rate shall be based on the total of all scheduled charges for all deaths, permanent total, and permanent partial disabilities, plus the total actual days of the disabilities of all temporary total disabilities, which occur during the period covered by the rate. The rate relates these days to the total employee-hours worked during the period and expresses the loss in terms of million man-hour units.

#### **4.2.2 Submission of Safety Records and Reports**

The Grid Owner and System Operator shall submit to **ERA** copies of records and reports required by safety department as amended. These shall include the measurement of performance specified in Section 3.5.2.

### **4.3 Safety Coordination**

#### **4.3.1 Safety Coordination Procedures**

4.3.1.1 The Grid Owner and Users shall adopt and use a set of Safety Rules and Local Safety Instructions for implementing Safety Precautions on HV and

EHV Equipment. The respective Safety Rules and Local Safety Instructions of the Grid Owner and the User shall govern any work or testing on the Grid or the User System.

4.3.1.2 The Grid Owner shall furnish the User a copy of its Safety Rules and Local Safety Instructions relating to the Safety Precautions on its HV and EHV Equipment.

4.3.1.3 The User shall furnish the Grid Owner a copy of its Safety Rules and Local Safety Instructions relating to the Safety Precautions on its HV and EHV Equipment.

4.3.1.4 Any party who wants to revise any provision of its Local Safety Instructions shall provide the other party a written copy of the revisions.

4.3.1.5 Safety coordination procedures shall be established for the coordination, establishment, maintenance, and cancellation of Safety Precautions on HV and EHV Equipment when work or testing is to be carried out on the Grid or the User System.

4.3.1.6 Work or testing on any Equipment at the Connection Point shall be carried out only in the presence of the representatives of the Grid Owner and the User.

4.3.1.7 The User (or Grid Owner) shall seek authority from the Grid Owner (or the User) if it wishes to access any Grid Owner (or User) Equipment.

4.3.1.8 When work or testing is to be carried out on the Grid and Safety Precautions are required on the HV and EHV Equipment of several User Systems, the Grid Owner shall ensure that the Safety Precautions on the Grid and on the System of all Users involved are coordinated and implemented.

4.3.1.9 Where work or testing is to be carried out on the Grid and the User becomes aware that Safety Precautions are also required on the System of other Users, the Grid Owner shall be promptly informed of the required Safety Precautions on the System of the other Users. The Grid Owner shall ensure that Safety Precautions are coordinated and implemented on the Grid and all User Systems.

### **4.3.2 Safety Coordinator**

4.3.2.1 The Grid Owner and the User shall assign a Safety Coordinator who shall be responsible for the coordination of Safety Precautions on the HV and EHV Equipment at their respective sides of the Connection Point. Any party who wants to change its Safety Coordinator shall notify the other party of the change.

4.3.2.2 For purposes of safety coordination, the Safety Coordinator requesting

that a Safety Precaution be applied on the System of the other party shall be referred to as the Requesting Safety Coordinator while the Safety Coordinator that will implement the requested Safety Precaution shall be referred to as the Implementing Safety Coordinator.

4.3.2.3 If work or testing is to be carried out on the Grid (or the User System) that requires Safety Precautions on the HV and EHV Equipment of the User System (or the Grid), the Requesting Safety Coordinator shall contact the Implementing Safety Coordinator to coordinate the necessary Safety Precautions.

4.4.2.4 If a Safety Precaution is required for the HV and EHV Equipment of other Users who were not mentioned in the request, the Implementing Safety Coordinator shall promptly inform the Requesting Safety Coordinator.

4.3.2.5 When a Safety Precaution becomes ineffective, the concerned Safety Coordinator shall inform the other Safety Coordinator(s) about it without delay stating the reason(s) why the Safety Precaution has lost its integrity.

### **4.3.3 Safety Logs and Record of Inter-System Safety Precautions**

4.3.3.1 The Grid Owner and the User shall maintain Safety Logs to record, in chronological order, all messages relating to Safety Coordination. The Safety Logs shall be retained for at least one (1) year.

4.3.3.2 The Grid Owner shall establish a record of inter-system Safety Precautions to be used by the Requesting Safety Coordinator and the Implementing Safety Coordinator in coordinating the Safety Precautions on HV and EHV Equipment. The record of intersystem Safety Precautions shall contain the following information:

- (a) Site and Equipment Identification of HV or EHV Equipment where Safety Precaution is to be established or has been established;
- (b) Location and the means of implementation of the Safety Precaution;
- (c) Confirmation of the Safety Coordinator that the Safety Precaution has been established; and
- (d) Confirmation of the Safety Coordinator that the Safety Precaution is no longer needed and has been cancelled.

### **4.3.4 Location of Safety Precautions**

4.3.4.1 When work or testing is to be carried out on the Grid (or the User System) and Safety Precautions are required on the User System (or the Grid), the Requesting Safety Coordinator shall contact the concerned Implementing Safety Coordinator to agree on the location(s) at which the Safety Precautions

will be implemented or applied. The Requesting Safety Coordinator shall specify the proposed locations at which Isolation and/or Grounding are to be established.

4.3.4.2 In the case of Isolation, the Implementing Safety Coordinator shall promptly notify the Requesting Safety Coordinator of the following:

(a) The Identification of each Point of Isolation using the Site and Equipment Identification specified in Article 7.11; and

(b) The means of implementing Isolation as specified in Section 7.8.5.

4.3.4.3 In the case of Grounding, the Implementing Safety Coordinator shall promptly notify the Requesting Safety Coordinator of the following:

(a) The Identification of each Point of Grounding using the Site and Equipment Identification specified in Article 7.11; and

(b) The means of implementing Grounding as specified in Section 7.8.5.

4.3.4.4 If the Requesting Safety Coordinator and the Implementing Safety Coordinator do not agree on the location(s), Grounding shall be established at the available points on the in feeds closest to the HV and EHV Equipment.

#### **4.3.5 Implementation of Safety Precautions**

4.3.5.1 Once the location(s) of Isolation and Grounding have been agreed upon, the Implementing Safety Coordinator shall ensure that the Isolation is implemented.

4.3.5.2 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 by such other method in accordance with the Local Safety Instructions of the Grid Owner or of the User, as the case may be; or

(b) An adequate physical separation ( *e.g.* Grounding Cluster) in accordance with the Local Safety Instructions of the Grid Owner or of the User. In addition, a Safety Tag shall be placed at the switching points.

4.3.5.3 The Implementing Safety Coordinator, after establishing the required Isolation in all locations on his System, shall notify the Requesting Safety Coordinator that the required Isolation has been implemented.

4.3.5.4 After receiving the confirmation of Isolation, the Requesting Safety Coordinator shall inform the Implementing Safety Coordinator of the establishment of Isolation on his System and request, if required, the implementation of Grounding.

4.3.5.5 The Implementing Safety Coordinator shall ensure the implementation of Grounding and notify the Requesting Safety Coordinator that Grounding



has been established on his System.

4.3.5.6 Grounding shall be implemented by any of the following:

- (a) A Grounding switch secured in a closed position by a lock and affixing a Safety Tag to it or by such other method in accordance with the Local Safety Instructions of the Grid Owner or the User, as the case may be; or
- (b) An adequate physical connection ( *e.g.* Grounding Cluster) which shall be in accordance with the methods set out in the Local Safety Instructions of the Grid Owner or those of User. In addition, a Safety Tag shall be placed at this point of connection and all related switching points.

4.3.5.7 If the disconnect switch or the Grounding switch is locked with its own locking mechanism or with a padlock, the key shall be secured in a key cabinet.

Note :This safety rules will be revised based on the provisions of the market rules.

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## **CHAPTER 5 CONNECTION CODE**

### **5.1 PURPOSE AND SCOPE**

#### **5.1.1 Purpose**

- (a) To specify the technical, design, and operational criteria at the User's Connection Point;
- (b) To ensure that the basic rules for connection to the Grid or to a User System are fair and non-discriminatory for all Users of the same category; and
- (c) To list and collate the data required by the Grid Owner from each category of User and to list the data to be provided by the Grid Owner to each category of User.

#### **5.1.2 Scope of Application**

This Chapter applies to the following Grid Users:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) Generators;
- (d) Distributors;
- (e) Suppliers; and
- (f) Any other entity with a User System connected to the Grid.

### **5.2 GRID TECHNICAL, DESIGN, AND OPERATIONAL CRITERIA**

#### **5.2.1 Power Quality Standards**

5.2.1.1 The Grid Owner and System Operator shall ensure that at any Connection Point in the Grid, the Power Quality standards specified in Article 3.2 are complied with.

5.2.1.2 Users seeking connection to the Grid or modification of an existing connection shall ensure that their Equipment can operate reliably and safely within the limits specified in Article 3.2 during normal conditions, and can

withstand the limits specified in this Article.

## **5.2.2 Frequency Variations**

5.2.2.1 During normal operating conditions, the Grid Frequency shall be within the limits specified in Section 3.2.2.

5.2.2.2 In case the System frequency momentarily rises to 52Hz or falls to 48Hz, all Generating Units shall remain in synchronism with the Grid for at least five (5) seconds to allow the System Operator to undertake measures to correct the situation.

## **5.2.3 Voltage Variations**

5.2.3.1 The Long Duration Voltage Variations at any Connection Point during normal conditions shall be within the limits specified in Section 3.2.3.

5.2.3.2 During Single Outage Contingencies, the RMS values of the voltages shall not result in an Undervoltage or Overvoltage at any Connection Point.

5.2.3.3 The Grid Owner shall consider the maximum estimated Voltage Swell in the selection of the voltage ratings of Grid Equipment.

## **5.2.4 Harmonics**

5.2.4.1 The Total Harmonic Distortion of the voltage and the Total Demand Distortion of the current, at any Connection Point, shall not exceed the limits prescribed in Section 3.2.4.

5.2.4.2 Users shall ensure that their System shall not cause the harmonics in the Grid to exceed the limits specified in Section 3.2.4.

## **5.2.5 Voltage Unbalance**

5.2.5.1 The maximum Negative Sequence Unbalance Factor at any Connection Point in the Grid shall not exceed the limits specified in Section 3.2.5 during normal operating conditions.

5.2.5.2 The maximum Zero Sequence Unbalance Factor at any Connection Point in the Grid shall not exceed the limits specified in Section 3.2.5 during normal operating conditions.

## **5.2.6 Voltage Fluctuation and Flicker Severity**

5.2.6.1 The Voltage Fluctuation at any Connection Point with a fluctuating

Demand shall not exceed the limits specified in Section 3.2.6.

5.2.6.2 The Flicker Severity at any Connection Point in the Grid shall not exceed the limits specified in Section 3.2.6.

### **5.2.7 Transient Voltage Variations**

5.2.7.1 The Grid and the User System shall be designed and operated to include devices that will mitigate the effects of transient Overvoltages on the Grid and the User System.

5.2.7.2 The Grid Owner and the User shall take into account the effect of electrical transients when specifying the insulation of their electrical Equipment.

5.2.7.3 Infrequent short-duration peaks may be permitted subject to the conditions specified in Section 3.2.7.

### **5.2.8 Grounding Requirements**

5.2.8.1 At nominal voltages of 110 kV and above, the Grid shall be effectively grounded with an Earth Fault Factor of less than 1.

5.2.8.2 At nominal voltages below 110 kV, the Grid Owner shall specify the grounding requirements and the applicable Earth Fault Factor at the Connection Point.

### **5.2.9 Equipment Standards**

5.2.9.1 All Equipment at the Connection Point shall comply with the requirements of the IEC Standards or their equivalent national standards.

5.2.9.2 All Equipment at the Connection Point shall be designed, manufactured, and tested in accordance with the quality assurance requirements of the IEC standard.

5.2.9.3 The prevailing standards at the time when the Connection Point was designed or modified, rather than the Test and Commissioning date or the Asset Transfer Date, shall apply to all Equipment at the Connection Point.

### **5.2.10 Maintenance Standards**

5.2.10.1 All Equipment at the Connection Point shall be operated and maintained in accordance with Good Industry Practice and in a manner that shall not pose a threat to the safety of any personnel or cause damage to the

Equipment of the Grid Owner or the User.

5.2.10.2 The User shall maintain a log containing the test results and maintenance records relating to its Equipment at the Connection Point and shall make this log available when requested by the Grid Owner.

5.2.10.3 The Grid Owner shall maintain a log containing the test results and maintenance records relating to its Equipment at the Connection Point and shall make this log available when requested by the User.

## **5.3 PROCEDURES FOR GRID CONNECTION OR MODIFICATION**

### **5.3.1 Connection Agreement**

5.3.1.1 Any User seeking a new connection to the Grid shall secure the required Connection Agreement with the Grid Owner prior to the actual connection to the Grid.

5.3.1.2 The Connection Agreement shall include provisions for the submission of information and reports, Safety Rules, Test and Commissioning programs, Electrical Diagrams, statement of readiness to connect, certificate of approval to connect, and other requirements prescribed by the **ERA**.

### **5.3.2 Amended Connection Agreement**

5.3.2.1 Any User seeking a modification of an existing connection to the Grid shall secure the required Amended Connection Agreement with the Grid Owner prior to the actual modification of the existing connection to the Grid.

5.3.2.2 The Amended Connection Agreement shall include provisions for the submission of additional information and reports required by the Grid Owner and other requirements prescribed by the **ERA**.

### **5.3.3 Grid Impact Studies**

5.3.3.1 The Grid Owner shall develop and maintain a set of required technical planning studies for evaluating the impact on the Grid of any proposed connection or modification to an existing connection. These planning studies shall be completed within the period prescribed by the **ERA**. The Grid Owner shall treat this period as the maximum acceptable planning study duration.

5.3.3.2 The Grid Owner shall specify which of the planning studies described in Article 6.3 will be carried out to evaluate the impact of the proposed User

Development on the Grid.

5.3.3.3 The User shall indicate whether it wishes the Grid Owner to undertake additional technical studies. The User shall shoulder the cost of the additional technical studies.

5.3.3.4 Any User applying for connection or a modification of an existing connection to the Grid shall take all necessary measures to ensure that the proposed User Development will not result in the Degradation of the Grid. The Grid Owner may disapprove an application for connection or a modification to an existing connection, if the Grid Impact Studies show that the proposed User Development will result in the Degradation of the Grid.

5.3.3.5 To enable the Grid Owner to carry out the necessary detailed Grid Impact Studies, the User may be required to provide some or all of the Detailed Planning Data listed in Article 6.5 ahead of the normal timescale referred to in Section 5.3.6.

#### **5.3.4 Application for Connection or Modification**

5.3.4.1 The Grid Owner shall establish the procedures for the processing of applications for connection or modification of an existing connection to the Grid.

5.3.4.2 Any User applying for connection or a modification of an existing connection to the Grid shall secure from the Grid Owner the Five-Year Statement of the TDP.

5.3.4.3 The User shall submit to the Grid Owner the completed application form for connection or modification of an existing connection to the Grid. The application form shall include the following information:

- (a) A description of the proposed connection or modification to an existing connection, which shall comprise the User Development at the Connection Point;
- (b) The relevant Standard Planning Data listed in Article 6.4; and
- (c) The Completion Date of the proposed User Development.

5.3.4.4 The User shall submit the planning data in three (3) stages, according to their degree of commitment and validation as described in Section 5.10.2.

These include:

- (a) Preliminary Project Planning Data;
- (b) Committed Project Planning Data; and
- (c) Connected Project Planning Data.

### **5.3.5 Processing of Application**

5.3.5.1 The Grid Owner shall process the application for connection or modification to an existing connection within 30 days from the submission of the completed application form.

5.3.5.2 After evaluating the application submitted by the User, the Grid Owner shall inform the User whether the proposed User Development is acceptable or not.

5.3.5.3 If the application of the User is acceptable, the Grid Owner and the User shall sign a Connection Agreement or an Amended Connection Agreement, as the case may be.

5.3.5.4 If the application of the User is not acceptable, the Grid Owner shall notify the User why its application is not acceptable. The Grid Owner shall include in its notification a proposal on how the User's application will be acceptable to the Grid Owner.

5.3.5.5 The User shall accept the proposal of the Grid Owner within 30 days, or a longer period specified in the Grid Owner's proposal, after which the proposal automatically lapses.

5.3.5.6 The acceptance by the User of the Grid Owner's proposal shall lead to the signing of a Connection Agreement or an Amended Connection Agreement.

5.3.5.7 If the Grid Owner and the User cannot reach agreement on the proposed connection or modification to an existing connection, the Grid Owner or the User may bring the matter before the **ERA** for resolution.

5.3.5.8 If a Connection Agreement or an Amended Connection Agreement is signed, the User shall submit to the Grid Owner, within 30 days from signing or a longer period agreed to by the Grid Owner and the User, the Detailed Planning Data pertaining to the proposed User Development, as specified in Article 6.5.

### **5.3.6 Submittals Prior to the Commissioning Date**

5.3.6.1 The following shall be submitted by the User prior to the commissioning date, pursuant to the terms and conditions and schedules specified in the Connection Agreement:

(a) Specifications of major Equipment not included in the Standard Planning Data and Detailed Planning Data;



- (b) Details of the protection arrangements and settings referred to in Section 5.4.9 for Generating Units and in Section 5.5.2 for Distributors and other Grid Users;
- (c) Information to enable the Grid Owner to prepare the Fixed Asset Boundary Document referred to in Article 5.7 including the name(s) of Accountable Manager(s);
- (d) Electrical Diagrams of the User's Equipment at the Connection Point as described in Article 5.8;
- (e) Information that will enable the Grid Owner to prepare the Connection Point Drawings, referred to in Article 5.9;
- (f) Copies of all Safety Rules and Local Safety Instructions applicable to the User's Equipment and a list of Safety Coordinators, pursuant to the requirements of Article 7.8;
- (g) A list of the names and telephone numbers of authorized representatives, including the confirmation that they are fully authorized to make binding decisions on behalf of the User, for Significant Incidents pursuant to the procedures specified in Section 7.7.2;
- (h) Proposed Maintenance Program; and
- (i) Test and Commissioning procedures for the Connection Point and the User Development.

5.3.6.2 The requirements in items (e) and (f) above need not be submitted for Embedded Generating Plants pursuant to the terms and conditions specified in the Connection Agreement.

### **5.3.7 Commissioning of Equipment and Physical Connection to the Grid**

5.3.7.1 Upon completion of the User Development, including work at the Connection Point, the Equipment at the Connection Point and the User Development shall be subjected to the Test and Commissioning procedures specified in Section 5.3.6.

5.3.7.2 The User shall then submit to the Grid Owner a statement of readiness to connect, which shall include the Test and Commissioning reports.

5.3.7.3 Upon acceptance of the User's statement of readiness to connect, the Grid Owner shall, within 15 days, issue a certificate of approval to connect.

5.3.7.4 The physical connection to the Grid shall be made only after the certificate of approval to connect has been issued by the Grid Owner to the User.

## **5.4 REQUIREMENTS FOR LARGE GENERATORS**

### **5.4.1 Requirements Relating to the Connection Point**

5.4.1.1 The Generator's Equipment shall be connected to the Grid at the voltage level(s) agreed to by the Grid Owner and the Generator based on Grid Impact Studies.

5.4.1.2 The Connection Point shall be controlled by a circuit breaker that is capable of interrupting the maximum short circuit current at the point of connection.

5.4.1.3 Disconnect switches shall also be provided and arranged to isolate the circuit breaker for maintenance purposes.

### **5.4.2 Generating Unit Power Output**

5.4.2.1 The Generating Unit shall be capable of continuously supplying its Active Power output, as specified in the Generator's Declared Data, within the System Frequency range of 49.5Hz to 50.5Hz. Any decrease of power output occurring in the Frequency range of 49.5Hz to 47.5Hz shall not be more than the required proportionate value of the System Frequency decay.

5.4.2.2 The Generating Unit shall be capable of supplying its Active Power and Reactive Power outputs, as specified in the Generator's Declared Data, within the voltage variations specified in Section 5.2.3 during normal operating conditions.

5.4.2.3 The Generating Unit shall be capable of supplying its Active Power output, as specified in the Generator's Declared Data, within the limits of 0.85 Power Factor lagging and 0.90 Power Factor leading at the Generating Unit's terminals, in accordance with its Reactive Power Capability Curve.

### **5.4.3 Frequency Withstand Capability**

5.4.3.1 If the System frequency momentarily rises to 52Hz or falls to 48Hz, all Generating Unit shall remain in synchronism with the Grid for at least five (5) seconds, as specified in Section 5.2.2. The Grid Owner may waive this requirement, if there are sufficient technical reasons to justify the waiver.

5.4.3.2 The Generator shall be responsible for protecting its Generating Units against damage for frequency excursions outside the range of 48Hz and 52Hz. The Generator shall decide whether or not to disconnect its Generating Unit from the Grid.

#### **5.4.4 Unbalance Loading Withstand Capability**

5.4.4.1 The Generating Unit shall meet the requirements for Voltage Unbalance as specified in Section 5.2.5.

5.4.4.2 The Generating Unit shall also be required to withstand without tripping, the unbalance loading during clearance by the Backup Protection of a close-up phase-to-phase fault on the Grid or, in the case of an Embedded Generating Unit, on the User System.

#### **5.4.5 Speed-Governing System**

5.4.5.1 The Generating Unit shall be capable of contributing to Frequency Control by continuous regulation of the Active Power supplied to the Grid or to the User System in the case of an Embedded Generating Unit.

5.4.5.2 The Generating Unit shall be fitted with a fast-acting speed-governing system to provide Frequency Control under normal operating conditions in accordance with Article 7.6. The speed-governing System shall have an overall speed-droop characteristic of five (5) percent or less. Unless waived by the Grid Owner in consultation with System Operator, the speed-governing System shall be capable of accepting raise and lower signals from the Control Center of the System Operator.

5.4.5.3 When a Generating Unit becomes isolated from the Grid, the speed-governing System shall provide Frequency Control to the resulting Island Grid. Exemptions from this requirement shall be specified in the Connection Agreement or Amended Connection Agreement.

#### **5.4.6 Excitation Control System**

5.4.6.1 The Generating Unit shall be capable of contributing to Voltage Control by continuous regulation of the Reactive Power supplied to the Grid or, in the case of Embedded Generating Unit, to the User System.

5.4.6.2 The Generating Unit shall be fitted with a continuously acting automatic excitation control System to control the terminal voltage without instability over the entire operating range of the Generating Unit.

5.4.6.3 The performance requirements for excitation control facilities, including power System stabilizers, where necessary for System operations shall be specified in the Connection Agreement or Amended Connection Agreement.

### **5.4.7 Black Start Capability**

5.4.7.1 The Grid shall have Black Start capability at a number of strategically located Generating Plants.

5.4.7.2 The Generator shall specify in its application for a Connection Agreement or Amended Connection Agreement if its Generating Unit has a Black Start capability.

### **5.4.8 Fast Start Capability**

5.4.8.1 The Generator shall specify in its application for a Connection Agreement or Amended Connection Agreement if its Generating Unit has a Fast Start capability.

5.4.8.2 The Generating Unit shall automatically Start-Up in response to frequency-level relays with settings in the range of 48Hz to 52Hz.

### **5.4.9 Protection Arrangements**

5.4.9.1 The protection of Generating Units and Equipment and their connection to the Grid shall be designed, coordinated, and tested to achieve the desired level of speed, sensitivity, and selectivity in fault clearing and to minimize the impact of faults on the Grid.

5.4.9.2 The Grid Owner and the User shall be solely responsible for the protection System of the electrical equipment and facilities at their respective sides of the Connection Point.

5.4.9.3 The Fault Clearance Time shall be specified in the Connection Agreement or Amended Connection Agreement. The Fault Clearance Time for a fault on the Grid where the Generator's Equipment are connected, or on the Generator's System where the Grid Owner's Equipment are connected, shall not be longer than:

- (a) 85 milliseconds (ms) for 500 kV;
- (b) 100 ms for 220 kV and 110 kV; and
- (c) 120 ms for voltages less than 110 kV.

5.4.9.4 Where the Generator's Equipment are connected to the Grid at 500 kV, 220 kV, or 110 kV and a circuit breaker is provided by the Generator (or by the Grid Owner) at the Connection Point to interrupt the fault current at any side of the Connection Point, a circuit breaker fail protection shall also be provided by the Generator (or the Grid Owner).

5.4.9.5 The circuit breaker fail protection shall be designed to initiate the

tripping of all the necessary electrically-adjacent circuit breakers and to interrupt the fault current within the next 150 milliseconds, in the event that the primary protection system fails to interrupt the fault current within the prescribed Fault Clearance Time.

5.4.9.6 The Generator shall provide protection against loss of excitation on the Generating Unit.

5.4.9.7 The Generator shall provide protection against pole-slipping on the Generating Unit.

5.4.9.8 The ability of the protection scheme to initiate the successful tripping of the Circuit Breakers that are associated with the faulty Equipment, measured by the System Protection Dependability Index, shall be not less than 80 percent.

#### **5.4.10 Transformer Connection and Grounding**

5.4.10.1 If the Generator's Equipment are connected to the Grid at a voltage that is equal to or greater than 110 kV, the high-voltage side of the transformer shall be connected in Wye, with the neutral available for connection to ground.

5.4.10.2 The Grid Owner shall specify the connection and grounding requirements for the low-voltage side of the transformer, in accordance with the provisions of Section 5.2.8.

### **5.5 REQUIREMENTS FOR DISTRIBUTORS AND OTHER GRID USERS**

#### **5.5.1 Requirements Relating to the Connection Point**

5.5.1.1 The Distributor's or other Grid User's Equipment shall be connected to the Grid at voltage level(s) agreed to by the Grid Owner and the Distributor (or other Grid User) based on Grid Impact Studies.

5.5.1.2 The Connection Point shall be controlled by a circuit breaker that is capable of interrupting the maximum short circuit current at the point of connection.

5.5.1.3 Disconnect switches shall also be provided and arranged to isolate the circuit breaker for maintenance purposes.

#### **5.5.2 Protection Arrangements**

5.5.2.1 The protection of the Distributor's or other Grid User's Equipment at

the Connection Point shall be designed, coordinated, and tested to achieve the desired level of speed, sensitivity, and selectivity in fault clearing and to minimize the impact of faults on the Grid.

5.5.2.2 The Grid Owner and the User shall be solely responsible for the protection systems of electrical equipment and facilities at their respective sides of the Connection Point.

5.5.2.3 The Fault Clearance Time shall be specified in the Connection Agreement or Amended Connection Agreement. The Fault Clearance Time for a fault on the Grid where the User's Equipment are connected, or on the User System where the Grid Owner's Equipment are connected, shall not be longer than:

- (a) 85 ms for 500 kV;
- (b) 100 ms for 220 kV and 110 kV; and
- (c) 120 ms for voltages less than 110 kV.

5.5.2.4 Where the Distributor's or other Grid User's Equipment are connected to the Grid at 500 kV, 220 kV, or 110 kV and a circuit breaker is provided by the Distributor or other Grid User (or by the Grid Owner) at the Connection Point to interrupt fault currents at any side of the Connection Point, a circuit breaker fail protection shall also be provided by the Distributor or other Grid User (or the Grid Owner).

5.5.2.5 The circuit breaker fail protection shall be designed to initiate the tripping of all the necessary electrically-adjacent circuit breakers and to interrupt the fault current within the next 150 milliseconds, in the event that the primary protection System fails to interrupt the fault current within the prescribed Fault Clearance Time.

5.5.2.6 Where the automatic reclosure of a circuit breaker is required following a fault on the User System, automatic switching Equipment shall be provided in accordance with the requirements specified in the Connection Agreement or Amended Connection Agreement.

5.5.2.7 The ability of the protection scheme to initiate the successful tripping of the Circuit Breakers that are associated with the faulty Equipment, measured by the System Protection Dependability Index, shall be not less than 80 percent.

5.5.2.8 The Grid Owner or the System Operator may require specific Users to provide other Protection schemes, designed and developed to maintain Grid Security, or to minimize the risk and/or impact of disturbances on the Grid.

### **5.5.3 Transformer Connection and Grounding**

5.5.3.1 If the Distributor's or other Grid User's Equipment are connected to the Grid at a voltage that is equal to or greater than 110 kV, the high-voltage side of the transformer shall be connected in Wye, with the neutral available for connection to ground.

5.5.3.2 The Grid Owner shall specify the connection and grounding requirements for the low-voltage side of the transformer, in accordance with the provisions of Section 5.2.8.

### **5.5.4 Under frequency Relays for Automatic Load Shedding**

5.5.4.1 The Connection Agreement or Amended Connection Agreement shall specify the manner in which Demand, subject to Automatic Load Shedding, will be split into discrete MW blocks to be actuated by Under frequency Relays.

5.5.4.2 The Under frequency Relays to be used in Automatic Load Shedding shall be fully digital with the following characteristics:

- (a) Frequency setting range: 48 to 52Hz in steps of 0.1 Hz, preferably 0.05 Hz;
- (b) Adjustable time delay: 0 to 60 s in steps of 0.1 s;
- (c) Rate of Frequency setting range: 0 to  $\pm 10$  Hz/s in steps of 0.1 Hz/s;
- (d) Operating time delay: less than 0.01s;
- (e) Voltage lock-out: Selectable within 55% to 90% of nominal voltage;
- (f) Facility stages: Minimum of two stages operation; and
- (g) Output contacts: Minimum of three output contacts per stage.

5.5.4.3 The Under frequency Relays shall be suitable for operation from a nominal DC input of 110 volts. The voltage supply to the Under frequency Relays shall be sourced from the primary System at the supply point to ensure that the input Frequency to the Under frequency Relay is the same as that of the primary System.

5.5.4.4 The tripping facility shall be designed and coordinated in accordance with the following reliability considerations:

- (a) Dependability: Failure to trip at any one particular Demand shedding point shall not harm the overall operation of the scheme. The overall dependability of the scheme shall not be lower than 96 percent; and
- (b) Outages: The amount of Demand under control shall not be reduced significantly during the Outage or maintenance of the Equipment.

## **5.6 COMMUNICATION AND SCADA EQUIPMENT REQUIREMENTS**

### **5.6.1 Communication System for Monitoring and Control**

5.6.1.1 A communication System shall be established so that the Grid Owner, the System Operator and the Users can communicate with one another, as well as exchange data signals for monitoring and controlling the Grid during normal and emergency conditions.

5.6.1.2 The Grid Owner shall provide the complete communication Equipment required for the monitoring and control of the Connection Point and the Generating Units.

5.6.1.3 The Grid Owner may use a combination of communication media such as fiber optics digital/analog Power Line Carrier (PLC) and, digital/analog microwave radio to link the User System with the Grid Owner's System. Backup communication may be referred to as UHF/VHF half-duplex, hand-held or base radios, and mobile (cellular) phones, if applicable.

### **5.6.2 SCADA System for Monitoring and Control**

5.6.2.1 The Grid Owner shall provide a Remote Terminal Unit (RTU) for interconnection with the System Operator's Control Center, to serve as telemetry Equipment for monitoring real-time information and controlling the Equipment at the User System.

5.6.2.2 The RTU shall be compatible with the Master Station protocol requirements and modem specifications of the System Operator. In the event that the Master Station is changed, the Grid Owner shall be responsible for any change needed for the RTU to match the new requirements.

5.6.2.3 The Grid Owner shall also provide, if applicable, other related Equipment such as transducers, cables, modems, etc. for interconnection with the SCADA System of the Grid.

## **5.7 FIXED ASSET BOUNDARY DOCUMENT REQUIREMENTS**

### **5.7.1 Fixed Asset Boundary Document**

5.7.1.1 The Fixed Asset Boundary Documents for any Connection Point shall provide the information and specify the operational responsibilities of the Grid Owner and the User for the following:



- (a) HV and EHV Equipment;
- (b) LV and MV Equipment; and
- (c) Communications and metering equipment.

5.7.1.2 For the Fixed Asset Boundary Document referred to in item (a) above, the responsible management unit shall be shown, in addition to the Grid Owner or the User. In the case of Fixed Asset Boundary Documents referred to in items (b) and (c) above, with the exception of protection equipment and inter-trip equipment operation, it will be sufficient to indicate the responsible User or the Grid Owner.

5.7.1.3 The Fixed Asset Boundary Document shall show precisely the Connection Point and shall specify the following:

- (a) Equipment and their ownership;
- (b) Accountable Managers;
- (c) Safety Rules and procedures including Local Safety Instructions and the Safety Coordinator(s) or any other persons responsible for safety;
- (d) Operational procedures and the responsible party for operation and control;
- (e) Maintenance requirements and the responsible party for undertaking maintenance; and
- (f) Any agreement pertaining to emergency conditions.

5.7.1.4 The Fixed Asset Boundary Documents shall be available at all times for the use of the operations personnel of the Grid Owner and the User.

## **5.7.2 Accountable Managers**

5.7.2.1 Prior to the Completion Date specified in the Connection Agreement or Amended Connection Agreement, the User shall submit to the Grid Owner a list of Accountable Managers who are duly authorized to sign the Fixed Asset Boundary Documents on behalf of the User.

5.7.2.2 Prior to the Completion Date specified in the Connection Agreement or Amended Connection Agreement, the Grid Owner shall provide the User the name of the Accountable Manager who shall sign the Fixed Asset Boundary Documents on behalf of the Grid Owner.

5.7.2.3 Any change to the list of Accountable Managers shall be communicated to the other party at least six (6) weeks before the change becomes effective. If the change was not anticipated, it must be communicated as soon as possible to the other party, with an explanation why the change had to be made.

5.7.2.4 Unless specified otherwise in the Connection Agreement or the

Amended Connection Agreement, the construction, Test and Commissioning, control, operation and maintenance of Equipment, accountability, and responsibility shall follow ownership.

### **5.7.3 Preparation of Fixed Asset Boundary Document**

5.7.3.1 The Grid Owner shall establish the procedure and forms required for the preparation of the Fixed Asset Boundary Documents.

5.7.3.2 The User shall provide the information that will enable the Grid Owner to prepare the Fixed Asset Boundary Document, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.7.3.3 The Grid Owner shall prepare the Fixed Asset Boundary Documents for the Connection Point at least two (2) weeks prior to the Completion Date.

5.7.3.4 The Fixed Asset Boundary Document for the Equipment at the Connection Point shall include the details of the lines or cables emanating from the Grid Owner's and the User's sides of the Connection Point.

5.7.3.5 The date of issue and the issue number shall be included in every page of the Fixed Asset Boundary Document.

### **5.7.4 Signing and Distribution of Fixed Asset Boundary Document**

5.7.4.1 Prior to the signing of the Fixed Asset Boundary Document, the Grid Owner shall send a copy of the completed Fixed Asset Boundary Document to the User, for any revision or for confirmation of its accuracy.

5.7.4.2 The Accountable Managers designated by the Grid Owner and the User shall sign the Fixed Asset Boundary Document, after confirming its accuracy.

5.7.4.3 Once signed but not less than two (2) weeks before the implementation date, the Grid Owner shall provide two (2) copies of the Fixed Asset Boundary Document to the User, with a notice indicating the date of issue, the issue number and the implementation date of the Fixed Asset Boundary Document.

## **5.7.5 Modifications of an Existing Fixed Asset Boundary Document**

5.7.5.1 When a User has determined that a Fixed Asset Boundary Document requires modification, it shall inform the Grid Owner at least eight (8) weeks before implementing the modification. The Grid Owner shall then prepare a revised Fixed Asset Boundary Document at least six (6) weeks before the implementation date of the modification.

5.7.5.2 When the Grid Owner has determined that a Fixed Asset Boundary Document requires modification, it shall prepare a revised Fixed Asset Boundary Document at least six (6) weeks prior to the implementation date of the modification.

5.7.5.3 When the Grid Owner or a User has determined that a Fixed Asset Boundary Document requires modification to reflect an emergency condition, the Grid Owner or the User, as the case may be, shall immediately notify the other party. The Grid Owner and the User shall meet to discuss the required modification to the Fixed Asset Boundary Document, and shall decide whether the change is temporary or permanent in nature. Within seven (7) days after the conclusion of the meeting between the Grid Owner and the User, the Grid Owner shall provide the User a revised Fixed Asset Boundary Document.

5.7.5.4 The procedure specified in Section 5.7.4 for signing and distribution shall be applied to the revised Fixed Asset Boundary Document. The Grid Owner's notice shall indicate the revision(s), the new issue number and the new date of issue.

## **5.8 ELECTRICAL DIAGRAM REQUIREMENTS**

### **5.8.1 Responsibilities of the Grid Owner and Users**

5.8.1.1 The Grid Owner shall specify the procedure and format to be followed in the preparation of the Electrical Diagrams for any Connection Point.

5.8.1.2 The User shall prepare and submit to the Grid Owner an Electrical Diagram for all the Equipment on the User's side of the Connection Point, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.8.1.3 The Grid Owner shall provide the User with an Electrical Diagram for all the Equipment on the Grid Owner's side of the Connection Point, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.8.1.4 If the Connection Point is at the User's Site, the User shall prepare and

distribute a composite Electrical Diagram for the entire Connection Point. Otherwise, the Grid Owner shall prepare and distribute the composite Electrical Diagram for the entire Connection Point.

### **5.8.2 Preparation of Electrical Diagrams**

5.8.2.1 The Electrical Diagrams shall provide an accurate record of the layout and circuit connections, ratings and identification of Equipment, and related apparatus and devices at the Connection Point.

5.8.2.2 All the Equipment at the Connection Point shall be shown in Electrical Diagram. The Electrical Diagrams shall represent, as closely as possible, the physical arrangement of the Equipment and their electrical connections.

5.8.2.3 The Electrical Diagrams shall be prepared using the Site and Equipment Identification prescribed in Article 7.11. The current status of the Equipment shall be indicated in the diagram.

5.8.2.4 The title block of the Electrical Diagram shall include the names of authorized persons together with provisions for the details of revisions, dates, and signatures.

### **5.8.3 Changes to Electrical Diagrams**

5.8.3.1 If the Grid Owner or a User decides to add new Equipment or change an existing Equipment Identification, the Grid Owner or the User, as the case may be, shall provide the other party a revised Electrical Diagram, at least one month prior to the proposed addition or change.

5.8.3.2 If the modification involves the replacement of existing Equipment, the revised Electrical Diagram shall be provided to the other party in accordance with the schedule specified in the Amended Connection Agreement.

5.8.3.3 The revised Electrical Diagram shall incorporate the new Equipment to be added, the existing Equipment to be replaced or the change in Equipment Identification.

### **5.8.4 Validity of Electrical Diagrams**

5.8.4.1 The composite Electrical Diagram prepared by the Grid Owner or the User, in accordance with the provisions of Section 5.8.1, shall be the Electrical Diagram to be used for all operation and planning activities associated with the Connection Point.

5.8.4.2 If a dispute involving the accuracy of the composite Electrical Diagram arises, a meeting between the Grid Owner and the User shall be held as soon as possible, to resolve the dispute.

## **5.9 CONNECTION POINT DRAWING REQUIREMENTS**

### **5.9.1 Responsibilities of the Grid Owner and Users**

5.9.1.1 The Grid Owner shall specify the procedure and format to be followed in the preparation of the Connection Point Drawing for any Connection Point.

5.9.1.2 The User shall prepare and submit to the Grid Owner the Connection Point Drawing for the User's side of the Connection Point, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.9.1.3 The Grid Owner shall provide the User with the Connection Point Drawing for the Grid Owner's side of the Connection Point, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.9.1.4 If the Connection Point is at the User Site, the User shall prepare and distribute a composite Connection Point Drawing for the entire Connection Point. Otherwise, the Grid Owner shall prepare and distribute the composite Connection Point Drawing for the entire Connection Point.

### **5.9.2 Preparation of Connection Point Drawings**

5.9.2.1 The Connection Point Drawing shall provide an accurate record of the layout and circuit connections, ratings and identification of Equipment, and related apparatus and devices at the Connection Point.

5.9.2.2 The Connection Point Drawing shall indicate the Equipment layout, common protection, and control and auxiliaries. The Connection Point Drawing shall represent, as closely as possible, the physical arrangement of the Equipment and their electrical connections.

5.9.2.3 The Connection Point Drawing shall be prepared using the Site and Equipment Identification prescribed in Article 7.11. The current status of the Equipment shall be indicated in the drawing.

5.9.2.4 The title block of the Connection Point Drawing shall include the names of authorized persons together with provision for the details of revisions, dates, and signatures.

### **5.9.3 Changes to Connection Point Drawings**

5.9.3.1 If the Grid Owner or a User decides to add new Equipment or change an existing Equipment Identification, the Grid Owner or the User, as the case may be, shall provide the other party a revised Connection Point Drawing, at least one month prior to the proposed addition or change.

5.9.3.2 If the modification involves the replacement of existing Equipment, the revised Connection Point Drawing shall be provided to the other party in accordance with the schedule specified in the Amended Connection Agreement.

5.9.3.3 The revised Connection Point Drawing shall incorporate the new Equipment to be added, the existing Equipment to be replaced, or the change in Equipment Identification.

5.9.3.4 The Grid Owner and the User shall, if they have agreed to do so in writing, modify their respective copies of the Connection Point Drawings to reflect the change that they have agreed on, in accordance with the schedule specified in the Connection Agreement or Amended Connection Agreement.

### **5.9.4 Validity of the Connection Point Drawings**

5.9.4.1 The composite Connection Point Drawing prepared by the Grid Owner or the User, in accordance with Section 5.9.1, shall be the Connection Point Drawing to be used for all operation and planning activities associated with the Connection Point.

5.9.4.2 If a dispute involving the accuracy of the composite Connection Point Drawing arises, a meeting between the Grid Owner and the User shall be held as soon as possible, to resolve the dispute.

## **5.10 GRID DATA REGISTRATION**

### **5.10.1 Data to be Registered**

5.10.1.1 The data relating to the Connection Point and the User Development that are submitted by the User to the Grid Owner shall be registered according to the following data categories:

- (a) Forecast Data;
- (b) Estimated Equipment Data; and
- (c) Registered Equipment Data.

5.10.1.2 The Forecast Data, including Demand and Active Energy, shall

contain the User's best estimate of the data being projected for the five (5) succeeding years.

5.10.1.3 The Estimated Equipment Data shall contain the User's best estimate of the values of parameters and information about the Equipment for the five (5) succeeding years.

5.10.1.4 The Registered Equipment Data shall contain validated actual values of parameters and information about the Equipment that are submitted by the User to the Grid Owner at the connection date. The Registered Equipment Data shall include the Connected Project Planning Data, which shall replace any estimated values of parameters and information about the Equipment previously submitted as Preliminary Project Planning Data and Committed Project Planning Data.

## **5.10.2 Stages of Data Registration**

5.10.2.1 The data relating to the Connection Point and the User Development that are submitted by a User applying for a Connection Agreement or an Amended Connection Agreement shall be registered in three (3) stages and classified accordingly as:

- (a) Preliminary Project Planning Data;
- (b) Committed Project Planning Data; and
- (c) Connected Project Planning Data;

5.10.2.2 The data that are submitted at the time of application for a Connection Agreement or an Amended Connection Agreement shall be considered as Preliminary Project Planning Data. These data shall contain the Standard Planning Data specified in Article 6.4, and the Detailed Planning Data specified in Article 6.5, when required ahead of the schedule specified in the Connection Agreement or Amended Connection Agreement.

5.10.2.3 Once the Connection Agreement or the Amended Connection Agreement is signed, the Preliminary Project Planning Data shall become the Committed Project Planning Data, which shall be used in evaluating other applications for Grid connection or modification of existing Grid connection and in preparing the Transmission Development Plan.

5.10.2.4 The Estimated Equipment Data shall be updated, confirmed, and replaced with validated actual values of parameters and information about the Equipment at the time of connection, which shall become the Connected Project Planning Data. These data shall be registered in accordance with the categories specified in Section 5.10.1 and shall be used in evaluating other applications for Grid connection or modification of existing Grid connection

and in preparing the Transmission Development Plan.

### **5.10.3 Data Forms**

The Grid Owner, in consultation with the System Operator and the Market Operator, shall develop the forms for all data to be submitted in accordance with an application for a Connection Agreement or an Amended Connection Agreement.



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## **CHAPTER 6 PLANNING CODE**

### **6.1 PURPOSE AND SCOPE**

#### **6.1.1 Purpose**

- (a) To specify the responsibilities of the Grid Owner, Grid Planning Subcommittee, and other Users in planning the development of the Grid;
- (b) To specify the technical studies and planning procedures that will ensure the safety, Security, Reliability, and Stability of the Grid;
- (c) To specify the planning data required for a User seeking a new connection or a modification of an existing connection to the Grid; and
- (d) To specify the data requirements to be used by the Grid Owner in planning the development of the Grid.

#### **6.1.2 Scope of Application**

This Chapter applies to all Grid Users including:

- (a) Grid Owner;
- (b) System Operator;
- (c) Market Operator;
- (d) Generators;
- (e) Distributors;
- (f) Suppliers; and
- (g) Any other entity with a User System connected to the Grid.

### **6.2 GRID PLANNING RESPONSIBILITIES AND PROCEDURES**

#### **6.2.1 Grid Planning Responsibilities**

6.2.1.1 The Grid Owner shall have lead responsibility for Grid planning, including:

- (a) Analyzing the impact of the connection of new facilities such as Generating Plants, Loads, transmission lines, or substations;
- (b) Planning the expansion of the Grid to ensure its adequacy to meet forecasted Demand and the connection of new Generating Plants; and
- (c) Identifying congestion problems that may result in increased Outages or

raise the cost of service significantly.

6.2.1.2 The System Operator shall be responsible in planning the expansion of communications and SCADA facilities.

6.2.1.3 The System Operator, Market Operator, and other Users shall cooperate with the Grid Owner in maintaining a Grid planning data bank, reviewing planning proposals as necessary, and advising the Grid Planning Subcommittee on improved Grid planning procedures.

6.2.1.4 The Grid Planning Subcommittee shall be responsible for:

- (a) Evaluating and making recommendations on the Transmission Development Plan to the Grid Management Committee;
- (b) Evaluating and recommending actions on proposed major Grid reinforcement and expansion projects; and
- (c) Periodically reviewing and recommending changes in planning procedures and standards.

## **6.2.2 Submission of Planning Data**

6.2.2.1 Any User applying for connection or a modification of an existing connection to the Grid shall submit to the Grid Owner the relevant Standard Planning Data specified in Article 6.4 and the Detailed Planning Data specified in Article 6.5, in accordance with the requirements prescribed in Article 5.3.

6.2.2.2 All Users shall submit annually to the Grid Owner the relevant planning data for the previous year and the five (5) succeeding years by calendar week 27 of the current year. These shall include the updated Standard Planning Data and the Detailed Planning Data.

6.2.2.3 The required Standard Planning Data specified in Article 6.4 shall consist of information necessary for the Grid Owner to evaluate the impact of any User Development on the Grid or to the System of other Users.

6.2.2.4 The Detailed Planning Data specified in Article 6.5 shall include additional information necessary for the conduct of a more accurate Grid planning study.

6.2.2.5 The Standard Planning Data and Detailed Planning Data shall be submitted by the User to the Grid Owner according to the following categories:

- (a) Forecast Data;
- (b) Estimated Equipment Data; and
- (c) Registered Equipment Data.

6.2.2.6 The Forecast Data shall contain the User's best estimate of the data,

including Energy and Demand, being projected for the five (5) succeeding years.

6.2.2.7 The Estimated Equipment Data shall contain the User's best estimate of the values of parameters and information pertaining to its Equipment.

6.2.2.8 The Registered Equipment Data shall contain validated actual values of parameters and information about the User's Equipment, which are part of the Connected Project Planning Data submitted by the User to the Grid Owner at the time of connection.

### **6.2.3 Consolidation and Maintenance of Planning Data**

6.2.3.1 The Grid Owner shall consolidate and maintain the Grid planning data according to the following categories:

- (a) Forecast Data;
- (b) Estimated Equipment Data; and
- (c) Registered Equipment Data.

6.2.3.2 If there is any change to its planning data, the User shall notify the Grid Owner of the change as soon as possible. The notification shall contain the time and date when the change took effect, or is expected to take effect, as the case may be. If the change is temporary, the time and date when the data is expected to revert to its previous registered value shall also be indicated in the notification.

### **6.2.4 Evaluation of Grid Expansion Project**

6.2.4.1 The Grid Owner shall conduct Grid Impact Studies to assess the effect of any proposed Grid expansion project on the Grid and the System of other Users.

6.2.4.2 The Grid Owner shall notify the User of any planned development in the Grid that may have an impact on the User System.

### **6.2.5 Evaluation of Proposed User Development**

6.2.5.1 The Grid Owner shall conduct Grid Impact Studies to assess the effect of any proposed User Development on the Grid and the System of other Users.

6.2.5.2 The Grid Owner shall notify the applicant User of the results of the Grid Impact Studies.

## **6.2.6 Preparation of TDP**

6.2.6.1 The Grid Owner shall collate and process the planning data submitted by the Users into a cohesive forecast and use this in preparing the data for the Five-Year Statement of the TDP.

6.2.6.2 If a User believes that the cohesive forecast data prepared by the Grid Owner does not accurately reflect its assumptions on the planning data, it shall promptly notify the Grid Owner of its concern. The Grid Owner and the User shall promptly meet to address the concern of the User.

## **6.3 GRID PLANNING STUDIES**

### **6.3.1 Grid Planning Studies to be Conducted**

6.3.1.1 The Grid Owner shall conduct Grid planning studies to ensure the safety, Reliability, Security, and Stability of the Grid for the following:

- (a) Preparation of the TDP to be integrated with the Power Development Program of the EC, pursuant to the provisions of the Act;
- (b) Evaluation of Grid reinforcement projects; and
- (c) Evaluation of any proposed User Development, which is submitted to Grid Owner in accordance with an application for a Connection Agreement or an Amended Connection Agreement.

6.3.1.2 The Grid planning studies shall be conducted to assess the impact on the Grid or to any User System of any Demand Forecast or any proposed addition or change of Equipment or facilities in the Grid or the User System and to identify corrective measures to eliminate the deficiencies in the Grid or the User System.

6.3.1.3 The Grid planning studies shall be conducted periodically to assess:

- (a) The behavior of the Grid during normal and Outage-contingency conditions; and
- (b) The behavior of the Grid during the electromechanical or electromagnetic transient induced by disturbances or switching operations.

6.3.1.4 The relevant technical studies described in Sections 6.3.2 to 6.3.8 and the required planning data specified in Articles 6.4 and 6.5 shall be used in the conduct of the Grid planning studies.

### **6.3.2 Load Flow Studies**

6.3.2.1 Load flow studies shall be performed to evaluate the behavior of the Grid for the existing and planned Grid facilities under forecasted maximum and minimum Load conditions and to study the impact on the Grid of the connection of new Generating Plants, Loads, or transmission lines.

6.3.2.2 For new transmission lines, the Load condition that produces the maximum power flows through the existing and new lines shall be identified and evaluated.

### **6.3.3 Short Circuit Studies**

6.3.3.1 Short circuit studies shall be performed to evaluate the effect on Grid Equipment of the connection of new Generating Plants, transmission lines, and other facilities that will result in increased fault duties for Grid Equipment. These studies shall identify the Equipment that could be permanently damaged when the current exceeds the design limit of the Equipment such as switchyard devices and substation buses. The studies shall also identify the circuit breakers, which may fail when interrupting possible short circuit currents.

6.3.3.2 Three-phase short-circuit studies shall be performed for all nodes of the Grid for different feasible generation, Load, and system circuit configurations. Single-phase short-circuit studies shall also be performed for critical Grid nodes. These studies shall identify the most severe conditions that the Grid Equipment may be exposed to.

6.3.3.3 Alternative Grid circuit configurations shall be studied to reduce the short circuit currents within the limits of existing Equipment. Such changes in circuit configuration shall be subjected to load flow and Stability analysis to ensure that the changes do not cause steady-state load flow or Stability problems.

6.3.3.4 The results shall be considered satisfactory when the short-circuit currents are within the design limits of Equipment and the proposed Grid configurations are suitable for flexible and safe operation.

### **6.3.4 Transient Stability Studies**

6.3.4.1 Transient Stability studies shall be performed to verify the impact of the connection of new Generating Plants, transmission lines, and substations and changes in Grid circuit configurations on the ability of the Grid to seek a

stable operating point following a transient disturbance. Transient Stability studies shall simulate the outages of critical Grid facilities such as major 500kV transmission lines and large Generating Units. The studies shall demonstrate that the Grid performance is satisfactory if:

- (a) The Grid remains stable after any Single Outage Contingency for all forecasted Load conditions; and
- (b) The Grid remains controllable after a Multiple Outage Contingency. In the case of Grid separation, no total blackout should occur in any Island Grid.

6.3.4.2 Transient Stability studies shall be conducted for all new 500 kV transmission lines or substations and for the connection of new Generating Units equal to or larger than 125 MW at 500 kV, 135 MW at 220 kV, and 60 MW at 110 kV. In other cases, the Grid Owner shall determine the need of performing transient Stability studies.

6.3.4.3 Studies shall be conducted to determine the possibility that Transient Instability problems may occur in the Grid.

### **6.3.5 Steady-State Stability Analysis**

6.3.5.1 Periodic studies shall be performed to determine if the Grid is vulnerable to steady-state Stability problems. Such problems occur on heavily-loaded Systems, where small disturbances may cause steady-state oscillations that can lead to major disturbances. The studies shall identify solutions, such as the installation of power system stabilizers or the identification of safe operating conditions.

6.3.5.2 Studies shall be conducted to determine the possibility that Dynamic Instability problems may occur in the Grid.

### **6.3.6 Voltage Stability Analysis**

6.3.6.1 Periodic studies shall be performed to determine if the Grid is vulnerable to voltage collapse under heavy loading conditions. A voltage collapse can proceed very rapidly if the ability of System's Reactive Power supply to support system voltages is exhausted. The studies shall identify solutions such as the installation of dynamic and static Reactive Power compensation devices to avoid vulnerability to voltage collapse. In addition, the studies shall identify safe Grid operating conditions where vulnerability to voltage collapse can be avoided until solutions are implemented.

6.3.6.2 Studies shall be conducted to determine the possibility that Voltage

Instability problems may occur in the Grid.

### **6.3.7 Electromagnetic Transient Analysis**

Electromagnetic transient studies shall be performed whenever very short-duration current and voltage transients can affect Equipment insulation, the thermal dissipation capacity of protection devices or the clearing capability of the protection System.

### **6.3.8 Reliability Analysis**

Reliability analysis shall be performed to determine the generation deficiency of the Grid using a probabilistic method such as Loss of Load Probability (LOLP) or Expected Energy Not Supplied (EENS).

## **6.4 STANDARD PLANNING DATA**

### **6.4.1 Historical Energy and Demand**

6.4.1.1 The User shall provide the Grid Owner its actual monthly Energy and Demand consumption at each Connection Point for the immediate past year.

6.4.1.2 The User shall also provide the Grid Owner with actual hourly load profiles for a typical weekday, weekend, and holiday.

### **6.4.2 Energy and Demand Forecast**

6.4.2.1 The User shall provide the Grid Owner with its Energy and Demand forecasts at each Connection Point for the five (5) succeeding years. Where the User System is connected to the Grid at more than one Connection Point, the Demand data to be provided by the User shall be the coincident peak Active Power Demand.

6.4.2.2 The Forecast Data for the first year shall include monthly Energy and Demand forecasts, while the remaining four years shall include only the annual Energy and Demand forecasts.

6.4.2.3 The User shall also provide the Grid Owner with forecasted hourly load profiles for a typical weekday, weekend, and holiday.

6.4.2.4 Distributors (and other Users) shall provide the net values of Energy and Demand forecast for the Distribution System (or the User System) at each Connection Point after any deductions to reflect the output of Embedded



Generating Plants. Such deductions shall be stated separately in the Forecast Data.

6.4.2.5 Generators shall submit to the Grid Owner the projected Energy and Demand to be generated by each Generating Plant. Forecast Data for Embedded Generating Units and Embedded Generating Plants shall be submitted through the Distributor.

6.4.2.6 In order to avoid the duplication of Forecast Data, each User shall indicate the Energy and Demand requirements that it shall meet under a contract. Where the User shall meet only a portion of the Energy and Demand requirements, it shall indicate in the Forecast Data that portion of the requirements and/or the portion of the forecast period covered by the contract.

6.4.2.7 If the User System is connected to the Grid at a Connection Point with a bus arrangement which is, or may be operated in separate sections, the Energy and Demand forecasts for each bus section shall be separately stated.

### **6.4.3 Generating Unit Data**

6.4.3.1 The Generator shall provide the Grid Owner with data relating to the Generating Units of its Generating Plant

6.4.3.2 The Distributor (or other User) shall provide the Grid Owner with data relating to the Generating Units of each Embedded Generating Plant.

6.4.3.3 The following information shall be provided for the Generating Units of each Generating Plant:

- (a) Rated Capacity (MVA and MW);
- (b) Rated Voltage (kV);
- (c) Type of Generating Unit and expected running mode(s);
- (d) Direct axis subtransient reactance (percent); and
- (e) Rated capacity, voltage, and impedance of the Generating Unit's step-up transformer.

6.4.3.4 If the Generating Unit is connected to the Grid at a Connection Point with a bus arrangement which is, or may be operated in separate sections, the bus section to which each Generating Unit is connected shall be identified.

### **6.4.4 User System Data**

6.4.4.1 The User shall provide the Electrical Diagrams and Connection Point Drawings of the User System and the Connection Point, as specified in Articles 5.8 and 5.9, respectively. The diagrams and drawings shall indicate the quantities, ratings, and operating parameters of the following:

- 
- (a) Equipment ( *e.g.* , Generating Units, power transformers, and Circuit Breakers);
  - (b) Electrical circuits ( *e.g.* , overhead lines and underground cables);
  - (c) Substation bus arrangements;
  - (d) Grounding arrangements;
  - (e) Phasing arrangements; and
  - (f) Switching facilities.

6.4.4.2 The User shall provide the values of the following circuit parameters of the overhead lines and/or underground cables from the User System substation to the Connection Point in the Grid:

- (a) Rated and operating voltage (kV);
- (b) Positive sequence resistance and reactance (ohm);
- (c) Positive sequence shunt susceptance (Siemens or  $\text{ohm}^{-1}$ );
- (d) Zero sequence resistance and reactance (ohm); and
- (e) Zero sequence susceptance (Siemens or  $\text{ohm}^{-1}$ ).

6.4.4.3 If the User System is connected to the Grid through a step-up transformer, the following data for the power transformers shall be provided:

- (a) Rated MVA;
- (b) Rated voltages (kV);
- (c) Winding arrangement;
- (d) Positive sequence resistance and reactance (at max, min, and nominal tap);
- (e) Zero sequence reactance for three-legged core type transformer;
- (f) Tap changer range, step size and type (on-load or off-load); and
- (g) Basic Lightning Impulse Insulation Level (kV).

6.4.4.4 The User shall provide the following information for the switchgear, including circuit breakers, load break switches, and disconnect switches at the Connection Point and at the substation of the User:

- (a) Rated voltage (kV);
- (b) Rated current (A);
- (c) Rated symmetrical RMS short-circuit current (kA); and
- (d) Basic Lightning Impulse Insulation Level (kV).

6.4.4.5 The User shall provide the details of its System Grounding. This shall include the rated capacity and impedances of the Grounding Equipment.

6.4.4.6 The User shall provide the data on independently-switched Reactive Power compensation Equipment at the Connection Point and/or at the substation of the User System. This shall include the following information:

- (a) Rated Capacity (MVAR);
- (b) Rated Voltage (kV);

- (c) Type ( *e.g.* , shunt inductor, shunt capacitor, static var compensator); and
- (d) Operation and control details ( *e.g.* fixed or variable, automatic, or manual).

6.4.4.7 If a significant portion of the User's Demand may be supplied from alternative Connection Point(s), the relevant information on the Demand transfer capability shall be provided by the User including the following:

- (a) The alternative Connection Point(s);
- (b) The Demand normally supplied from each alternative Connection Point;
- (c) The Demand which may be transferred from or to each alternative Connection Point; and
- (d) The control ( *e.g.*, manual or automatic) arrangements for transfer including the time required to effect the transfer for Forced Outage and planned maintenance conditions.

6.4.4.8 If a Distribution System (or other User System) has Embedded Generating Plants and significantly large motors, the short circuit contribution of the Embedded Generating Units and the large motors at the Connection Point shall be provided by the Distributor (or the other User). The short circuit current shall be calculated in accordance with the IEC Standards or their equivalent national standards.

## **6.5 DETAILED PLANNING DATA**

### **6.5.1 Generating Unit and Generating Plant Data**

6.5.1.1 The following additional information shall be provided for the Generating Units of each Generating Plant:

- (a) Derated Capacity (MW) on a monthly basis if applicable;
- (b) Additional capacity (MW) obtainable from Generating Units in excess of Net Declared Capability;
- (c) Minimum Stable Loading (MW);
- (d) Reactive Power Capability Curve;
- (e) Stator armature resistance;
- (f) Direct axis synchronous, transient, and subtransient reactances;
- (g) Quadrature axis synchronous, transient, and subtransient reactances;
- (h) Direct axis transient and subtransient time constants;
- (i) Quadrature axis transient and subtransient time constants;
- (j) Turbine and Generating Unit inertia constant (MWsec/MVA);
- (k) Rated field current (amps) at rated MW and MVAR output and at rated terminal voltage; and

(l) Short circuit and open circuit characteristic curves.

6.5.1.2 The following information for Step-up Transformers shall be provided for each Generating Unit:

- (a) Rated MVA;
- (b) Rated Frequency (Hz);
- (c) Rated voltage (kV);
- (d) Voltage ratio;
- (e) Positive sequence reactance (maximum, minimum, and nominal tap);
- (f) Positive sequence resistance (maximum, minimum, and nominal tap);
- (g) Zero sequence reactance;
- (h) Tap changer range;
- (i) Tap changer step size; and
- (j) Tap changer type: on load or off load.

6.5.1.3 The following excitation control system parameters shall be provided for each Generating Unit:

- (a) DC gain of Excitation Loop;
- (b) Rated field voltage;
- (c) Maximum field voltage;
- (d) Minimum field voltage;
- (e) Maximum rate of change of field voltage (rising);
- (f) Maximum rate of change of field voltage (falling);
- (g) Details of Excitation Loop described in diagram form showing transfer functions of individual elements;
- (h) Dynamic characteristics of over excitation limiter; and
- (i) Dynamic characteristics of under excitation limiter.

6.5.1.4 The following speed-governing system parameters shall be provided for each reheat steam Generating Unit:

- (a) High pressure governor average gain (MW/Hz);
- (b) Speeder motor setting range;
- (c) Speed droop characteristic curve;
- (d) High pressure governor valve time constant;
- (e) High pressure governor valve opening limits;
- (f) High pressure governor valve rate limits;
- (g) Reheater time constant (Active Energy stored in reheater);
- (h) Intermediate pressure governor average gain (MW/Hz);
- (i) Intermediate pressure governor setting range;
- (j) Intermediate pressure governor valve time constant;
- (k) Intermediate pressure governor valve opening limits;

- (l) Intermediate pressure governor valve rate limits;
- (m) Details of acceleration sensitive elements in high pressure and intermediate pressure governor loop; and
- (n) A governor block diagram showing the transfer functions of individual elements.

6.5.1.5 The following speed-governing system parameters shall be provided for each non-reheat steam, gas turbine , geothermal, and hydro Generating Unit:

- (a) Governor average gain;
- (b) Speeder motor setting range;
- (c) Speed droop characteristic curve;
- (d) Time constant of steam or fuel governor valve or water column inertia;
- (e) Governor valve opening limits;
- (f) Governor valve rate limits; and
- (g) Time constant of turbine.

6.5.1.6 The following plant flexibility performance data shall be submitted for each Generating Plant:

- (a) Rate of loading following weekend Shutdown (Generating Unit and Generating Plant);
- (b) Rate of loading following an overnight Shutdown (Generating Unit and Generating Plant);
- (c) Block load following synchronizing;
- (d) Rate of Load Reduction from normal rated MW;
- (e) Regulating range; and
- (f) Load rejection capability while still Synchronized and able to supply load.

6.5.1.7 The following auxiliary Demand data shall be submitted:

- (a) Normal unit-supplied auxiliary load for each Generating Unit at rated MW output; and
- (b) Each Generating Plant auxiliary Load other than (a) above and where the station auxiliary Load is supplied from the Grid.

## **6.5.2 User System Data**

6.5.2.1 The Grid Owner and the User shall exchange information, including details of physical and electrical layouts, parameters, specifications, and protection, needed to conduct an assessment of transient Overvoltage effects in the Grid or the User System.

6.5.2.2 The User shall provide additional planning data that may be requested by the Grid Owner.

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## CHAPTER 7 OPERATION CODE

### 7.1 PURPOSE AND SCOPE

#### 7.1.1 Purpose

- (a) To specify the operating states, operating criteria, and protection scheme that will ensure the safety, Reliability, Security, and efficiency of the Grid;
- (b) To define the operational responsibilities of the System Operator and all Grid Users;
- (c) To specify the notices to be issued by the System Operator to Users, and the notices to be issued by Users to the System Operator and other Grid Users, and the operational reports to be prepared by the System Operator.
- (d) To specify the operating and maintenance programs that will establish the availability and aggregate capability of the generation System to meet the forecasted Demand;
- (e) To describe the operating reserves and demand control strategies used for the control of the System Frequency and the methods used for voltage control;
- (f) To specify the instructions to be issued by the System Operator and other Users and the procedure to be followed during emergency conditions;
- (g) To specify the procedures for the coordination, establishment, maintenance, and cancellation of Safety Precautions when work or testing other than the System Test is to be carried out on the Grid or the User System;
- (h) To establish a procedure for the conduct of System Tests which involve the simulation of conditions or the controlled application of unusual or extreme conditions that may have an impact on the Grid or the User System;
- (i) To identify the tests and the procedure that need to be carried out to confirm the compliance of a Generating Unit with its registered parameters and its ability to provide Ancillary Services; and
- (j) To specify the requirements for Site and Equipment Identification at the Connection Point.

#### 7.1.2 Scope of Application

This Chapter applies to the following Grid Users:

- (a) The Grid Owner;
- (b) The System Operator;

- (c) Generators;
- (d) Distributors; and
- (e) Any other entity with a User System connected to the Grid.

## **7.2 GRID OPERATING STATES, OPERATING CRITERIA, AND PROTECTION**

### **7.2.1 Grid Operating States**

7.2.1.1 The Grid shall be considered to be in the Normal State when:

- (a) The Operating Margin is sufficient;
- (b) The Grid Frequency is within the limits of 49.5 and 50.5 Hz, as specified in Section 3.2.2;
- (c) The voltages at all Connection Points are within the limits of 0.95 and 1.05 of the nominal value, as specified in Section 3.2.3;
- (d) The loading levels of all transmission lines and substation Equipment are below 90% of their continuous ratings; and
- (e) The Grid configuration is such that any potential fault current can be interrupted and the faulted Equipment can be isolated from the Grid.

7.2.1.2 The Grid shall be considered to be in the Alert State when any one of the following conditions exists:

- (a) The Grid Contingency Reserve is less than the capability of the largest Synchronized Generating Unit or the power import from a single Grid interconnection, whichever is higher;
- (b) The voltages at the Connection Points are outside the limits of 0.95 and 1.05 but within the limits of 0.90 and 1.10 of the nominal value;
- (c) There is Critical Loading or Imminent Overloading of transmission lines or substation Equipment.
- (d) A weather disturbance has entered the Sudan area of responsibility, which may affect Grid operations; or
- (e) Peace and order problems exist, which may pose a threat to Grid operations.

7.2.1.3 The Grid shall be considered to be in the Emergency State when a Multiple Outage Contingency has occurred without resulting in Total System Blackout, and any one of the following conditions exists:

- (a) There is generation deficiency;
- (b) Grid transmission voltages are outside the limits of 0.90 and 1.10; or
- (c) The loading level of any transmission line or substation Equipment is



above 110% of its continuous rating.

7.2.1.4 The Grid shall be considered to be in the Extreme State when the corrective measures undertaken by the System Operator during an Emergency State failed to maintain System Security and resulted in cascading Outages, islanding, and/or System voltage collapse.

7.2.1.5 The Grid shall be considered to be in Restorative State when Generating Units, transmission lines, substation Equipment, and Loads are being Energized and Synchronized to restore the Grid to its Normal State.

## **7.2.2 Grid Operating Criteria**

7.2.2.1 The Grid shall be operated so that it remains in the Normal State.

7.2.2.2 The Grid shall be operated and maintained to meet the Power Quality standards specified in Article 3.2.

7.2.2.3 The Security and Reliability of the Grid shall be based on the Single Outage Contingency criterion. This criterion specifies that the Grid shall continue to operate in the Normal State following the loss of one Generating Unit, transmission line, or transformer.

7.2.2.4 The Grid Frequency shall be controlled by the Frequency Regulating Reserve during normal conditions, and by the timely use of Contingency Reserve and Demand Control during emergency conditions.

7.2.2.5 The Grid Voltage shall be operated at safe level to reduce the vulnerability of the Grid to Transient Instability, Dynamic Instability, and Voltage Instability problems.

7.2.2.6 Adequate Frequency Regulating Reserve and Contingency Reserve shall be available to stabilize the System and facilitate the restoration to the Normal State following a Multiple Outage Contingency.

7.2.2.7 Following a Significant Incident that makes it impossible to avoid Island Grid operation, the Grid shall separate into several self-sufficient Island Grids, which shall be resynchronized to restore the Grid to a Normal State.

7.2.2.8 Sufficient Black Start and Fast Start capacity shall be available at strategic locations to facilitate the restoration of the Grid to the Normal State following a Total System Blackout.

## **7.2.3 Grid Protection**

7.2.3.1 The Grid shall have adequate and coordinated primary and backup protection at all times to limit the magnitude of Grid disturbances when a fault or Equipment failure occurs.

7.2.3.2 The User shall design, coordinate, and maintain its protection System to ensure the desired speed, sensitivity, and selectivity in clearing faults on the User's side of the Connection Point. Such protection System shall be coordinated with the Grid Owner's protection System.

7.2.3.3 Grid protection schemes shall have provisions for the utilization of short-term emergency thermal Equipment ratings, where such ratings can be justified.

## **7.3 OPERATIONAL RESPONSIBILITIES**

### **7.3.1 Operational Responsibilities of the System Operator**

7.3.1.1 The System Operator is responsible for Operating and maintaining Power Quality in the Grid during normal conditions, in accordance with the provision of Article 3.2, and in proposing solutions to Power Quality problems.

7.3.1.2 The System Operator shall be responsible for determining, acquiring, and dispatching the capacity needed to supply the required Grid Ancillary Services and for developing and proposing Wheeling Charges and Ancillary Service tariffs to the **ERA**.

7.3.1.3 The System Operator is responsible for ensuring that load-generation balance is maintained during emergency conditions and for directing Grid recovery efforts following these emergency conditions.

7.3.1.4 The System Operator is responsible for controlling Grid Voltage Variations during emergency conditions through a combination of direct control and timely instructions to Generators and other Grid Users.

7.3.1.5 When separation into Island Grids occurs, the System Operator is responsible for maintaining normal Frequency in the resulting Island Grids and for ensuring that resynchronization can quickly commence and be safely and successfully accomplished.

7.3.1.6 The System Operator is responsible for preparing, together with the Grid Owner, the Grid Operating and Maintenance Program.

7.3.1.7 The System Operator is responsible for performing all necessary studies to determine the safe operating limits that will protect the Grid against any instability problems, including those due to Multiple Outage Contingencies.

### **7.3.2 Operational Responsibilities of the Grid Owner**

7.3.2.1 The Grid Owner is responsible for providing and maintaining all Grid

Equipment and facilities, including those required for maintaining Power Quality.

7.3.2.2 The Grid Owner is responsible for designing, installing, and maintaining the Grid's protection System that will ensure the timely disconnection of faulted facilities and Equipment.

7.3.2.3 The Grid Owner is responsible for ensuring that safe and economic Grid operating procedures are always followed.

7.3.2.4 The Grid Owner is responsible for preparing, together with the System Operator, the Grid Operating and Maintenance Program.

7.3.2.5 The Grid Owner is responsible for executing the instructions of the System Operator during emergency conditions.

7.3.2.6 The Grid Owner is responsible for developing and proposing Wheeling Charges to the **ERA**.

### **7.3.3 Operational Responsibilities of Generators**

7.3.3.1 The Generator is responsible for maintaining its Generating Units to fully deliver the capabilities declared in its Connection Agreement or Amended Connection Agreement.

7.3.3.2 The Generator is responsible for providing accurate and timely planning and operations data to the Grid Owner and System Operator.

7.3.3.3 The Generator shall be responsible for ensuring that its Generating Units will not disconnect from the Grid during disturbances except when the Frequency or Voltage Variation would damage Generator's Equipment or when the System Operator has agreed for the Generator to do so.

7.3.3.4 The Generator is responsible for executing the instructions of the System Operator during emergency conditions.

### **7.3.4 Operational Responsibilities of Other Grid Users**

7.3.4.1 The User is responsible for assisting the System Operator in maintaining Power Quality in the Grid during normal conditions by correcting any User facility that causes Power Quality problems.

7.3.4.2 The User shall be responsible in ensuring that its System will not cause the Degradation of the Grid. It shall also be responsible in undertaking all necessary measures to remedy any Degradation of the Grid that its System has caused.

7.3.4.3 The User is responsible for providing and maintaining voltage-control Equipment on its System to support the voltage at the Connection Point.

7.3.4.4 The User is responsible for providing and maintaining Reactive Power supply facilities on its System to meet its own Reactive Power Demand.

7.3.4.5 The User is responsible for maintaining an Automatic Load Shedding scheme, as necessary, to meet the targets agreed to with the System Operator.

7.3.4.6 The User is responsible for executing the instructions of the System Operator during emergency conditions.

## **7.4 GRID OPERATIONS NOTICES AND REPORTS**

### **7.4.1 Grid Operations Notices**

7.4.1.1 The following notices shall be issued, without delay, by the System Operator to notify all Grid Users of an existing alert state:

(a) Yellow Alert when the Contingency Reserve is less than the capacity of the largest Synchronized Generating Unit or power import from a single interconnection, whichever is higher;

(b) Red Alert when the Contingency Reserve is zero or a generation deficiency exists or if there is Critical Loading or Imminent Overloading of transmission lines or Equipment;

(c) Weather Disturbance Alert when a weather disturbance has entered the Sudan area of responsibility;

(d) Blue Alert when a tropical disturbance is expected to make a landfall within 24 hours; and

(e) Security Red Alert when peace and order problems exist, which may affect Grid operations.

7.4.1.2 A Significant Incident Notice shall be issued by the System Operator, the Grid Owner or any User if a Significant Incident has transpired on the Grid or the System of the User, as the case may be. The notice shall be issued within 15 minutes from the occurrence of the Significant Incident, and shall identify its possible consequences on the Grid and/or the System of other Users and any initial corrective measures that were undertaken by the System Operator, the Grid Owner, or the User, as the case may be.

7.4.1.3 A Planned Activity Notice shall be issued by a User to the Grid Owner and the System Operator for any planned activity such as a planned Shutdown or Scheduled Maintenance of its Equipment at least seven (7) days prior to the actual Shutdown or maintenance. The System Operator shall notify the User of its approval or disapproval of the User's request at least five (5) days before the actual work commences.

## **7.4.2 Grid Operations Reports**

7.4.2.1 The Grid Owner and the System Operator shall prepare and submit to the GMC weekly reports on Grid operation. These reports shall include an evaluation of the Events and other problems that occurred within the Grid for the previous week, the measures undertaken by the Grid Owner and the System Operator to address them, and the recommendations to prevent their recurrence in the future.

7.4.2.2 The System Operator shall submit to the GMC the Significant Incident Reports prepared pursuant to the provisions of Section 7.7.2.

7.4.2.3 The Grid Owner and the System Operator shall prepare and submit to the GMC quarterly and annual operations reports. These reports shall include the Significant Incidents that had a Material Effect on the Grid or the System of any User.

## **7.5 GRID OPERATING AND MAINTENANCE PROGRAMS**

### **7.5.1 Grid Operating Program**

7.5.1.1 The System Operator, in consultation with the Grid Owner, shall prepare the following Operating Programs that specify the Availability and aggregate capability of the Generating Plants to meet the forecasted Demand:

- (a) Three-year Operating Program;
- (b) Annual Operating Program;
- (c) Monthly Operating Program;
- (d) Weekly Operating Program; and
- (e) Daily Operating Program.

7.5.1.2 The three-year Operating Program shall be developed annually for the three (3) succeeding years based on the User's historical Energy and Demand data as specified in Section 6.4.1, the five-year Forecast Data submitted by the Users as specified in Section 6.4.2 and the three-year Maintenance Program developed in accordance with Section 7.5.2.

7.5.1.3 The annual Operating Program shall be developed using the first year of the three-year Operating Program and the annual Maintenance Program developed in accordance with Section 7.5.2.

7.5.1.4 The monthly Operating Program shall specify the details of the Operating Program for each week of the month.

7.5.1.5 The weekly Operating Program shall specify the details of the hourly Demand forecasts and the available Generating Units for each day of the

week. The weekly Operating Program shall be completed not later than the 12:00 hours of the last Business Day of the week immediately preceding the week for which the Operating Program applies to.

7.5.1.6 The daily Operating Program shall be developed for the day-ahead by 12:00 hours every day for scheduling, dispatching, and planning for Ancillary Services.

7.5.1.7 If a User has determined that its Demand pattern or forecast has changed or will change significantly from the data previously submitted, the User shall immediately provide the System Operator with the updated data so that the Grid Operating Program can be adjusted accordingly.

## **7.5.2 Grid Maintenance Program**

7.5.2.1 The Grid Owner, in consultation with the System Operator, shall prepare the following Grid Maintenance Programs based on the forecasted Demand, the User's provisional Maintenance Program, and requests for maintenance schedule:

- (a) Three-Year Maintenance Program;
- (b) Annual Maintenance Program;
- (c) Monthly Maintenance Program;
- (d) Weekly Maintenance Program; and
- (e) Daily Maintenance Program.

7.5.2.2 The three-year Maintenance Program shall be prepared annually for the three (3) succeeding years. The annual Maintenance Program shall be developed based on the maintenance schedule for the first year of the three-year Maintenance Program. The monthly, weekly, and daily Maintenance Programs shall provide details for the preparation of the Grid Operating Programs specified in Section 7.5.1.

7.5.2.3 The Grid Maintenance Programs shall be developed taking into account the following:

- (a) The forecasted Demand;
- (b) The Maintenance Program actually implemented;
- (c) The requests by Users for changes in their maintenance schedules;
- (d) The requirements for the maintenance of the Grid;
- (e) The need to minimize the total cost of the required maintenance; and
- (f) Any other relevant factor.

7.5.2.4 The User shall provide the Grid Owner by week 27 of the current year a provisional Maintenance Program for the three (3) succeeding years. The

following information shall be included in the User's provisional Maintenance Program or when the User requests for a maintenance schedule for its System or Equipment:

- (a) Identification of the Equipment and the MW capacity involved;
- (b) Reasons for the maintenance;
- (c) Expected duration of the maintenance work;
- (d) Preferred start date for the maintenance work and the date by which the work shall have been completed; and
- (e) If there is flexibility in dates, the earliest start date and the latest completion date.

7.5.2.5 The Grid Owner shall endeavor to accommodate the User's request for maintenance schedule at particular dates in preparing the Grid Maintenance Program.

7.5.2.6 The Grid Owner shall provide the User a written copy of the User's approved Maintenance Program.

7.5.2.7 If the User is not satisfied with the Maintenance Schedule allocated to its Equipment, it shall notify the Grid Owner to explain its concern and to propose changes in the Maintenance Program. The Grid Owner and the User shall discuss and resolve the problem. The Maintenance Program shall be revised by the Grid Owner based on the resolution of the User's concerns.

## **7.6 FREQUENCY CONTROL AND VOLTAGE CONTROL**

### **7.6.1 Methods of Frequency and Voltage Control**

7.6.1.1 The Grid Frequency shall be controlled by the timely use of Frequency Regulating Reserve, Contingency Reserve, and Demand Control.

7.6.1.2 The Frequency Regulating (or load following) Reserve shall include the following:

- (a) Primary Response of Generating Units; and
- (b) Secondary Response of Generating Units.

7.6.1.3 The Contingency Reserve shall include the following:

- (a) Spinning Reserve (or hot standby reserve); and
- (b) Backup Reserve (or cold standby reserve).

7.6.1.4 Demand Control to reduce the Demand of the Grid shall be implemented when the System Operator has issued a Red Alert notice due to generation deficiency or when a Multiple Outage Contingency resulted in Island Grid operation. The Demand Control shall include the following:

- (a) Automatic Load Shedding;
- (b) Manual Load Shedding;
- (c) Demand reduction on instruction by the System Operator;
- (d) Demand Disconnection initiated by Users;
- (e) Customer Demand Management; and
- (f) Voluntary Load Curtailment.

7.6.1.5 The control of voltage can be achieved by managing the Reactive Power supply in the Grid. These include the operation of the following Equipment:

- (a) Synchronous Generating Units;
- (b) Synchronous condensers;
- (c) Static VAR compensators;
- (d) Shunt capacitors and reactors; and
- (e) On-Load tap changing transformers.

## **7.6.2 Primary and Secondary Response of Generating Units**

7.6.2.1 A Generating Unit providing Primary Response for Frequency regulation as an Ancillary Service shall operate in an automatic Frequency-sensitive mode (also known as free-governor mode) for automatic response of the Unit's power output to changes in Frequency. The speed-governing Systems of the Generating Unit shall have a maximum response time of five (5) seconds.

7.6.2.2 Secondary Response shall be required from selected Generating Units providing Ancillary Services for Frequency regulation. Frequency Control using the Secondary Response of the Generating Unit shall be accomplished through Automatic Generation Control or manual adjustment of generation with specific Dispatch Instructions from the System Operator. The maximum response time for the change in the Unit's power output shall be 25 seconds and which shall be sustainable for at least 30 minutes.

7.6.2.3 The Generator shall not override the free-governor mode or Automatic Generation Control mode of a Generating Unit, which is providing Primary or Secondary Response.

## **7.6.3 Spinning Reserve and Backup Reserve**

7.6.3.1 A Generating Unit providing Spinning Reserve as an Ancillary Service shall be Synchronized with the Grid and be available to automatically respond to any sudden loss or significant reduction in generating capacity.



7.6.3.2 A Generating Unit providing Backup Reserve shall have Fast Start capability and its capacity shall be sustainable for a minimum period of eight (8) hours.

#### **7.6.4 Automatic Load Shedding**

7.6.4.1 The System Operator shall establish the level of Demand required for Automatic Load Shedding in order to limit the consequences of a major loss of generation in the Grid. The System Operator shall conduct the appropriate technical studies to justify the targets and/or to refine them as necessary.

7.6.4.2 The User shall prepare its ALSH program in consultation with the System Operator. The User Demand that is subject to ALSH shall be split into rotating discrete MW blocks. The System Operator shall specify the number of blocks and the under frequency setting for each block.

7.6.4.3 If the User does not implement an Automatic Load Shedding program, the Grid Owner shall install the Under frequency Relay at the main feeder and the System Operator shall drop the total User Demand as a single block, if the need arises.

7.6.4.4 To ensure that a subsequent fall in frequency will be contained by the operation of ALSH, additional Manual Load Shedding shall be implemented so that the loads that were dropped by ALSH can be reconnected.

7.6.4.5 If an ALSH has taken place, the affected Users shall not reconnect their feeders without clearance from the System Operator. The System Operator shall issue the instruction to reconnect, once the Frequency of the Grid has recovered. Subject to available generation, the first circuit to trip shall be the first to be energized.

7.6.4.6 The User shall notify the System Operator of the actual Demand that was disconnected by ALSH, or the Demand that was restored in the case of reconnection, within five (5) minutes of the load shedding or reconnection.

#### **7.6.5 Manual Load Shedding**

7.6.5.1 The User shall make arrangement that will enable it to disconnect its Customers immediately following the issuance by the System Operator of an instruction to implement Manual Load Shedding.

7.6.5.2 Distributors shall, in consultation with the System Operator, establish a priority scheme for Manual Load Shedding based on equitable load allocation.

7.6.5.3 If the System Operator has determined that the Manual Load Shedding

carried out by the User is not sufficient to contain the decline in Grid Frequency, the System Operator may disconnect the total Demand of the User in an effort to preserve the integrity of the Grid.

7.6.5.4 If a User disconnected its Customers upon the instruction of the System Operator, the User shall not reconnect the affected Customers until instructed by the System Operator to do so.

### **7.6.6 Demand Control**

7.6.6.1 If Demand Control due to generation deficiency needs to be implemented, the System Operator shall issue a Red Alert Warning by 16:00 hours, a day ahead. The Red Alert Warning shall specify the amount and the period during which the Demand reduction will be required. During Demand Control, generation Dispatch shall cease and shall not be reimplemented until the System Operator has determined that it is safe to do so.

7.6.6.2 The System Operator shall issue a Demand Control Imminent Warning when a Demand reduction is expected within the next 30 minutes. The Demand Control Imminent Warning shall be effective for one (1) hour and shall be automatically canceled if it is not re-issued by the System Operator.

7.6.6.3 The User shall provide the System Operator with the amount of Demand reduction actually achieved after the implementation of Demand Control.

7.6.6.4 In the event of a protracted shortage in generation and when a reduction in Demand is envisioned by the System Operator to be prolonged, the System Operator shall notify the User of the expected duration.

7.6.6.5 The User shall abide by the instruction of the System Operator with regard to the restoration of Demand. The restoration of Demand shall be achieved as soon as possible and the process of restoration shall begin within two (2) minutes after the instruction is given by the System Operator.

### **7.6.7 Demand Control Initiated by a User**

7.6.7.1 If a User intends to implement for the following day Demand Control through a Demand disconnection at the Connection Point, it shall notify the System Operator of the hourly schedule before 09:00 hours of the current day. The notification shall contain the following information:

(a) The proposed (in the case of prior notification) and actual (in the case of

subsequent notification) date, time, and duration of implementation of the Demand Disconnection; and

(b) The magnitude of the proposed reduction by the use of Demand Disconnection.

The User shall provide the System Operator with the amount of Demand reduction actually achieved by the use of the Demand Disconnection.

7.6.7.2 If a User intends to implement for the following day Demand Control through Customer Demand Management, it shall notify the System Operator of the hourly schedule before 09:00 hours of the current day. The notification shall contain the following information:

(a) The proposed (in the case of prior notification) and actual (in the case of subsequent notification) date, time, and duration of implementation of the Customer Demand Management; and

(b) The magnitude of the proposed reduction by use of the Customer Demand Management. The User shall provide the System Operator with the amount of Demand reduction actually achieved by the use of the Customer Demand Management.

7.6.7.3 If the Demand Control involves the disconnection of an industrial circuit, Voluntary Load Curtailment (VLC) or any similar scheme shall be implemented wherein the Customers are divided into VLC Weekday groups (e.g., Monday Group, Tuesday Group, etc.). Customers participating in the VLC shall voluntarily reduce their respective Loads for a certain period of time depending on the extent of the generation deficiency. Industrial Customers who implemented a VLC shall provide the System Operator with the amount of Demand reduction actually achieved through the VLC scheme.

## **7.7 EMERGENCY PROCEDURES**

### **7.7.1 Preparation for Grid Emergencies**

7.7.1.1 The System Operator shall give an instruction or a directive to any User for the purpose of mitigating the effects of the disruption of electricity supply attributable to any of the following:

- (a) Natural disaster;
- (b) Civil disturbance; or
- (c) Fortuitous event.

7.7.1.2 The Grid Owner and the System Operator shall develop, maintain, and distribute a Manual of Grid Emergency Procedures, which lists all parties to be

notified, including their business and home phone numbers, in case of an emergency. The manual shall also designate the location(s) where critical personnel shall report for Grid restoration duty.

7.7.1.3 Emergency drills shall be conducted at least once a year to familiarize all personnel responsible for emergency and Grid restoration activities with the emergency and restoration procedures. The drills shall simulate realistic emergency situations. The Manual of Grid Emergency Procedures shall be followed. A drill evaluation shall be performed and deficiencies in procedures and responses shall be identified and corrected.

## **7.7.2 Significant Incident Procedures**

7.7.2.1 The Grid Owner and all Users shall provide the System Operator, in writing, the telephone numbers of persons who can make binding decisions when there is a Significant Incident.

7.7.2.2 Following the issuance of a Significant Incident Notice by the System Operator, the Grid Owner, or a User, any Grid User may file a written request for a joint investigation of the Significant Incident. If there have been several Significant Incidents, the joint investigation may include the other Significant Incidents.

7.7.2.3 A joint investigation of the Significant Incident shall be conducted only when the System Operator, the Grid Owner, and the User involved have reached an agreement to conduct the joint investigation.

7.7.2.4 The System Operator shall submit a written report to the GMC and the **ERA** detailing all the information, findings, and recommendations regarding the Significant Incident.

7.7.2.5 The following minimum information shall be included in the written report following the joint investigation of the Significant Incident:

- (a) Time and date of the Significant Incident;
- (b) Location of the Significant Incident;
- (c) Equipment directly involved and not merely affected by the Event;
- (d) Description of the Significant Incident;
- (e) Demand (in MW) and generation (in MW) interrupted and the duration of the Interruption;
- (f) Generating Unit: Frequency response (MW correction achieved subsequent to the Significant Incident); and
- (g) Generating Unit: MVAR performance (change in output subsequent to the Significant Incident).

### **7.7.3 Black Start Procedures**

7.7.3.1 If a Significant Incident resulted in a Partial System Blackout or a Total System Blackout, the System Operator shall inform the Users that it intends to implement a Black Start.

7.7.3.2 The System Operator shall issue instructions for the Generating Plants with Black Start capability to initiate the Start-Up. The Generator providing Black Start shall then inform the System Operator that its Generating Plants are dispatch able within thirty (30) minutes for the restoration of the Grid.

7.7.3.3 Upon receipt of the instruction from the System Operator, Generating Plants providing Black Start shall Start-Up immediately to energize a part of the Grid and/or synchronize to the Grid.

7.7.3.4 The overall strategy in the restoration of the Grid after a Total System Blackout shall, in general, include the following:

- (a) Overlapping phases of Blackout restoration of Island Grids;
- (b) Step-by-step integration of the Island Grids into larger subsystems; and
- (c) Eventual restoration of the Grid.

7.7.3.5 The System Operator shall coordinate the provision of Backup Reserve for thermal Generating units so that these can be put back to the Grid without going to the full restart procedure.

7.7.3.6 The System Operator shall inform the Grid Users, after completing the Black Start procedure and the restoration of the Grid, that the Blackout no longer exists and that the Grid is back to the Normal State.

### **7.7.4 Resynchronization of Island Grids**

7.7.4.1 When parts of the Grid are not Synchronized with each other, the System Operator shall instruct Users to regulate Generation and/or Demand to enable the isolated Island Grids to be resynchronized.

7.7.4.2 If a part of the Grid is not connected to the rest of the Grid, but there is no Blackout in that part of the Grid, the System Operator shall undertake the resynchronization of that part to the Grid.

## **7.8 SAFETY COORDINATION**

### **7.8.1 Safety Coordination Procedures**

7.8.1.1 The Grid Owner and Users shall adopt and use a set of Safety Rules and Local Safety Instructions for implementing Safety Precautions on HV and EHV Equipment. The respective Safety Rules and Local Safety Instructions of

the Grid Owner and the User shall govern any work or testing on the Grid or the User System.

7.8.1.2 The Grid Owner shall furnish the User a copy of its Safety Rules and Local Safety Instructions relating to the Safety Precautions on its HV and EHV Equipment.

7.8.1.3 The User shall furnish the Grid Owner a copy of its Safety Rules and Local Safety Instructions relating to the Safety Precautions on its HV and EHV Equipment.

7.8.1.4 Any party who wants to revise any provision of its Local Safety Instructions shall provide the other party a written copy of the revisions.

7.8.1.5 Safety coordination procedures shall be established for the coordination, establishment, maintenance, and cancellation of Safety Precautions on HV and EHV Equipment when work or testing is to be carried out on the Grid or the User System.

7.8.1.6 Work or testing on any Equipment at the Connection Point shall be carried out only in the presence of the representatives of the Grid Owner and the User.

7.8.1.7 The User (or Grid Owner) shall seek authority from the Grid Owner (or the User) if it wishes to access any Grid Owner (or User) Equipment.

7.8.1.8 When work or testing is to be carried out on the Grid and Safety Precautions are required on the HV and EHV Equipment of several User Systems, the Grid Owner shall ensure that the Safety Precautions on the Grid and on the System of all Users involved are coordinated and implemented.

7.8.1.9 Where work or testing is to be carried out on the Grid and the User becomes aware that Safety Precautions are also required on the System of other Users, the Grid Owner shall be promptly informed of the required Safety Precautions on the System of the other Users. The Grid Owner shall ensure that Safety Precautions are coordinated and implemented on the Grid and all User Systems.

## **7.8.2 Safety Coordinator**

7.8.2.1 The Grid Owner and the User shall assign a Safety Coordinator who shall be responsible for the coordination of Safety Precautions on the HV and EHV Equipment at their respective sides of the Connection Point. Any party who wants to change its Safety Coordinator shall notify the other party of the change.

7.8.2.2 For purposes of safety coordination, the Safety Coordinator requesting that a Safety Precaution be applied on the System of the other party shall be

referred to as the Requesting Safety Coordinator while the Safety Coordinator that will implement the requested Safety Precaution shall be referred to as the Implementing Safety Coordinator.

7.8.2.3 If work or testing is to be carried out on the Grid (or the User System) that requires Safety Precautions on the HV and EHV Equipment of the User System (or the Grid), the Requesting Safety Coordinator shall contact the Implementing Safety Coordinator to coordinate the necessary Safety Precautions.

7.8.2.4 If a Safety Precaution is required for the HV and EHV Equipment of other Users who were not mentioned in the request, the Implementing Safety Coordinator shall promptly inform the Requesting Safety Coordinator.

7.8.2.5 When a Safety Precaution becomes ineffective, the concerned Safety Coordinator shall inform the other Safety Coordinator(s) about it without delay stating the reason(s) why the Safety Precaution has lost its integrity.

### **7.8.3 Safety Logs and Record of Inter-System Safety Precautions**

7.8.3.1 The Grid Owner and the User shall maintain Safety Logs to record, in chronological order, all messages relating to Safety Coordination. The Safety Logs shall be retained for at least one (1) year.

7.8.3.2 The Grid Owner shall establish a record of inter-system Safety Precautions to be used by the Requesting Safety Coordinator and the Implementing Safety Coordinator in coordinating the Safety Precautions on HV and EHV Equipment. The record of intersystem Safety Precautions shall contain the following information:

- (a) Site and Equipment Identification of HV or EHV Equipment where Safety Precaution is to be established or has been established;
- (b) Location and the means of implementation of the Safety Precaution;
- (c) Confirmation of the Safety Coordinator that the Safety Precaution has been established; and
- (d) Confirmation of the Safety Coordinator that the Safety Precaution is no longer needed and has been cancelled.

### **7.8.4 Location of Safety Precautions**

7.8.4.1 When work or testing is to be carried out on the Grid (or the User System) and Safety Precautions are required on the User System (or the Grid), the Requesting Safety Coordinator shall contact the concerned Implementing Safety Coordinator to agree on the location(s) at which the Safety Precautions will be implemented or applied. The Requesting Safety Coordinator shall

specify the proposed locations at which Isolation and/or Grounding are to be established.

7.8.4.2 In the case of Isolation, the Implementing Safety Coordinator shall promptly notify the Requesting Safety Coordinator of the following:

(a) The Identification of each Point of Isolation using the Site and Equipment Identification specified in Article 7.11; and

(b) The means of implementing Isolation as specified in Section 7.8.5.

7.8.4.3 In the case of Grounding, the Implementing Safety Coordinator shall promptly notify the Requesting Safety Coordinator of the following:

(a) The Identification of each Point of Grounding using the Site and Equipment Identification specified in Article 7.11; and

(b) The means of implementing Grounding as specified in Section 7.8.5.

7.8.4.4 If the Requesting Safety Coordinator and the Implementing Safety Coordinator do not agree on the location(s), Grounding shall be established at the available points on the in feeds closest to the HV and EHV Equipment.

## **7.8.5 Implementation of Safety Precautions**

7.8.5.1 Once the location(s) of Isolation and Grounding have been agreed upon, the Implementing Safety Coordinator shall ensure that the Isolation is implemented.

7.8.5.2 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 by such other method in accordance with the Local Safety Instructions of the Grid Owner or of the User, as the case may be; or

(b) An adequate physical separation ( *e.g.* Grounding Cluster) in accordance with the Local Safety Instructions of the Grid Owner or of the User. In addition, a Safety Tag shall be placed at the switching points.

7.8.5.3 The Implementing Safety Coordinator, after establishing the required Isolation in all locations on his System, shall notify the Requesting Safety Coordinator that the required Isolation has been implemented.

7.8.5.4 After receiving the confirmation of Isolation, the Requesting Safety Coordinator shall inform the Implementing Safety Coordinator of the establishment of Isolation on his System and request, if required, the implementation of Grounding.

7.8.5.5 The Implementing Safety Coordinator shall ensure the implementation of Grounding and notify the Requesting Safety Coordinator that Grounding has been established on his System.



7.8.5.6 Grounding shall be implemented by any of the following:

- (a) A Grounding switch secured in a closed position by a lock and affixing a Safety Tag to it or by such other method in accordance with the Local Safety Instructions of the Grid Owner or the User, as the case may be; or
- (b) An adequate physical connection ( *e.g.* Grounding Cluster) which shall be in accordance with the methods set out in the Local Safety Instructions of the Grid Owner or those of User. In addition, a Safety Tag shall be placed at this point of connection and all related switching points.

7.8.5.7 If the disconnect switch or the Grounding switch is locked with its own locking mechanism or with a padlock, the key shall be secured in a key cabinet.

## **7.8.6 Authorization of Testing**

If the Requesting Safety Coordinator wishes to authorize a test on HV or EHV Equipment, he shall only do so after the following procedures have been implemented:

- (a) Confirmation is obtained from the Implementing Safety Coordinator that no person is working on or testing, or has been authorized to work on or test, any part of his System within the Points of Isolation identified on the form;
- (b) All Safety Precautions other than the current Safety Precautions have been cancelled; and
- (c) The Implementing Safety Coordinator agrees with him on the conduct of testing in that part of the System.

## **7.8.7 Cancellation of Safety Precautions**

7.8.7.1 When the Requesting Safety Coordinator decides that Safety Precautions are no longer required, he shall contact the Implementing Safety Coordinator and inform him that the Safety Precautions are no longer required.

7.8.7.2 Both coordinators shall then cancel the Safety Precautions.

## **7.9 SYSTEM TEST**

### **7.9.1 System Test Requirements**

7.9.1.1 System Test, which involves the simulation of conditions or the controlled application of unusual or extreme conditions that may have an impact on the Grid or the User System, shall be carried out in a manner that

shall not endanger any personnel or the general public.

7.9.1.2 The threat to the integrity of Equipment, the Security of the Grid, and the detriment to the Grid Owner and other Users shall be minimized when undertaking a System Test on the Grid or the User System.

## **7.9.2 System Test Request**

7.9.2.1 If the Grid Owner (or a User) wishes to undertake a System Test on the Grid (or the User System), it shall submit to the System Operator a System Test Request that contains the following:

- (a) The purpose and nature of the proposed System Test;
- (b) The extent and condition of the Equipment involved; and
- (c) A proposed System Test Procedure specifying the switching sequence and the timing of the switching sequence.

7.9.2.2 The Test Proponent shall provide sufficient time for the System Operator to plan the proposed System Test. The System Operator shall determine the time required for each type of System Test.

7.9.2.3 The System Operator may require additional information before approving the proposed System Test if the information contained in the System Test Request is insufficient or the proposed System Test Procedure cannot ensure the safety of personnel and the Security of the Grid.

7.9.2.4 The System Operator shall determine and notify other Users, other than the System Test Proponent, that may be affected by the proposed System Test.

7.9.2.5 The System Operator may also initiate a System Test if it has determined that the System Test is necessary to ensure the safety, Stability, Security, and Reliability of the Grid.

## **7.9.3 System Test Group**

7.9.3.1 Within one (1) month after the acceptance of a System Test Request, the System Operator shall notify the System Test Proponent, the Grid Owner (if it is not the System Test Proponent) and the affected Users of the proposed System Test. The notice shall contain the following:

- (a) The purpose and nature of the proposed System Test, the extent and condition of the Equipment involved, the identity of the System Test Proponent, and the affected Users;
- (b) An invitation to nominate representative(s) for the System Test Group to be established to coordinate the proposed System Test; and

(c) If the System Test involves work or testing on HV and EHV Equipment, the Safety Coordinators and the safety procedures specified in Article 7.8.

7.9.3.2 The System Test Proponent, the Grid Owner (if it is not the System Test Proponent) and the affected Users shall nominate their representative(s) to the System Test Group within one (1) month after receipt of the notice from the System Operator. The System Operator may decide to proceed with the proposed System Test even if the affected Users fail to reply within that period.

7.9.3.3 The System Operator shall establish a System Test Group and appoint a System Test Coordinator, who shall act as chairman of the System Test Group. The System Test Coordinator may come from the System Operator or the System Test Proponent.

7.9.3.4 The members of the System Test Group shall meet within one (1) month after the Test Group is established. The System Test Coordinator shall convene the System Test Group as often as necessary.

7.9.3.5 The agenda for the meeting of the System Test Group shall include the following:

(a) The details of the purpose and nature of the proposed System Test and other matters included in the System Test Request;

(b) Evaluation of the System Test Procedure as submitted by the System Test Proponent and making the necessary modifications to come up with the final System Test Procedure;

(c) The possibility of scheduling simultaneously the proposed System Test with any other test and with Equipment Maintenance which may arise pursuant to the Maintenance Program requirements of the Grid or Users; and

(d) The economic, operational, and risk implications of the proposed System Test on the Grid, the System of the other Users, and the Scheduling and Dispatch of the Generating Plants.

7.9.3.6 The System Test Proponent, the Grid Owner (if it is not the System Test Proponent) and the affected Users (including those which are not represented in the System Test Group) shall provide the System Test Group, upon request, with such details as the System Test Group reasonably requires to carry out the proposed System Test.

## **7.9.4 System Test Program**

7.9.4.1 Within two (2) months after the first meeting and at least one (1) month prior to the date of the proposed System Test, the System Test Group shall submit to the System Operator, the System Test Proponent, the Grid

Owner (if it is not the System Test Proponent), and the affected Users a proposed System Test Program which shall contain the following:

- (a) Plan for carrying out the System Test;
- (b) System Test Procedure to be followed during the test including the manner in which the System Test is to be monitored;
- (c) List of responsible persons, including Safety Coordinators when necessary, who will be involved in carrying out the System Test;
- (d) An allocation of all testing costs among the affected parties; and
- (e) Such other matters as the System Test Group may deem appropriate and necessary and are approved by the management of the affected parties.

7.9.4.2 If the proposed System Test Program is acceptable to the System Operator, the System Test Proponent, the Grid Owner (if it is not the System Test Proponent), and the affected Users, the final System Test Program shall be constituted and the System Test shall proceed accordingly. Otherwise, the System Test Group shall revise the System Test Program.

7.9.4.3 If the System Test Group is unable to develop a System Test Program or reach a decision in implementing the System Test Program, the System Operator shall determine whether it is necessary to proceed with the System Test to ensure the Security of the Grid.

7.9.4.4 The System Test Coordinator shall be notified in writing, as soon as possible, of any proposed revision or amendment to the System Test Program prior to the day of the proposed System Test. If the System Test Coordinator decides that the proposed revision or amendment is meritorious, he shall notify the System Operator, the System Test Proponent, the Grid Owner (if it is not the System Test Proponent), and the affected Users to act accordingly for the inclusion thereof. The System Test Program shall then be carried out with the revisions or amendments if the System Test Coordinator received no objections.

7.9.4.5 If System conditions are abnormal during the scheduled day for the System Test, the System Test Coordinator may recommend a postponement of the System Test.

## **7.9.5 System Test Report**

7.9.5.1 Within two (2) months or a shorter period as the System Test Group may agree after the conclusion of the System Test, the System Test Proponent shall prepare and submit a System Test Report to the System Operator, the Grid Owner (if it is not the System Test Proponent), the affected Users, and the members of the System Test Group.

7.9.5.2 After the submission of System Test Report, the System Test Group shall be automatically dissolved.

7.9.5.3 The System Operator shall submit the System Test Report to the GMC for its review and recommendations.

## **7.10 GENERATING UNIT CAPABILITY TESTS**

### **7.10.1 Test Requirements**

7.10.1.1 Tests shall be conducted, in accordance with the agreed procedure and standards, to confirm the compliance of Generating Units for the following:

(a) Capability of Generating Units to operate within their registered Generation parameters;

(b) Capability of the Generating Units to meet the applicable requirements of the Grid Code;

(c) Capability to deliver the Ancillary Service that the Generator had agreed to provide; and

(d) Availability of Generating Units in accordance with their capability declaration.

7.10.1.2 All tests shall be recorded and witnessed by the authorized representatives of the Grid Owner, Generator, and/or User.

7.10.1.3 The Generator shall demonstrate to the Grid Owner the reliability and accuracy of the test instruments and Equipment to be used in the test.

7.10.1.4 The Grid Owner may at any time issue instructions requiring tests to be carried out on any Generating Unit. All tests shall be of sufficient duration and shall be conducted no more than twice a year except when there are reasonable grounds to justify the necessity for further tests.

7.10.1.5 If a Generating Unit fails the test, the Generator shall correct the deficiency within an agreed period to attain the relevant registered parameters for that Generating Unit.

7.10.1.6 Once the Generator achieves the registered parameters of its Generating Unit that previously failed the test, it shall immediately notify the Grid Owner. The Grid Owner shall then require the Generator to conduct a retest in order to demonstrate that the appropriate parameter has already been restored to its registered value.

7.10.1.7 If a dispute arises relating to the failure of a Generating Unit to pass a given test, the Grid Owner, the Generator and/or User shall seek to resolve

the dispute among themselves.

7.10.1.8 If the dispute cannot be resolved, one of the parties may submit the issue to the GMC.

## **7.10.2 Tests to be Performed**

7.10.2.1 The Reactive Power test shall demonstrate that the Generating Unit meets the registered Reactive Power Capability requirements specified in Section 5.4.2. The Generating Unit shall pass the test if the measured values are within  $\pm 5$  percent of the Capability as registered with the Grid Owner.

7.10.2.2 The Primary Response test shall demonstrate that the Generating Unit has the capability to provide Primary Response, as specified in Section 7.6.2. The Generating Unit shall pass the test if the measured response in MW/Hz is within  $\pm 5$  percent of the required level of response within five (5) seconds.

7.10.2.3 The Fast Start capability test shall demonstrate that the Generating Unit has the capability to automatically Start-Up, synchronize with the Grid within 15 minutes and be loaded up to its offered capability, as specified in Section 5.4.8. The Generating Unit shall pass the test if it meets the Fast Start capability requirements.

7.10.2.4 The Black Start test shall demonstrate that the Generating Plant with Black Start capability can implement a Black Start procedure, as specified in Section 7.7.3. To pass the test, the Generating Unit shall start on its own, synchronize with the Grid and carry load without the need for external power supply.

7.10.2.5 The Declared Data capability test shall demonstrate that the Generating Unit can be scheduled and dispatched in accordance with the Declared Data. To pass the test, the unit shall satisfy the ability to achieve the Declared Data.

7.10.2.6 The Dispatch accuracy test shall demonstrate that the Generating Unit meets the relevant Generation Scheduling and Dispatch Parameters. The Generating Unit shall pass the test if:

- (a) In the case of synchronization, the process is achieved within  $\pm 5$  minutes of the registered synchronization time;
- (b) In the case of synchronizing generation (if registered as a Generation Scheduling and Dispatch Parameters), the synchronizing generation achieved is within an error level equivalent to 2.5% of Net Declared Capability;
- (c) In the case of meeting ramp rates, the actual ramp rate is within  $\pm 10\%$  of the registered ramp rate;

(d) In the case of meeting Load reduction rates, the actual Load reduction rate is within  $\pm 10\%$  of the registered Load reduction rate; and

(e) In the case of all other Generation Scheduling and Dispatch Parameters, values are within  $\pm 1.5\%$  of the declared values.

7.10.2.7 The Ancillary Service acceptability test shall determine the committed services in terms of parameter quantity or volume, timeliness, and other operational requirements. Generators providing Ancillary Services shall conduct the test or define the committed service. However, monitoring by the Grid Owner of Ancillary Service performance in response to System-derived inputs shall also be carried out.

## **7.11 SITE AND EQUIPMENT IDENTIFICATION**

### **7.11.1 Site and Equipment Identification Requirements**

7.11.1.1 The Grid Owner shall develop and establish a standard system for Site and Equipment Identification to be used in identifying any Site or Equipment in all Electrical Diagrams, Connection Point Drawings, Grid operations instructions, notices, and other documents.

7.11.1.2 The identification for the Site shall include a unique identifier for each substation and switchyard where a Connection Point is located.

7.11.1.3 The identification for Equipment shall be unique for each transformer, transmission line, transmission tower or pole, bus, circuit breaker, disconnect switch, grounding switch, capacitor bank, reactor, lightning arrester, CCPD, and other HV and EHV Equipment at the Connection Point.

### **7.11.2 Site and Equipment Identification Label**

7.11.2.1 The Grid Owner shall develop and establish a standard labeling system, which specifies the dimension, sizes of characters, and colors of labels, to identify the Sites and Equipment.

7.11.2.2 The Grid Owner or the User shall be responsible for the provision and installation of a clear and unambiguous label showing the Site and Equipment Identification at their respective System.

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## **Chapter 8 Interchange Scheduling and Dispatch Code**

### **8.1 Purpose and Scope**

#### **8.1.1 Purpose**

- (a) To specify the responsibilities of the Market Operator, the System Operator, and other Users in Scheduling and Dispatch;
- (b) To define the operational criteria for the preparation of the Generation Schedule and issuance of Dispatch Instructions;
- (c) To specify the process and requirements for the preparation of the Generation Schedule; and
- (d) To specify the Central Dispatch process.

#### **8.1.2 Scope of Application**

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) The Market Operator;
- (d) Generators;
- (e) Distributors;
- (f) Suppliers; and
- (g) Any entity with a User System connected to the Grid.

### **8.2 SCHEDULING AND DISPATCH RESPONSIBILITIES**

#### **8.2.1 Responsibilities of the Market Operator**

8.2.1.1 The Market Operator shall be responsible for the preparation of the Generation Schedule, in accordance with the Market Rules and the procedure described in Article 8.4.

8.2.1.2 The Market Operator shall be responsible for the issuance of the final Generation Schedule.

## **8.2.2 Responsibilities of the System Operator**

8.2.2.1 The System Operator shall be responsible in providing Central Dispatch for the Scheduled Generating Units, following the procedures specified in Article 8.5, and the Generation Schedule prepared by the Market Operator.

8.2.2.2 The System Operator is responsible for ensuring that a number of strategically located Generating Units are available for Ancillary Services, including the provision of Frequency Regulating Reserve and Contingency Reserve.

8.2.2.3 The System Operator shall be responsible in issuing Dispatch Instructions for the Scheduled Generating Units and the Generating Units providing Ancillary Services.

## **8.2.3 Responsibilities of the Grid Owner**

8.2.3.1 The Grid Owner is responsible for providing the System Operator and the Market Operator with data on the availability and operating status of Grid facilities and Equipment to be used in determining the constraints of the Grid for Scheduling and Dispatch.

8.2.3.2 The Grid Owner is responsible for the Grid operations necessary to implement the Dispatch Instructions of the System Operator.

## **8.2.4 Responsibilities of Generators**

8.2.4.1 The Generator is responsible for submitting the Capability and Availability Declaration, Generation Scheduling and Dispatch Parameters, and other data for its Scheduled Generating Units.

8.2.4.2 The Generator with a Scheduled Generating Unit shall be responsible for ensuring that all Dispatch Instructions from the System Operator are implemented.

8.2.4.3 The Generator providing Ancillary Services shall be responsible in ensuring that its Generating Units can provide the necessary support when instructed by the System Operator to do so.

## **8.2.5 Responsibilities of Distributors and Other Users**

8.2.5.1 Distributors and other Users are responsible for submitting their Demand data for the Grid Operating Program to be used in Scheduling and

Dispatch.

8.2.5.2 Distributors and other Users are responsible for implementing all Dispatch Instructions pertaining to Demand Control during an emergency situation.

## **8.3 SCHEDULING AND DISPATCH PRINCIPLES**

### **8.3.1 Grid Operating Margin**

8.3.1.1 The Operating Margin of the Grid shall include the generating capacity for the Frequency Regulating Reserve, which is required to respond to changes in Demand during normal conditions and the Contingency Reserve needed to respond to a sudden reduction in generation during emergency conditions, in accordance with the Grid operating criteria specified in Section 7.2.2.

8.3.1.2 The System Operator shall allocate the Frequency Regulating Reserve to strategically located Generating Plants in order to achieve the required levels of Primary Response and Secondary Response to Frequency changes in the Grid.

8.3.1.3 The System Operator shall allocate the Contingency Reserve to strategically located Generating Plants to cover against uncertainties in Generating Plant availability.

### **8.3.2 Scheduling and Dispatch Criteria**

8.3.2.1 The Market Operator and the System Operator shall take into account the following operational criteria in Scheduling and Dispatch:

- (a) The Synchronized generating capacity shall be sufficient to match, at all times, the forecasted Grid Demand and the required Frequency Regulating Reserve and Contingency Reserve to ensure the Security and Reliability of the Grid;
- (b) The availability of Generating Units at strategic locations so that the Grid will continue to operate in Normal State even with the loss of the largest Generating Unit or the power import from a single interconnection, whichever is larger;
- (c) The technical and operational constraints of the Grid and the Generating Units; and
- (d) The Security and Stability of the Grid.

8.3.2.2 The Market Operator shall take into account the following factors in

preparing the Generation Schedule:

- (a) The registered parameters of the Scheduled Generating Units;
- (b) The requirements for voltage control and Reactive Power;
- (c) The need to provide an Operating Margin for Frequency Control;
- (d) Availability of Ancillary Services; and
- (e) Bilateral contracts between Generators and Users.

8.3.2.3 The System Operator shall take into account the following factors in dispatching Generating Units and in satisfying needs for imbalance Energy in real time:

- (a) The Generation Schedule;
- (b) The Demand requirements of the Users;
- (c) Grid congestion problems;
- (d) System Loss; and
- (e) The requirements for Ancillary Services.

### **8.3.3 Scheduling and Dispatch Data**

8.3.3.1 All the bids to buy Energy and offers to supply Energy for each hour of the trading day shall be submitted to the Market Operator one day ahead of the trading day.

8.3.3.2 The Generator shall submit to the System Operator the following information for its Scheduled Generating Units:

- (a) Details of any special factor which may have a significant effect on the output of the Scheduled Generating Unit;
- (b) Any temporary change, and its possible duration, to the Registered Data of the Scheduled Generating Unit; and
- (c) Any temporary change, and its possible duration, of the Generator's availability to provide Ancillary Services.

8.3.3.3 The Generator shall, without delay, notify the System Operator and Market Operator of any change in the Capability and Availability Declaration, Generation Scheduling and Dispatch Parameters, and other relevant generation data.

8.3.3.4 In addition to its Demand Forecast, the Distributor and other User shall notify the Market Operator and the System Operator of the following:

- (a) Constraints on its Distribution System (or User System) which the Market Operator and the System Operator may need to take into account in Scheduling and Dispatch;
- (b) The requirements for voltage control and Reactive Power which the System Operator may need to take into account for the reliability of the Grid;

and

(c) The requirements for Ancillary Services which the System Operator may need to consider for the Security and Stability of the Grid.

## **8.4 GENERATION SCHEDULING PROCEDURE**

### **8.4.1 Preparation of the Generation Schedule**

8.4.1.1 The System Operator shall prepare a cohesive forecast of hourly Grid Demand, which shall include the System Loss in the Grid.

8.4.1.2 The Market Operator shall prepare a Merit Order Table considering the Generation Scheduling and Dispatch Parameters and Generation Price Data of the Scheduled Generating Units.

8.4.1.3 Scheduled Generating Units shall be committed, following the Merit Order Table, until the Grid Demand and System Loss are fully covered. Additional Generating Units shall be committed to meet the Operating Margin required by of the Grid.

8.4.1.4 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.

### **8.4.2 Capability and Availability Declaration**

8.4.2.1 The Generator shall provide the Market Operator the Capability and Availability Declaration of its Generating Units for the next Schedule Day within the deadline prescribed by the Market Rules.

8.4.2.2 If the Generating Unit Capability and Availability Declaration for the next Schedule Day have not been submitted within the prescribed deadline, the Generating Unit shall be excluded in the next Schedule Day. If this leads to inadequate Operating Margin, the Market Operator shall make best efforts to obtain increased Capability from the available Generators. If necessary, the Market Operator may treat the excluded Generating Unit as the last priority in the Merit Order Table.

8.4.2.3 The following data shall constitute the Capability and Availability Declaration of each Scheduled Generating Unit:

(a) Capability and Availability Data:

(1) Generating Unit Availability (start time and date) and Capability (gross and net);

(2) Generating Unit loss of capability (day, start time, end time);

- (3) Time required to Synchronize;
- (4) Initial Conditions (time last Synchronized or Shutdown); and
- (5) Additional Generation capacity above the Net Declared Capability;
- (b) Generation Scheduling and Dispatch Parameters:
  - (1) Generating Unit inflexibility (description, start date and time, end date and time, MW);
  - (2) Generating Unit synchronizing intervals (hot interval, Shutdown time);
  - (3) Generating Unit Shutdown Intervals;
  - (4) Generating Unit Minimum Stable Loading;
  - (5) Generating Unit Minimum Downtime;
  - (6) Generating Unit Minimum Uptime;
  - (7) Generating Unit two shifting limitation;
  - (8) Generating Unit Synchronizing Generation (Hot Synchronizing Generation, Shutdown time);
  - (9) Generating Unit Synchronizing groups;
  - (10) Generating Unit ramp rates hot and cold (three rates each for three different levels of turbine metal temperature with time breakpoints);
  - (11) Generating Unit ramp-up rate MW breakpoints;
  - (12) Generating Unit ramp-down rates (three rates with two MW breakpoints);
  - (13) Generating Unit loading rates (three rates with two MW breakpoints);
  - (14) Generating Unit Load Reduction rates (three rates with two MW breakpoints); and
  - (15) Maximum Generation reduction in MVAR generation Capability;
- (c) Price Data:
  - (1) Generating Unit Start-Up Price;
  - (2) Generating Unit No-Load Price; and
  - (3) Generating Unit Incremental Price.

### **8.4.3 Redeclaration of Capability and Availability**

8.4.3.1 If a Scheduled Generating Unit becomes available at a different capacity, the Generator shall provide the Market Operator, within the prescribed deadline, a revised Capability and Availability Declaration and any revision to the data listed in Section 8.4.2.

8.4.3.2 If the revised Capability and Availability Declaration is submitted within the prescribed deadline, the Market Operator shall take the revised Capability and Availability Declaration into account in the preparation of the final day-ahead Generation Schedule.

#### **8.4.4 Merit Order Table**

8.4.4.1 Using the Price Data specified in Section 8.4.2, The Market Operator shall prepare a Merit Order Table based on ascending prices. The Scheduled Generating Unit that has the lowest price per kWh shall be at the top of the Merit Order Table.

8.4.4.2 Once prepared, the Merit Order Table shall be used in determining which Generating Unit will be committed for the day-ahead Generation Schedule.

#### **8.4.5 Unconstrained and Constrained Generation Schedules**

8.4.5.1 The Market Operator shall use the Merit Order Table to match the offers to supply Energy with the bids to buy Energy, in accordance with the Market Rules, in developing the day-ahead Unconstrained Generation Schedule.

8.4.5.2 The System Operator shall determine the feasibility of the Unconstrained Generation Schedule submitted by the Market Operator considering the constraints in the Grid.

8.4.5.3 The Unconstrained Generation Schedule shall then be adjusted by the Market Operator to develop the final Constrained Generation Schedule

8.4.5.4 After the completion of the Scheduling process, but before the issuance of the Generation Schedule, the Market Operator may make necessary adjustments to the output of the Scheduling process. Such adjustments may be due to the following factors:

- (a) Changes to Generation Scheduling and Dispatch Parameters of Scheduled Generating Units except Generation Price Data;
- (b) Changes to Grid Demand Forecast;
- (c) Changes to transmission line and transformer constraints;
- (d) Changes to Scheduled Generating Units' requirements within constrained groups following notification to the Market Operator of the changes in Capability and Availability of another User;
- (e) Changes to Scheduled Generating Units' requirements within constrained groups, following reappraisal of Demand Forecast within that constrained group;
- (f) Changes to Grid conditions which may have a Material Effect on the Grid; and
- (g) Changes to the scheduled daily water usage of hydroelectric Generating Plants.

## **8.4.6 Issuance of Generation Schedule**

8.4.6.1 The Generation Schedule for the next Schedule Day shall be issued by the Market Operator within the period prescribed by the Market Rules. However, if a Significant Incident occurred while the Generation Schedule is being prepared, the Market Operator may extend the deadline for issuance of the final Generation Schedule.

8.4.6.2 The final Generation Schedule shall indicate the hourly output of each Scheduled Generating Unit for the following Schedule Day. It shall also indicate the Generating Units that are providing specific Ancillary Services.

## **8.5 CENTRAL DISPATCH PROCEDURE**

### **8.5.1 Dispatch Instructions**

8.5.1.1 The Dispatch Instruction shall contain the following:

- (a) The specific Generating Unit to which the instruction applies;
- (b) The MW and MVAR output required;
- (c) Target time of Scheduled Generating Units Ramp-up and Ramp-down rates;
- (d) Start and synchronizing time of Scheduled Generating Units; and
- (e) The Dispatch Instruction issuance time.

8.5.1.2 In addition to instructions relating to the dispatch of Active Power, the Dispatch Instruction may also include:

- (a) Details of the type of reserves to be carried out by each unit, including specifications of the duration in which that reserve may be dispatched;
- (b) An instruction for Generating Units to provide operational requirements and Ancillary Service;
- (c) Target voltage levels at instructed generating capacity level or the individual Reactive Power output at the Bus or at the Connection Point;
- (d) Requirement to change to the other Frequency Control mode;
- (e) Instructions relating to abnormal conditions, such as an Adverse Weather Condition or high/low Grid voltage;
- (f) An instruction for hydroelectric Generating Units to operate in the synchronous condenser operating mode; and
- (g) Mode changes for Pumped Storage Plants.

8.5.1.3 The Dispatch Instructions shall be recorded in a logbook or other means of recording.



8.5.1.4 The System Operator shall issue the Dispatch Instructions to all Generators regarding their day-ahead hourly Generation Schedule through an appropriate means of communication.

8.5.1.5 The hourly loading and load reduction embodied in the Generation Schedule issued to Scheduled Generating Units shall remain valid unless superseded by another Dispatch Instruction.

8.5.1.6 In the event of two or more Generating Units having the same price, the System Operator shall dispatch the Generating Unit that will result in a smaller System Loss.

8.5.1.7 In the event that the System Operator is unable to identify a reason to differentiate which of the Scheduled Generating Units to Shutdown based on the Merit Order Table, the System Operator shall instruct a Scheduled Generating Unit to Shutdown using the following factors:

- (a) Effect on power flows (resulting in the minimization of System Loss);
- (b) Reserve Capability;
- (c) Reactive Power worth; and
- (d) Generation Scheduling and Dispatch Parameters.

8.5.1.8 The period of placing the Generating Unit online and Shutdown reflected in the Generation Schedule are only tentative and can be modified by another Dispatch Instruction.

## **8.5.2 Dispatch Instructions for Scheduled Generating Units**

8.5.2.1 The Dispatch Instruction to a Scheduled Generating Unit shall contain the scheduled time and the Power output of the Generating Unit.

8.5.2.2 Ramp-up and Ramp-down rates shall be in accordance with the Generation Schedule unless otherwise stated. If a different Ramp-up and Ramp-down rates are required, the target time to achieve the desired output shall be stated accordingly.

8.5.2.3 The Dispatch Instruction to Synchronize shall be issued by the System Operator specifying the time and sequence of synchronization. The Dispatch Instruction for canceling the previous instruction to Synchronize shall be issued accordingly when necessary.

8.5.2.4 The Dispatch Instruction to Shutdown a Generating Unit shall specify the Shutdown time.

## **8.5.3 Dispatch Instructions for Ancillary Services**

8.5.3.1 The Dispatch Instructions for Frequency Regulating Reserve shall

specify whether the Generating Unit will provide Primary Response or Secondary Response.

8.5.3.2 The Dispatch Instructions for Spinning Reserve and Back-up Reserve shall contain the generating capacity to be provided by the specific Generating Unit.

8.5.3.3 The Dispatch Instructions for Black Start shall contain the specific instruction for the Generating Units to initiate a Black Start procedure.

8.5.3.4 The Dispatch Instructions for emergency load reduction shall contain the generating capacity to be dropped and the time the load reduction is to be implemented.

8.5.3.5 The Dispatch Instructions for Voltage Control shall specify the target voltage level or the maximum generation of Reactive Power.

#### **8.5.4 Scheduled Generating Unit's Response to Dispatch Instructions**

8.5.4.1 The Generator shall acknowledge immediately and comply with the Dispatch Instructions it received from the System Operator.

8.5.4.2 A Scheduled Generating Unit already Synchronized but not yet operating at its Net Declared Capability, shall be ready to implement subsequent Dispatch Instructions, or shall notify the System Operator of any possible time delay if not ready to implement such order.

8.5.4.3 Generating Units providing Frequency Regulating Reserve and Contingency Reserve for the Grid shall respond to the Dispatch Instructions of the System Operator according to the required capability of the Generating Units as specified in Article 5.4.

8.5.4.4 In the event that in carrying out the Dispatch Instructions, an unforeseen problem arises, the Generator shall notify the System Operator without delay.

8.5.4.5 Where there are changes in conditions, the Generator shall report such changes to the System Operator for updating the appropriate Dispatch Instructions.

8.5.4.6 Any Scheduled Generating Unit, previously Synchronized to the Grid, that gets isolated, shall notify the System Operator immediately and shall state the cause of isolation.

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## Chapter 9 Metering Code

### 9.1 Purpose and Scope

#### 9.1.1 Purpose

- (a) To establish the requirements for metering the Active and Reactive Energy and Demand input to and output from the Grid; and
- (b) To ensure accurate and prompt procedures for providing and processing metering data for billing and settlements of the Electricity Market.

#### 9.1.2 Scope of Application

This Chapter applies to all Grid Users including:

- (a) The Grid Owner;
- (b) The System Operator;
- (c) The Market Operator;
- (d) Generators;
- (e) Distributors;
- (f) Suppliers; and
- (g) Any entity with a User System connected to the Grid.

### 9.2 METERING REQUIREMENTS

#### 9.2.1 Metering Equipment

The metering equipment at the Connection Point shall consist of:

- (a) Instrument transformers;
- (b) Lightning protection;
- (c) Revenue class meters;
- (d) Integrating pulse recorder(s) and time source; and
- (e) All interconnecting cables, wires, and associated devices, *i.e.*, test blocks, pulse repeaters, loading resistors, etc.
- (f) Data communication devices whenever communication services are available.

## **9.2.2 Metering Responsibility**

9.2.2.1 The Meter Operator shall supply, install, connect, test, adjust, place in service, operate, check, and maintain the primary revenue metering System. Consistent with the Market Rules, all primary revenue meters shall be owned and maintained by the Meter Operator.

9.2.2.2 Prior to the grant of permission to participate in the Electricity Market, each market participant shall register with the Market Operator the metering Equipment at each Connection Point. The registration shall be done in accordance with the Market Rules of the Electricity Market. It shall be the responsibility of the market participant to demonstrate that its metering equipment meets all the technical requirements and standards set forth in this Chapter. The Market Operator shall accept a meter registration only if all the relevant requirements of the Grid Code and Market Rules have been met.

## **9.2.3 Active Energy and Demand Metering**

9.2.3.1 Active Energy and Demand Revenue Metering shall be required at every Connection Point. The metering point shall be as close as possible to the Connection Point, otherwise a procedure shall be established to adjust Energy loss between the metering point and the Connection Point.

9.2.3.2 The meter pulses shall be made available to allow separate recording of the input and output Active Energy and Power at each Connection Point.

## **9.2.4 Reactive Energy and Demand Metering**

9.2.4.1 Reactive Energy and Demand Revenue metering shall be required at every Connection Point. The metering point shall be as close as possible to the Connection Point, otherwise a separate procedure for adjusting Energy loss between the point of metering and Connection Point shall be developed.

9.2.4.2 The Reactive Energy and Demand metering shall be provided to independently meter input and output from the Grid. It shall measure all quadrants in which Reactive Power flow is possible.

9.2.4.3 The meter pulses shall be made available to allow separate recording of the input and output Reactive Energy and Demand at each Connection Point.

## **9.2.5 Integrating Pulse Meters**

9.2.5.1 To accommodate the operation of the Electricity Market, Integrating Pulse Meters shall be provided at every Connection Point to record Active and Reactive integrated Demand data for use in billing and settlements for Energy services provided by the Grid and for transactions between Users. An exemption to this requirement shall be allowed for those Users provided bundled services from the Operator.

9.2.5.2 All Integrating Pulse Meters shall be capable of electronic downloading of stored data or manual on-site interrogation by the Meter Operator.

9.2.5.3 All Integrating Pulse Meters shall have fail safe storage for at least two months of integrated demand data and be capable of retaining readings and time of day for at least two (2) days without an external power source.

## **9.3 METERING EQUIPMENT STANDARDS**

### **9.3.1 Voltage Transformers**

9.3.1.1 The voltage transformers shall comprise three (3) units for a three-phase set, each of which complies with the IEC Standard or its equivalent national standard for metering, and is of the 0.2 accuracy class. These voltage transformers shall be connected Wye-Wye with both star points grounded to a grounding Grid of acceptable resistance and shall provide a four-wire secondary connection.

9.3.1.2 The voltage drop in each phase of the voltage transformer connections of the same accuracy and class shall not exceed 0.2 V. It shall be connected only to a billing meter with a burden that shall not affect the accuracy of measurement.

### **9.3.2 Current Transformers**

9.3.2.1 The current transformers shall comprise three units for a three-phase set, each of which complies with the IEC Standard or its equivalent national standard for metering, and is of 0.2 accuracy class. It is preferred that two (2) current transformer cores with corresponding number of secondary coils per phase be provided between the connection box and the terminal of the metering element on the meter so that the current transformer connections for checking meter pulses can be completely separated from those provided for

the revenue meters of this Chapter.

9.3.2.2 Provisions shall be made for another secondary winding if a check metering current supply is requested by the User. The current transformer's rated secondary current shall be either 1 or 5 amperes. The neutral conductor 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.

### **9.3.3 Meters**

9.3.3.1 Meters shall be of the three-element type rated for the required site, comply with the appropriate IEC Standards or their equivalent national standards, for static watt-hour meter and other types of meters, and be of the accuracy class of 0.2 or equivalent. The meters shall measure and locally display at least the kW, kWh, kVAR, kVARh, and cumulative Demand, with the features of time-of-use, maintenance records, and pulse output.

9.3.3.2 A cumulative record of the parameters measured shall be available on the meter. Bi-directional meters shall have two such records available. If combined Active Energy and Reactive Energy meters are provided, then a separate record shall be provided for each measured quantity and direction. The loss of auxiliary supply to the meter shall not erase these records.

9.3.3.3 For participants of the Electricity Market, Standard communication protocols used for metering /billing systems complying with latest IEC standard shall be supported for the meter data transferring . the meter shall be equipped with an exchangeable communication interface to allow different types of physical interfaces e.g serial , Ethernet, optical ... etc. pulse output shall be provided as an option for each measured quantity. The pulse output shall be from a three-wire terminal with pulse duration in the range from 40 to 80 milliseconds (preferably selectable) and with selective pulse frequency or rate. The minimum pulse frequency shall comply with the IEC Standard or its equivalent national standard, for the shortest integration period and the accuracy class of the meter. Pulse output shall be galvanically isolated from the voltage/current transformers being measured and from the auxiliary supply input terminals. The insulation test voltage shall be 1000 VAC, 50 Hz and applied for one minute.

### **9.3.4 Integrating Pulse Recorders**

9.3.4.1 Integrating Pulse Recorders shall be capable of recording integrated Demand periods adjustable between fifteen (15) minutes and sixty (60)

minutes. An exemption to this requirement shall be allowed for those Users supplied with bundled services.

9.3.4.2 Each recorder shall be capable of electronic data transfer through dedicated telephone lines or the Grid Owner's communication channels or manual downloading of data on-site. The Grid Owner shall allow an exemption to this requirement for those Users supplied with bundled services.

9.3.4.3 The integrating pulse recorders 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 was generated. The integrating pulse recorder shall be regularly interrogated and the record shall also be maintained at the recorder for two (2) complete billing periods between one (1) interrogation or sixty (60) days, whichever is longer.

9.3.4.4 The time reference used with the Demand recorder shall ensure that the Demand period accuracy of this integrating pulse recorder is with a time error of no more than +/-1 second.

9.3.4.5 All revenue metering installations shall record time, based on Sudan standard time.

9.3.4.6 The start of each demand period shall be within +/-30 seconds of the standard time.

9.3.4.7 Reprogramming of integrating pulse recorders shall be done as soon as possible within one billing cycle if there is a time error.

## **9.4 METERING EQUIPMENT TESTING AND MAINTENANCE**

### **9.4.1 Instrument Transformer Testing**

9.4.1.1 Test on the Instrument Transformers shall be done by a party authorized by the Meter Operator and the concerned User during the Test and Commissioning stage and then at least once every five (5) years or as the need arises due to questions on accuracy. The tests shall be carried out in accordance with this Chapter or an agreed equivalent international standard.

9.4.1.2 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. Burden Test shall be conducted during commissioning, re-installation or relocation or when requested by the User and/or the Grid Owner. Loading resistors for compensating low burdens may be allowed as long as accuracy level is sustained.



## **9.4.2 Meter Testing and Calibration**

The Meter Operator and User, through the **ERA** or an independent party authorized by the **ERA**, shall test and seal the meters at least once a year and recalibrate or replace such meters if found to be outside the acceptable accuracy stipulated in the Grid Code.

## **9.4.3 Request for Test**

9.4.3.1 A User or the Market Operator may request a test of the installed metering equipment if it has reason to believe that the performance of the Equipment is not within the accuracy limits set forth in this Chapter. The test shall be done by the **ERA** or by an independent party authorized by the **ERA**.

9.4.3.2 If the meter Equipment fails the test, the Meter Operator shall pay for the cost of the test. If the meter Equipment passes the test, the party who requested the test shall pay for the test cost.

## **9.4.4 Maintenance of Metering Equipment**

9.4.4.1 The metering equipment at the Connection Point shall be maintained by the Meter Operator. All test results, maintenance programs, and sealing records shall be kept for the life of the Equipment. The Equipment data and test records shall be made available to authorized parties.

9.4.4.2 The Meter Operator shall repair the metering System as soon as practical and in any event within two (2) days if a metering System malfunctions or maintenance occurs. The Meter Operator shall be allowed to charge the metering services provided, subject to the approval of the **ERA**.

## **9.4.5 Metering Equipment Security**

The Meter Operator shall take all reasonable steps to prevent unauthorized interference with the Equipment. The Meter Operator shall provide seals and other appropriate devices to prevent unauthorized alteration on site settings and calibrations. The metering Equipment cubicle shall be completely and securely locked and sealed, provided any register on Equipment is visible and accessible. The Meter Operator shall also provide appropriate security against unauthorized access and against corruption of data in transmission.

## **9.5 METER READING AND METERING DATA**

### **9.5.1 Integrating Pulse Metering Data**

9.5.1.1 The Meter Operator or the Data Collection Agent shall download Integrating Pulse Metering data (the actual hourly data on generation and off-takes at each Connection Point during the previous week) for billing and settlement purposes of the Electricity Market. Each User shall be provided full access to the data for his Connection Point.

9.5.1.2 The pulses from two or more meters may be combined into one integrating Pulse Recorder provided all the requirements of this Chapter are met. In each hour, one of the time periods shall commence on the hour.

9.5.1.3 The meter pulses that need to be integrated into the recorder are:

- (a) Active Energy and Demand incoming and outgoing in the Transmission System; and
- (b) Reactive Energy and Demand incoming and outgoing in the Transmission System.

9.5.1.4 Provisions shall be made by the Market Operator to permit on-site as well as remote interrogation of the Integrating Pulse Recorder.

### **9.5.2 Electronic Data Transfer Capability**

All the metering systems shall have the capability of electronic data transfer. During the transition period, on-site metering and manual data transfer (*e.g.*, by fax) may be necessary.

### **9.5.3 On-Site Meter Reading**

If on-site meter reading is necessary, it shall be witnessed by authorized representatives of all concerned parties on the date and time stipulated in a separate agreement.

### **9.5.4 Running Total of Active Energy and Power**

At input/output connections, the Active Energy and Active Power metering shall provide the running total of the Energy. Combined meters which measure both the Active Energy and Active Power input to and output from the Grid shall have the running totals available for each measured quantity, each direction, and each quadrant or combination of quadrants.

### **9.5.5 Running Total of Reactive Energy and Power**

At input/output connections, the Reactive Energy and Reactive Power metering shall provide the running totals of the Energy. Combined meters which measure both the Reactive Energy and Reactive Power input to and output from the Grid shall have the running totals available for each measured quantity, each direction, and each quadrant or combination of quadrants.

### **9.5.6 Responsibility for Billing**

The Market Rules of the Electricity Market set out the weekly billing and statement procedures. The System Operator shall be responsible for the provision of the meter data to the Market Operator consistent with the weekly time schedule.

### **9.5.7 Billing and Settlement Procedure**

9.5.7.1 By 10:00 hours every Sunday or the first Business Day of the week, all Meter Operators (or designated Data Collection Agent) shall send electronically or by fax to the System Operator the hourly data on actual input (supply) and output (demand) of each metering point for the previous week.

9.5.7.2 By 12:00 hours of the same day, the System Operator shall transfer electronically or by fax to the Market Operator the hourly data on actual input and output at all metering points for the previous week. At the same time, the System Operator shall provide the Market Operator actual hourly dispatch logs for the previous week. The dispatch log data shall be flagged when a market participant (Generator or Distributor) was instructed to increase (decrease) output or to reduce (increase) demand. This information shall be used to calculate the imbalance Energy and Ancillary Service charges.

9.5.7.3 The Market Operator shall, based on the provided meter data and dispatch logs, prepare provisional invoices according to the billing and settlement procedures established in the Market Rules.

### **9.5.8 Validation and Substitution of Metering Data**

9.5.8.1 The Market Operator shall be responsible for the validation and substitution of metering data. The method for data validation and substitution shall be developed as part of the Market Rules.

9.5.8.2 In principle, check metering data, where available, shall be used to

validate metering data provided that check metering Equipment accuracy conforms to the standards of this Chapter. If a check meter is not available or the metering data is missing, then a substitute value shall be prepared by the Market Operator using the Electricity Market's data validation and substitution method approved by the ERA.

### **9.5.9 Storage and Availability of Metering Data**

9.5.9.1 The individuals registered with the Market Operator as the Meter Registrant shall be the owner of all the metering data.

9.5.9.2 The Market Operator shall keep the metering data for five years.

9.5.9.3 No alteration to the metering data stored in the database shall be permitted.

9.5.9.4 User's meter data shall be considered confidential and shall be made available only to the System Operator and Market Operator, the User, and the ERA.

## **9.6 SETTLEMENT AUDIT PROCEDURE**

### **9.6.1 Right to Request Settlement Audit**

The User shall have the right to request an audit of the settlement data related to its account and the right to choose an independent third party qualified to perform the audit. The System Operator, Meter Operator, and Market Operator shall cooperate in the auditing process.

### **9.6.2 Allocation of Audit Cost**

The requesting party is responsible for all outside auditor costs unless the Grid Owner, System Operator, and/or Market Operator agree to pay some or all of these costs.

### **9.6.3 Audit Results**

The audit results shall be issued to the System Operator and Market Operator who shall issue a response to the audit report, including any adjustment in account billing/payments proposed.

#### **9.6.4 Audit Appeals**

If any User disagrees with the System Operator and/or Market Operator's response to the audit, that response may be appealed to an arbitrator selected by the Grid Management Committee. The procedure for the settlements dispute set forth in Grid Management Chapter shall also apply to audit appeals.