KINGDOM OF CAMBODIA

NATION RELIGION KING

ELECTRICITY AUTHORITY OF CAMBODIA

No. 069-09-EAC

Phnom Penh, May 22, 2009

DECISION

ON APPROVAL AND ISSUE OF GRID CODE

ELECTRICITY AUTHORITY OF CAMBODIA

-Having seen the Electricity Law of the Kingdom of Cambodia promulgated by the Royal KRAM No. NS/RKM/0201/03 dated February 2, 2001

-Having seen the Royal Decree No. NS/RKT/0408/378 of April 4, 2008 of Preahbath Samdech

Preah **NORODOM SIHAMONY**, the King of the Kingdom of Cambodia, on the appointment of Excellency **TY NORIN** as Chairman of Electricity Authority of Cambodia for a renewed term

-In accordance with the consultation with concerned Ministries, institutions, and licensees made

from November 4, 2008 to March 31, 2009

In accordance with the decision of EAC's session No. 156 dated May 22, 2009

DECIDES

Article 1:

To approve and issue the regulation called **Grid Code** under the Electricity Law of the Kingdom of Cambodia to establish the basic rules, requirements, procedures and standards that

govern the operation, maintenance and development of the High Voltage Transmission System

in Cambodia.

Article 2:

The regulation has the content as in the attached document.

Article 3:

The regulation is applicable to National Transmission Licensee, Special Purpose Transmission Licensees operating High Voltage transmission system and the Users of the High Voltage Transmission System.

Article 4:

The regulation shall come into force from the date of signing.

Article 5:

The Secretariat of Electricity Authority of Cambodia shall publicize the regulation.

CHAIRMAN

ELECTRICITY AUTHORITY OF CAMBODIA

CC:

-Ministry of Industry, Mines and Energy

-EDC

-Special Purpose Transmission Licensee operating HV transmission system

-Users of High Voltage Transmission System

-Archives

CAMBODIA

GRID CODE

MAY 2009

KINGDOM OF CAMBODIA

NATION RELIGION KING

Cambodia Grid Code

Preface

The Cambodia Transmission System (CTS) is in very early stage of development. Till November 2007, the Phnom Penh System was the only transmission systems in Cambodia. The Phnom Penh System consists of a number of 115 kV lines connecting a number of sub-stations and generating plants to supply electricity to Phnom Penh

and the areas around it. Some of the generating plants are connected to the system at medium voltage through the subtransmission/distribution system. Electricité Du Cambodge (EDC) owns the HV, MV and LV lines and substations and some of the generating plants; while the other generating plants are owned by Independent Power Producers (IPPs), who sell the electricity generated by them to EDC.

In November 2007 the North-West Transmission System (connecting Thailand system with Banteay Meanchey, Siem Reap and Battambang through 115 kV transmission lines) was commissioned. A Special Purpose Transmission Licensee owns and operates this 115 kV system and has a transmission agreement with EDC. Electricity is purchased by EDC from Thailand and supplied to its customers in Banteay Meanchey, Siem Reap and Battambang. Subtransmission system is being constructed to take power supply to other towns and rural areas of these three provinces.

Projects are ongoing to get electric power to Cambodia through high voltage lines from Vietnam and Laos. In future there may be more External Interconnections to the CTS for import of power from other systems or export of power to other systems. In the coming years more generating plants and transmission lines are planned. Such additions will extend the existing systems, create new separate systems and interconnect the separate system to form larger systems. With gradual reinforcements and extensions, the separate systems will ultimately develop into one system consisting of meshed network and radial transmission lines covering whole of Cambodia. As per the indication available till now, most of the new generating plants may be owned by IPPs while some transmission lines will be owned by EDC and others will be owned by many Special Purpose Transmission Licensees. EDC is likely to be the single buyer and also have agreements with other transmission line owners to use their transmission system for transmitting electricity to different load centers.

The Distribution Systems supplying electricity to Phnom Penh and surrounding areas are now connected to the Phnom Penh system. At present no consumer is connected to the system at HV. In future a large number of Subtransmission and Distribution systems will be connected to the CTS to deliver electricity to consumers in Cambodia.

With the establishment of bigger industries, in future some consumers may be connected directly to the CTS at HV or to substations by direct MV feeders.

The safe, reliable and efficient operation of the Cambodia Transmission System, having large number of participants including NTL, SPTL, Generation Licensees, Licensees with Embedded Generating Units, External Interconnectors, Distribution Licensees and consumers, requires the coordinated operation of all participants. In this coordinated operation the Control Centers play a very important part. To make this coordination possible, it is required that the basic rules of operation are established. This 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 Cambodia.

Electricité Du Cambodge (EDC) has been issued a Consolidated License consisting of a Generation License, National Transmission License and a Distribution License by Electricity Authority of Cambodia (EAC). Condition 1 of chapter 3 of the License Conditions applicable to the transmission license provides that EDC shall prepare its Transmission Code, which after approval by EAC, shall be in force at all times and EDC shall implement and comply with this Transmission Code. EDC shall periodically review (including upon the request of EAC) the Transmission Code and its implementation. Revisions to the Transmission Code proposed by EDC shall require approval of EAC. So according to the License Condition, it is the responsibility of EDC to manage, review and implement this Grid Code. To make the Grid Code implement able, it is required that EDC periodically consult other participants and take their views into consideration. For this purpose, provision has been made in this Grid Code for a Grid Code Review Panel.

For security and quality supply, the electrical system has to be planned properly based on studies. The planning of the power sector has the following main components:

a. Demand Forecast – For planning purposes, not only the demand of whole system is required, but also the demand on each element of the system to

be planned is required. For planning the transmission system the demand at each connection point, each substation and each system is required. For planning of a subtransmission system or distribution system the demand in each feeder in the subtransmission system or distribution system and each transformer is required.

b. Generation and Import Planning – The generation and import planning will depend on the demand and policy on development and utilization of generation resources and import of electricity from other countries. The generation and import planning will have to ensure that sufficient energy and capacity is available to meet the demand according to the planning criteria.

c. Transmission System Planning – The transmission system planning has to take into consideration the demand forecast and generation and import planning and ensure that quality supply is available to meet the system demand at each connection point according to the planning criteria.

d. Subtransmission and Distribution planning – The Subtransmission and Distribution system consists of a large number of small systems and each system is planned based on the connection point, demand on each system and sources of power, if any, connected to each system.

As per Electricity Law, the Ministry of Industry, Mines and Energy is responsible for the planning in the power sector. The provision in this regard in the Article 3 of the Electricity Law is:

“The Ministry of Industry, Mines and Energy shall be responsible for setting and administrating the government policies, strategies and planning in the power sector.”

Power system planning needs a lot of data and the originator of the data is best suited to provide the data. The subtransmission and distribution systems, being small and simple consisting mostly of radial systems, are easy to plan and can be

planned as a number of separate systems. But the planning of the transmission system is complex and a lot more technical. So in the Cambodia context the planning may be done at two levels. MIME may decide the broad policy defining the systems to be developed in public sector and by private sector, development and utilization of generation resources and import of electricity from other countries and need not be responsible for the detail planning.

The transmission system, often consisting of parallel meshed paths, needs detailed studies and has to be planned as an integrated system and hence is to be done by one agency. In Cambodia, different lines of the transmission system are likely to be owned by different owners – EDC and other SPTL. Each SPTL will own and operate only a specified part of the transmission system and hence is neither equipped nor required by conditions of its license to carry out the planning of the entire transmission system. On the other hand, it is expected that all or most of the transmission facilities will be owned or controlled (under transmission agreements) by EDC and EDC will be in a better position to take up planning of the entire transmission system. It will have most of the required data and technical know-how to carry out the planning. As per the provision of the Electricity Law, MIME will set the policy and will be responsible for the overall planning of the power sector, preparing the National Plan for the power sector in Cambodia, but EDC will be responsible to carry out the detail planning of the entire transmission system implementing the policy and National Plan of MIME. Hence in this Code, EDC, the National Transmission Licensee has been given the responsibilities of planning the transmission system. The Planning Code provides for the supply of the required information by Users of the transmission system so that EDC can undertake the planning and development of the CTS.

The Generation Licensees and HV Customers need connections to the CTS to deliver electricity and take supply of electricity. The transmission system of one owner needs to be connected to the adjacent transmission system of another owner to have a meshed network and to transmit electricity to the load centers. The

Connection Code specifies the minimum technical, design and operational criteria which must be complied by the Generation Licensee and Customers seeking connection to the CTS and the transmission system owners. It also specifies the procedure to be followed for getting connected to the CTS. The Protection Code specifies the minimum protection to be provided and the procedure to enforce protection coordination. The Safety Co-ordination Code describes the safe procedures to carry out works at Connection Sites where equipments of more than one owner are installed.

Different elements of the CTS like generating unit, transmission line, equipment in substation etc are to be taken out of service for periodical and emergency maintenance. These outages are to be planned so that there is minimum possible interruption to the supply. The Outage Planning Code describes the outage planning process.

In any grid system, the supply (generation and import) and demand must be matched at all times. The performance of the system needs to be monitored continuously to avoid overloading of any element or operating an element beyond permissible limits as well as to ensure that quality and reliability of supply is

maintained. This work is done by the Control Centers. The Control centers carry out the functions of scheduling and dispatch of generating plants and imports, maintain voltage at different nodes and frequency of the system within allowed limits, and restore the system after any faults and outages. The Scheduling and Dispatch Code, Frequency and Voltage Management Code, and Contingency Planning Code cover these operation procedures. The Control Center requires on line data and information relating to the operation of the system. The procedures for the same are described in Metering, Communication and Data Acquisition Code and Code on Event and Accident Reporting.

GRID CODE

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Chapter 1

GENERAL PROVISIONS

1.1 Grid Code

The 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 Cambodia. The safe, reliable and efficient operation of the Cambodia Transmission System (CTS) requires the cooperation of all participants of the electricity industry. It is important that all Users follow the instructions of the Control Center to ensure reliable operation of the CTS.

1.2 Scope of Application of Grid Code

The Grid Code is applicable to all Users of the Cambodia Transmission System including:

a. The National Transmission Licensee

b. Special Purpose Transmission Licensees operating High Voltage Transmission System

c. Generation Licensees operating Generating Plant connected directly with the Cambodia Transmission System (CTS) or operating Embedded Generating Plant connected to Subtransmission System or Distribution System which is connected to CTS

d. Special Purpose Transmission Licensees operating Medium Voltage Subtransmission System connected directly with the Cambodia Transmission System (CTS)

e. Distribution Licensees operating Distribution System connected directly with the CTS

f. Consumers having their System connected directly with the CTS

g. External Interconnectors connected to the CTS

The Chapter 3: Connection Code of this Grid Code is also applicable to the Users intending to get connected to the Transmission System prior to their generating, transmitting, supplying, or consuming electricity, as the case may be.

1.3 Grid Code Review and Revisions

To keep the Grid Code relevant to the changes and development of the CTS, the Grid Code will be reviewed periodically, as and when required and when so directed by EAC. The Users can propose revisions to the Grid Code so that the Grid Code is capable of meeting its intended purpose. To carry out these reviews a Grid Code Review Panel headed by the NTL will be formed.

1.3.1 Members of the Review Panel

The Grid Code Review Panel shall consist of the following members:

a. An officer from Transmission Department of NTL – Chairman of the Panel

b. Another officer from Transmission Department of NTL – Member Secretary of the Panel

c. One member from each of the Special Purpose Transmission Licensees operating HV Transmission System

d. One member from each of the Generation Licensees connected directly with the Cambodian Transmission System (CTS) at HV

e. One member to represent all the HV consumers connected to the CTS at HV

f. One member from Distribution Department of EDC as operator of Subtransmission System and Distribution System connected to the CTS

g. One member to represent all SPTL having Subtransmission system and Distribution Licensees operating MV system connected directly to the CTS

h. One member to represent all Generation Licensees under Central Dispatch delivering electricity at MV One representative from EAC shall be invited to attend the meetings of the Panel as an observer.

The National Transmission Licensee (NTL) shall inform all Users represented on the Panel in writing of the names and addresses of the Panel Chairman and Member Secretary at least seven days before the first Panel meeting and of any subsequent changes in due course.

Each User represented on the Panel shall inform the Panel Member Secretary in writing of the name and designation of their Panel representative not less than 3 days before the first Panel meeting and of any subsequent change in due course.

In the case of sub-paragraphs e, g and h above, the member representing the group will be selected by the Secretary of the Panel on rotation basis from the group and the term of the member will be a calendar year. By 1st December each year the Secretary shall intimate the next member of the group to nominate its representative to the review panel by 15th December and on receipt of the name of the new member, the Secretary shall intimate other members of the Review Panel and EAC about the change of members to the review Panel for the next calendar year.

Sub-meetings may be held by the NTL with a User to discuss individual requirements and with groups of Users to prepare proposals for the Panel meeting.

The Panel may set up sub-committees for detail studies of related problems.

1.3.2 Functions of the Panel

The functions of the Panel are as follows:

a. To keep the Grid Code and its workings under scrutiny and review

b. To analyze any major grid disturbances soon after the occurrence and evolve any consequent revision to the Grid Code.

c. To consider all proposals made by Users or EAC for amendment to the Grid Code

d. To issue guidance on the interpretation and implementation of the Grid Code.

e. To examine problems raised by Users.

1.3.3 Rules of Business

The Rules to be followed by the Panel in conducting their business shall be formulated by the Panel themselves and shall be approved by EAC. The Panel will meet at least once in six months. The NTL shall send to EAC following reports at the conclusion of

each Review Meeting of the Panel:

a. A report on the outcome of such review

b. Any proposed revisions to the Grid Code for approval of EAC

c. All written representations or objections from Users arising during the review.

1.3.4 Procedure for Revision

The Member Secretary of the Review Panel shall present all proposed revisions of the Grid Code to the Panel for its consideration. The Panel shall also examine any financial cost involved in the implementation of the proposed revision and the affected Users. The cost will be borne by the Users as provided in the relevant agreement. If no provision exists in the relevant agreement, the Panel should recommend which Users are to bear the cost for approval by EAC.

All revisions to the Grid Code shall require approval of EAC. The NTL shall prepare the revised versions of the Grid Code once the revisions are approved by EAC. The revision number and date of issue shall appear on relevant pages of the Grid Code. Every change from the previous version shall be clearly marked in the margin. In addition, a revision sheet shall be placed at the front of the revised version that lists the number of every changed Section. The NTL shall send copies of the revised version of Grid Code to all Users.

1.4 Grid Code Interpretation

1.4.1 In the event that any User requires additional interpretation of the intention and application of any provision of the Grid Code, it may apply to the NTL for such interpretation. Provided that the request is reasonable the NTL shall provide the User with an interpretation of the relevant provision.

In the event that the User, acting reasonably, considers that an interpretation provided by the NTL is incomplete, the User may request additional clarification from the NTL.

1.4.2 In the event that the User, acting reasonably, considers that an interpretation provided by the NTL pursuant to sub-section 1.4.1 is unreasonable or incorrect, the User may require the NTL to refer the matter to the Grid Code Review Panel for consideration, in which case the NTL shall refer the matter to the Grid Code Review Panel for consideration at the next scheduled meeting of the Grid Code Review Panel (or in the event that there is insufficient time before the next scheduled meeting, then at the meeting immediately following the next scheduled meeting).

1.5 Derogations

1.5.1 If a User finds that it is, or will be, unable to comply with any provision of the Grid Code, then it shall without delay report such non-compliance to the NTL and shall, subject to the provisions of sub-section 1.5.2 make such reasonable efforts as are required to remedy such noncompliance as soon as reasonably practicable.

1.5.2 Where the non-compliance is:

a. with reference to Equipment connected to the CTS and is caused solely or mainly as a result of a revision to the Grid Code; or

b. with reference to Equipment which is connected, approved to connect, or for which approval to connect to the CTS is being sought, and the User believes either that it would be unreasonable (including cost and technical considerations) to require it to remedy such non-compliance or that it should be granted an extended period to remedy such non-compliance, it shall promptly submit to EAC a request for a derogation from such provision and shall provide the NTL with a copy of such a request.

1.5.3 A request for derogation from any provision of the Grid Code shall contain:

a. the version number and date of the Grid Code which includes the provision against which the non-compliance or predicted non-compliance is identified;

b. identification of the Equipment in respect of which a derogation is sought and, if relevant, the nature and extent to which the non-compliance exists;

c. identification of the provision with which the User is, or will be, unable to comply;

d. the reason for the non-compliance; and

e. the date by which compliance will be achieved (if remedy of the noncompliance is possible).

1.5.4 If the NTL finds that it is, or will be, unable to comply with any provision of the Grid Code, then it shall, subject to the remaining provisions of this Section 1.5 make such reasonable efforts as are required to remedy such non-compliance as soon as reasonably practicable.

1.5.5 If the NTL believes either that it would be unreasonable (including cost and technical considerations) to require it to remedy such non-compliance or that it should be granted an extended period to remedy such non-compliance, it shall promptly submit to EAC a request for a derogation from such provision along with the information set out in sub-section 1.5.3.

1.5.6 On receipt of any request for derogation, EAC shall consider such request and provided that EAC considers that the grounds for the derogation are reasonable, then EAC shall grant such derogation unless the derogation would, or it is likely that it would, have a material adverse impact on the security and stability of the CTS or impose unreasonable costs on the operation of the CTS or on other Users. In its consideration of a derogation request by a User, EAC may contact the relevant User and or

the NTL to obtain clarification of the request, or to obtain further information regarding the request, or to discuss changes to the request. The NTL may also contact the relevant User to obtain clarification of the request, or obtain further information regarding the request, or to discuss changes to the request. The User shall respond to all such requests without undue delay.

1.5.7 Derogations from any provision of the Grid Code shall contain:

a. the version number and date of the Grid Code which includes the provision against which the derogation applies;

b. identification of the provision with which the derogation applies;

c. identification of the Equipment in respect of which a derogation applies and, if relevant, the nature and extent to which the derogation applies including alternate compliance provisions;

d. the reason for the non-compliance requiring derogation;

e. the date by which the derogation ends if compliance will be achieved, or by which such derogation expires.

1.5.8 To the extent of any derogation granted in accordance with this Section 1.5, the NTL and/or the User (as the case may be) shall be relieved from its obligation to comply with the applicable provision of the Grid Code and shall not be liable for failure to so comply but shall comply with any alternate provisions as set forth in the derogation.

1.5.9 The NTL shall:

a. keep a register of all derogations which have been granted, identifying the User and Equipment in respect of whom the derogation has been granted, the relevant provision of the Grid Code and the Grid Code version number, the period of the derogation and the extent of compliance to the provision; and

b. on request from any User, provide a copy of such register of derogations to such User

1.5.10 Where a material change in circumstance has occurred, a review of any existing derogations, and any derogations under consideration, may be initiated by EAC by itself or at the request of the NTL, or Users.

Chapter 2

PLANNING CODE

2.1 Introduction

Proper and desired development of the CTS will involve its reinforcements and extension from time to time which will arise for a number of reasons, including but not limited to the following.

a. Extension of the Cambodia Transmission System from time to time for providing Grid supply to new areas.

b. The introduction of a new Connection Point or the modification of an existing Connection Point between a User System and the Cambodia Transmission System required for various reasons, including but not limited to connection of a new power plant, connection of a new load, change in the capacity of a power plant or change in the quantum of load already connected to the CTS or modification of a User System.

c. Development on a User System already connected to the Cambodia Transmission System.

d. A general increase in system capacity to remove operating constraints and maintain standards of security.

e. Stability considerations.

f. Cumulative effect of any of the above.

The time required for the design and development of the reinforcement or extension of the Cambodia Transmission System or User System is appreciable and will depend on the type and extent of the work. Hence advance timely action is required for the planning of the system to allow adequate time for all aspects of development of a project. The information required for the planning and design of the system also should be available in advance. To this effect the Planning Code

imposes a time scale, for actions to be taken for planning of the system and the exchange of necessary information required for planning.

2.2 Objective

The objectives of the Planning Code are:

a. To specify the responsibilities of the NTL and other Users in planning the development of the Cambodia Transmission System;

b. To specify the technical studies and planning procedures that will ensure the safety, security, reliability and stability of the Cambodia Transmission System;

c. To specify the planning data required for a User seeking a new connection or a modification of an existing connection to the Cambodia Transmission System; and

d. To specify the data requirements in planning the development of the Cambodia Transmission System.

2.3 Transmission System Planning Responsibilities

2.3.1 The National Transmission Licensee is responsible for planning the Cambodia Transmission System. It shall take the National Plan on Power Sector prepared by MIME as base for planning of the Cambodia Transmission System.

2.3.2 The Users of the CTS including Special Purpose Transmission Licensees, Generation Licensees are responsible for submission of the required planning data to enable the National Transmission Licensee to maintain the data bank required for grid planning.

2.4 Studies for Transmission System Planning

2.4.1 The CTS should be evolved based on detailed power studies. Subject to Section 2.4.2, the NTL may conduct some or all of the following studies, as it decides to be necessary:

a. Power Flow Studies – Power flow studies are performed to evaluate the behavior of the transmission system for the existing and planned transmission facilities under forecasted maximum and minimum load conditions and to study the impact on the transmission system of the connection of new Generating Plant, loads or transmission lines. For new transmission lines, the load condition that produces maximum power flows through the existing and new lines are identified and evaluated.

b. Short Circuit Studies – Short circuit studies are performed to evaluate the effect on transmission system equipment of the connection of new Generating Plants, transmission lines and other facilities that result in increased fault duties for transmission system equipment. These studies identify the equipment that can be permanently damaged during fault condition due to current exceeding the design limit of the equipment.

c. Stability Studies

Transient stability studies are performed to verify the impact of the connection of new Generating Plants, transmission lines and substations and other changes in transmission circuit configurations on the ability of the Grid to seek a stable operating point following a transient disturbance. This study simulates the outage of critical grid facilities such as major lines and generating units. This study may be performed only when connection of major facilities are done.

Voltage stability studies are performed periodically to determine if the Grid is vulnerable to voltage collapse under heavy loading condition. A voltage collapse can proceed very rapidly if the ability of System's Reactive Power supply to support system voltages is exhausted. The study identifies safe Grid operating

conditions where vulnerability to voltage collapse can be avoided until solutions are implemented.

Steady state oscillatory stability studies are 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.

d. Electromagnetic Transient Studies – Electromagnetic transient studies are performed to determine switching/ temporary over voltages which can affect equipment insulation, the thermal dissipation capacity or the clearing capacity of the protection devices.

2.4.2 However, when directed by EAC, the NTL shall carry out the studies stated in the direction.

2.5 Planning Standards and Procedures

The CTS shall be planned in accordance with the Transmission System planning standard for Cambodia and the system should confirm to the Technical Standards issued by MIME.

2.6 Submission of Planning Data

2.6.1 Any User applying for connection or a modification of an existing connection to the CTS shall submit to the NTL the relevant Standard Planning Data specified in Section 2.9 and the Detailed Planning Data specified in Section 2.10, in accordance with the requirement prescribed in Section 3.5 of Connection Code.

2.6.2 All Users shall submit annually to the NTL by 1st July the Standard Planning Data and Detailed Planning Data indicating the current position and any changes expected in the next seven years.

2.6.3 All Users having a load demand shall submit annually to the NTL by 1st

July the Forecast Demand Data specified in Section 2.8 for each Connection Point for the next seven years.

2.6.4 All SPTL shall submit monthly to the NTL the Historical Demand Data specified in Section 2.7 for each Connection Point, each voltage level at the substation during the previous month by 5th of each month. The NTL shall collect this data relating to the Transmission System under its control.

2.6.5 The NTL shall consolidate and maintain the planning data. The NTL shall collate and process the planning data submitted by the Users into a cohesive forecast and use this in preparing the statement on system available capacity as provided in its license conditions (Chapter 5, Condition 1.2 of license issued to EDC).

2.7 Historical Demand Data

2.7.1 The SPTL shall provide to the NTL the actual monthly Energy, maximum and minimum Demand in MW and corresponding reactive Demand in MVAr during the month for each connection point and each voltage level of the substation under its control. The SPTL shall also provide the NTL with actual hourly load profile for a typical weekday, weekend and holiday.

2.7.2 The NTL shall maintain a database of hourly demand for each separate System in its Control Center.

2.8 Forecast Demand Data

2.8.1 All Users having a load demand shall provide to the NTL with its Energy and Demand Forecast at each Connection Point for the next seven years by 1stJuly each year. The forecast data for the first year shall include monthly Energy and Demand forecasts, with forecasted hourly load profiles for a typical weekday, weekend and holiday. The forecast data for the remaining six years shall include only the annual Energy and Demand forecast. The forecast data shall be the total Energy and Demand requirement at the Connection Point including losses in the User system.

Users having Embedded Generating Plant shall provide the net values of Energy and Demand forecast after deductions to reflect the output of Embedded Generating Plants. Such deductions shall be stated separately in the Forecast Demand Data.

2.8.2 The NTL will use the above information in a reasonable manner and prepare a demand forecast for the next seven years for each Connection

Point, for each voltage level at each substation and for each separate Grid by 31st October each year.

2.9 Standard Planning Data

The User shall provide the electrical diagram of its system and information about each of the facility as stated in this Section.

2.9.1 User System and Connection Point Data

The User shall provide electrical diagram for the User System and Connection Point indicating the arrangement, ratings etc of the following:

a. Equipments such as Generating Units, power transformers, circuit breakers etc;

b. Electric lines and cables

c. Substation bus arrangements

d. Grounding arrangements

e. Switching facilities

f. Phasing arrangements.

2.9.2 Generating Unit Data

The following information shall be provided for each Generating Unit of each Generating Plant including Embedded Generating Plant:

a. Rated capacity (MVA and MW)

b. Rated Voltage (kV)

c. Type of Generating Unit

d. Expected mode(s) of running

e. Direct axis sub-transient reactance (percent).

2.9.3 HV lines and cables

The following information shall be provided for the HV lines and cables from the Connection Point to the User System substation.

a. Rated voltage (kV)

b. Positive sequence resistance and reactance (ohm)

c. Positive sequence shunt susceptance (ohm-1)

d. Zero sequence resistance and reactance (ohm)

e. Zero sequence shunt susceptance (ohm-1)

2.9.4 Power Transformer

The following information shall be provided for the power transformers in the User System.

a. Rated capacity (MVA)

b. Rated voltage ratio (kV)

c. Winding arrangement

d. Positive sequence resistance and reactance at maximum, minimum and normal tap

e. Zero sequence reactance for three-legged core type transformer

f. Tap changer range, step size and type (on-load or off-load)

g. Basic lightning impulse insulation level (kV)

2.9.5 Switchgear

The following information shall be provided 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)

d. Basic lightning impulse insulation level (kV)

2.9.6 System Grounding

The following information shall be provided for the system grounding.

a. Rated capacity

b. Impedances of the grounding equipment

2.9.7 Reactive Power compensation equipment

The following information shall be provided on Reactive Power compensation equipment at the Connection Point and/or at the substation of the User System.

a. Rated capacity (MVAr)

b. Rated Voltage (kV)

c. Type (e.g., shunt inductor, shunt capacitor, static VAr compensator etc)

d. Operation details (e.g., fixed or switched)

e. If switched – control details (automatic or manual)

f. If automatic control – details of setting

g. If it has Black Start capability.

2.10 Detailed Planning Data

2.10.1 Generating Unit Data

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

a. Derated capacity (MW) if applicable

b. Additional capacity (MW) obtainable in excess of declared capacity, if any

c. Minimum Stable Loading (MW)

d. Reactive Power Capability Curve

e. Stator armature resistance

f. Direct axis synchronous, transient and sub-transient reactance

g. Quadrature axis synchronous, transient and sub-transient reactances

h. Turbine and Generating Unit inertia constant (MWsec/MVA)

i. Rated field current (A) at rated MW and MVAr output and at rated terminal voltage

j. Short circuit and open circuit characteristic curves

2.10.2 Data for Excitation Control system of 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 under-excitation limiter.

2.10.3 Data for speed-governing system for each reheat steam Generating Unit

a. High pressure governor average gain (MW/Hz)

b. Speeder motor setting range

c. Speed drop characteristic curve

d. High pressure governor valve time constant

e. High pressure governor valve opening limits

f. High pressure governor valve rate limits

g. Re-heater time constant (Active Energy stored in re-heater)

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

n. A governor block diagram showing the transfer functions of individual elements

2.10.4 Data for speed-governing system for each non-reheat steam, gas turbine, geothermal and hydro Generating Unit

a. Governor average gain

b. Speeder motor setting range

c. Speed drop characteristic curve

d. Time constant of steam or fuel governor valve or water column inertia

e. Governor valve opening limits

f. Time constant of turbine

Chapter 3

CONNECTION CODE

3.1 Introduction

As the CTS is developed, extended and or strengthened, more transmission lines, Generating Plant and load will be connected to the existing system. For safe and efficient operation of the system, the two systems at the Connection Point have to comply with certain technical, design and operational conditions. Connection Code specify the technical, design and operational criteria which must be complied by any User connected to the CTS.

3.2 Objective

The objectives of the Connection Code are:

a. To specify the minimum technical, design and operational criteria

b. To ensure that the basic rules for connection to the CTS or to a User System are fair and non-discriminatory for all Users of the same category

c. To list and collate the data required by the Transmission System Owner/NTL from each category of User and to list the data to be provided by the NTL to each category of User

d. To ensure that any new connection shall not impose any adverse

effects on existing Users, nor shall a new connection suffer adversely due to existing Users.

3.3 Technical, Design and Operational Criteria

3.3.1 CTS Performance Characteristics

The NTL shall ensure that the CTS will comply with the following operational criteria.

a. System Frequency shall be nominally 50 Hz and shall be controlled within the limits of 49.5 Hz – 50.5 Hz unless exceptional circumstances prevail. The System Frequency could fall to 47 Hz or rise to 52 Hz in exceptional circumstances.

b. System Voltage at the Connection Point will normally remain within the operating range stated in the table below unless exceptional conditions prevail.

Nominal Voltage Higher Limit Lower Limit

230 kV 245 kV 207 kV

115 kV 123 kV 103.5 kV

22 kV 24 kV 19.8 kV

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Following major System faults, the maximum over voltage of +15% for the 230 kV system and +20% for the 115 kV system may occur but the duration shall not exceed 15 minutes unless exceptional conditions prevail. Under fault conditions, voltage may collapse transiently to zero at the point of fault until the fault is cleared.

c. The maximum total levels of harmonic voltage distortion and the total demand distortion of the current on CTS at a Connection Point under normal operating conditions and under both planned and unplanned outage conditions (other than for infrequent short duration peaks) shall be:

Harmonic Voltage Distortion

Individual Distortion Voltage Level

(kV)

Total Harmonic

Distortion Odd Even

115-230 2.5% 1.5% 1%

22 3% 2% 1%

Harmonic Current Distortion

Individual Distortion Voltage Level

(kV)

Total Demand

Distortion Odd Even

115-230 2.5% 2% 0.5%

22 5% 4% 1%

The Equipments connected to the CTS should be capable of withstanding the above harmonic distortions.

d. Under normal operating and planned outage conditions, the maximum negative phase sequence component of the phase voltage on CTS shall not exceed 1% other than for infrequent short duration peaks with a maximum value of 2%.

e. The short circuit current level at a point on the CTS shall be below the levels stated below:

40 kA on the 230kV system

31.5 kA on the 115kV system

12.5 kA on the 22kV system

3.3.2 User System General Provisions

a. Equipment Standard

All Equipment at the Connection Point shall comply with the Technical Standards issued by MIME. For standards not provided

in the Technical Standards, the Equipments shall comply with the IEC Standards. All Equipment should be capable of operating Version 0 – 22 – May 22, 2009 Cambodia Grid Code under or protected for the system conditions defined in Section 3.3.1 above.

b. Protection, Communication, Telemetry

The User System should comply with the provisions given in Chapter 10 – Protection Code and Chapter 11 – Metering, Communication and Data Acquisition Code.

c. Harmonics

Users shall ensure that their System shall not cause the harmonics in the CTS to exceed the limits specified in Section 3.3.1(c).

d. Fault rating of equipment

The fault rating of any equipment shall not be less than the fault level in that part of the network at any time over the life of the equipment.

3.3.3 Generating plant

All Generating Units must be capable of supplying rated Active Power output at any point between the limits 0.85 power factor lagging and 0.95 power factor leading at the Generating Unit terminals, unless otherwise agreed by the NTL. The short circuit ratio of the Generating Units shall be not less than 0.5 unless otherwise agreed by the NTL.

A Generating Unit must be capable of continuously supplying its rated Active Power output at the Generating Unit terminals within the System Frequency range 49.5 to 50.5 Hz. Any decrease of Active Power output occurring in the frequency range 49.5 to 47 Hz should not be more than pro rata with frequency.

Design of Generating Unit must ensure continuous operation of the Generating Units for Frequency range of 47.5 to 52 Hz and operation f or a period of 20 seconds each time the frequency is between 47 and 47.5 Hz.

The Active Power output at the Generating Unit terminals under steady state conditions should not be affected by voltage changes in the normal operating range specified in Section 3.3.1.b. The Reactive Power output at the Generating Unit terminals under steady state conditions and at rated Active Power should be fully available within the range ±5% of nominal grid system voltage at the Connection Point.

Each Generating Unit must be capable of contributing to, in a manner satisfactory to the NTL, frequency and voltage control by modulation of Active Power and Reactive Power supplied to the CTS.

Each Generating Unit must be fitted with a fast acting proportional turbine speed governor to provide frequency control under normal operational conditions in accordance with Chapter 6: Frequency and Voltage Management Code. Where a Generating Unit becomes isolated from the rest of the CTS but is still supplying consumers, the speed governor must also be able to control the Frequency between 47.5Hz and 52Hz.

A continuously-acting fast-response automatic excitation control system is required to control the Generating Unit voltage without instability over the entire operating range of the Generating Unit. The control system may be required to include power system stabilizing equipment if required by the NTL.

On-load tap changing facilities are required on Generating Unit transformer for dispatch of Reactive Power. The transformer voltage ratio, tapping range and step sizes must be such that the

reactive requirements specified in Paragraph 4 above of this Subsection are fully complied with.

The higher voltage windings of the Generating Unit transformer connecting a Generating Unit to the CTS at voltages of 115 kV and above shall be star connected with the star point earthed in accordance with IEC standards.

The NTL shall be entitled to acquire such operational metering, control parameter and Equipment data as it reasonably requires for the purposes of managing the CTS.

3.3.4 Distribution Licensees and Consumers connected directly to CTS

a. Under-frequency relays

If required by NTL, the Users with load shall provide suitable under-frequency relays for automatic disconnection of demand blocks of predetermined sizes when the System Frequency falls below predetermined values.

b. Neutral Earthing

The upper voltage winding of the three phase transformers connected to CTS at voltages of 115 kV and above shall be star

 connected with the star point connected to earth as per IEC standards.

3.3.5 Maintenance Standard

All Equipments at the Connection Site shall be operated and maintained in accordance with Prudent Utility 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 Transmission System Owner or the User.

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

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

3.4 Procedure for Connection or Modification of a Connection to the CTS sought by NTL

3.4.1 The NTL, seeking to establish a new connection or modification to an existing connection to the Transmission System, shall first evaluate the impact of the proposed connection or modification to the existing connection. For this, the NTL may carry out some or all of the planning studies, it considers necessary, out of the studies described in Section 2.4. The NTL shall not submit an application for connection or a modification to an existing connection, if the studies show that the proposed connection or a modification to an existing connection will result in the Degradation of the CTS.

3.4.2 If the studies show that the proposed connection or a modification to an existing connection will not result in the Degradation of the CTS, the NTL shall submit the following report, data and undertaking along with an application to the TS Owner:

a. Report stating purpose of proposed connection or modification, details of Connection Point, description of Equipment to be connected or of the modification to the existing Equipment.

b. Construction schedule and target completion date

c. Confirmation that the prospective installation complies with the Technical Standards of Cambodia

3.4.3 Normally, the TS owner shall inform the NTL within 30 days of receipt of the application complete with all information whether the proposed connection or modification is acceptable or not. If the nature of complexity of the proposal is such that the above time limit is not

adequate, the TS owner shall intimate the NTL and EAC about the extent of further time required for intimating the decision.

3.4.4 The intimation of acceptance of the proposal shall include an offer to sign a Connection Agreement or an Amended Connection Agreement within a specified time limit which shall not be less than 60 days. A Connection Agreement shall include, as appropriate, within its term and conditions the following:

a. A condition requiring all parties to comply with the Grid Code

b. Details of connection

c. Commercial arrangements

d. Details of information to be submitted by the NTL prior to the date of commissioning including protection arrangement and settings, Site Responsibility Document and safety rules and test and commissioning schedule

e. Details of any capital related payments

f. Guide lines on protection, communication etc

In case the above provisions are already included in an agreement such as power purchase agreement, supply agreement, transmission/ wheeling agreement, it may not be necessary to sign a separate Connection Agreement.

3.5 Procedure for Connection or Modification of a Connection to the CTS sought by a User other than the NTL

3.5.1 Any User, other than the NTL, seeking to establish a new connection or modification to an existing connection to the Transmission System shall submit the following report, data and undertaking along with an application to the NTL:

a. Report stating purpose of proposed connection or modification, details of Connection Point, description of Equipment to be connected or modification to the existing Equipment.

b. Construction schedule and target completion date

c. Standard Planning Data

d. Confirmation that the prospective installation complies with the Technical Standards of Cambodia

e. All other information as the NTL may reasonably require for evaluating the application.

3.5.2 The NTL shall evaluate the impact on the CTS of the proposed connection or modification to the existing connection. The NTL shall specify if any of the planning studies described in Section 2.4 are required to be carried out afresh to evaluate the impact of the proposed connection or modification to the existing connection. The User shall indicate whether it wishes the NTL to undertake additional technical studies. The User shall bear the cost of all the studies carried out to evaluate the impact. The NTL may disapprove an application for connection or a modification to an existing connection, if the studies show that the proposed connection or a

modification to an existing connection will result in the Degradation of the CTS.

3.5.3 If the studies show that the proposed connection or a modification to an existing connection will not result in the Degradation of the CTS, the NTL shall consult the TS owner on the proposed User Development and work out the details of any and all works required to be carried out by the TS owner and decide if the proposal is acceptable. The NTL in consultation with the TS owner shall work out the capital-related payments, if any, arising from the works to be carried out by the TS owner.

3.5.4 Normally, the NTL shall inform the User within 90 days of receipt of the application complete with all information whether the proposed User Development is acceptable or not. If the nature of complexity of the proposal is such that the above time limit is not adequate, the NTL shall

intimate the User and EAC about the extent of further time required for intimating the decision.

3.5.5 The intimation of acceptance of the proposal shall include an offer to sign a Connection Agreement or an Amended Connection Agreement within a specified time limit which shall not be less than 60 days. If the TS owner is a SPTL and not the NTL, the Connection Agreement shall be a tripartite agreement between the NTL, TS owner and User seeking the User Development. A Connection Agreement shall include, as appropriate, within its term and conditions the following:

a. A condition requiring all parties to comply with the Grid Code

b. Details of connection , technical requirements with specific reference to reactive power compensation, operation of Generating Units, if any, and commercial arrangements

c. Time limit for submission of Detailed Planning Data

d. Details of information to be submitted by the User prior to the date of commissioning including additional equipment data, protection arrangement and settings, information required to prepare the Site Responsibility Document and safety rules and test and commissioning procedures

e. Details of any capital related payments

f. Guide lines on protection, communication etc

3.6 Site Responsibility Document

3.6.1 A Connection Site may be owned either by the TS owner or a User seeking connection to the CTS. For every connection to the CTS a Site Responsibility Document shall be prepared and issued by the TS owner at least two weeks before the date of commissioning of the connection. The Site Responsibility Document shall state the following for each equipment installed at the Connection Site:

a. The ownership of equipment

b. The responsibility of control equipment

c. The responsibility for maintenance of the equipment

d. The responsibility for operation of equipment

e. The manager of the site

f. The responsibility for all matters relating to persons at site.

The User shall provide the information that will enable the TS owner to prepare the Site Responsibility Document.

The Site Responsibility Document shall be a part of the Connection Agreement.

3.6.2 The owner of the Connection Site shall provide reasonable access and other required facilities to the User whose equipments are installed or are to be installed at the Connection Site for installation, operation, and maintenance etc of these equipments.

Chapter 4

OUTAGE PLANNING CODE

4.1 Introduction

In the process of power supply, all equipment put in operation in the power system needs to be taken out of service for some time for checking, maintenance, and repair. Outage Planning is concerned with the co-ordination of the release of the Generating Units, External Interconnections and Transmission System for construction, repair and maintenance purposes.

4.2 Objective

The objective of Outage Planning is to define the process, which will allow harmonizing the outages of all Generating Units, Generating Plants, External Interconnections and the CTS while maintaining system security to the extent possible.

4.3 Outage Planning Process

4.3.1 Users, having generation and/or transmission, shall provide the NTL with their provisional Outage Plan for the next year by 1st July each year. The following information shall be included in the provisional Outage Plan:

a. Identification of the equipment and MW capacity involved

b. Reasons for the proposed outage

c. Expected duration of the outage

d. Preferred start date for the outage

e. If there is flexibility in dates, the earliest start date and the latest completion date.

4.3.2 In preparing the Outage Plan, the NTL shall endeavor to accommodate the User's request for the dates, while taking into account the requirements of:

a. Demand Forecast

b. The needed cold reserve (back-up reserve)

c. Available generation capacity and exchange of power with other systems

d. Forecast of hydrological reliability

e. System Security, to the extent possible

4.3.3 The NTL shall produce a coordinated generation and transmission Outage Plan and shall provide the User a copy of the User's approved Outage Plan by 30th September each year.

4.3.4 If the User is not satisfied with the Outage Plan allocated to its Equipment, it shall notify the NTL by 10th October explaining its concerns and

 proposing changes to the Outage Plan. The NTL and User shall discuss and resolve the problem. The Outage Plan shall be revised by the NTL based on the resolution of the User's concerns before 20th October each year.

4.3.5 If the Outage Plan is likely to affect the supply to a User connected to and receiving supply from the CTS, the NTL will intimate each relevant User

by 20th

October each year about the probable period and the manner in which the supply of electricity to the User is likely to be affected during next year. The relevant User may use the information to develop the Outage Plan of its System. It may be noted that the actual period and the manner in which the supply is affected may change during implementation of the Outage Plan.

4.4 Release of Equipments included in the Outage Plan for maintenance

Notwithstanding provision in any approved Outage plan, no transmission circuit or Generating Unit shall be removed from service by the User without specific release from the Control Center.

Once an Outage has commenced, if any delay in restoration is apprehended, the Control Center or User concerned shall inform the other party promptly together with revised estimation of restoration time.

Chapter 5

SCHEDULING AND DISPATCH CODE

5.1 Introduction

This Chapter specifies the procedure to be adopted for the scheduling and dispatch of Generating Units to meet demand and to achieve an economic operation while maintaining power quality, stability and the stability and security of the CTS.

5.2 Objective

The objectives of Scheduling and Dispatch are:

a. To define the operational criteria for the preparation of the Generation Schedule and issuance of Dispatch Instructions

b. To specify the process and requirements for preparation of the Generation Schedule

c. To specify the Central Dispatch process.

5.3 Scheduling and Dispatch Principles

5.3.1 Operating Margin

The Operating Margin 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. The Frequency Regulating Reserve and Contingency Reserve shall be allocated to strategically located Generating Plants to keep the frequency within limits.

However, when a major portion of the demand is met from imports from other systems, the capacity of the Operating Margin to be provided from generating capacity connected to CTS may be decided by the Control Center depending on the real situation.

5.3.2 Scheduling and Dispatch Criteria

The Control Center shall endeavor to 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 Demand and the required Frequency Regulating Reserve and Contingency Reserve to ensure the Security and Reliability of the CTS

b. The availability of Generating Units at strategic locations so that the CTS 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 CTS and the Generating Units

d. The Security and Stability of the CTS

The Control Center shall take into account the following factors in preparing the Generation Schedule:

a. The registered parameters of the Generating Units

b. The availability from External Interconnections

c. The requirement of Reactive Power for voltage control

d. The need to provide an Operating Margin for frequency control

e. The availability of Ancillary Services

f. Bilateral contracts between Generation Licensees and Users

g. Merit Order Dispatch

The Control Center shall take into account the following factors in Dispatching Generating Units:

a. The Generation Schedule

b. The Demand from the Users

c. Transmission System restraints

d. System Loss

e. The requirement for Ancillary Services

f. Merit Order Dispatch

5.4 Scheduling and Dispatch Data

5.4.1 Generation Licensees

All Generation Licensees connected directly to CTS and Generation Licensee operating Embedded Generating Plant subject to Central Dispatch shall provide the hourly MW and MVAr availability of all Generating Units for the next day (00.00 – 24.00 hours) to the Control Center by 10.00 hrs on each day.

In working out the MW and MVAr availability, the Generation Licensees operating Hydro Generating Units shall take into account their respective reservoir levels and any other restrictions and shall report the reservoir level and restrictions to the Control Center.

The User having Embedded Generating Plant not subject to Central Dispatch connected to its system shall provide the hourly MW and MVAr net

injection to the transmission system for the next day (00.00 – 24.00 hours) to the Control Center by 10.00 hrs on each day.

The Generation Licensees shall, without delay, notify the Control Center of any change in the declared availability.

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5.4.2 External Interconnectors

External Interconnectors shall provide the hourly MW and MVAr export and import or agreed availability for the next day to the Control Center by 10.00 hrs on each day.

In the event of no intimation from an External Interconnector, the Control Center shall make an estimate of the export and import.

5.4.3 Other Users

In addition to its Demand Forecast as provided in Section 2.8, all Users having a load demand shall notify the Control Center, without delay, of any constraints or development on the User System which may have substantial effect on its Demand along with its likely duration, which the Control Center needs to take into account in Scheduling and Dispatch.

5.5 Scheduling and Dispatch Procedure

5.5.1 The Control Center shall prepare a cohesive forecast of hourly System Demand, which shall include the System Loss.

5.5.2 The Control Center shall prepare a Merit Order Table considering the incremental cost of Generation/Import according to the PPAs. If the price for any Generating Plant/source is different for different blocks of time during the day, the Merit Order Table shall be prepared for each such blocks of time so that the correct Merit Order is reflected in the Table. In the event two or more Generating Units having the same price, the Generating Unit that will result in a smaller System loss will be given higher merit.

5.5.3 All Generation Licensees including the licensees operating Embedded Generating Plants under Central Dispatch and External Interconnectors shall provide the hourly MW and MVAr availability as provided in Section 5.4.

5.5.4 The Control Center shall use the Merit Order Table to match the hourly demand requirement with the available capacity of Generating Plant in developing the Generation Schedule for the next day. In deciding the Generation Schedule, the Control Center shall also take into consideration the following factors:

a. Transmission constraint from time to time

b. The need to provide operating margins and reserves required to be maintained

c. Minimum Stable Loading of Generating Units (Technical limits of operation of Generating Units)

d. Scheduled daily water usage of hydroelectric Generating Plants

e. Overall economy for the cost of power

If the available capacity is not sufficient to meet the demand forecast and reserves, discreet load blocks equal to the amount of shortfall in capacity shall be identified for load shedding and the affected Users should be intimated about the identification and amount of load and duration of the load shedding.

The Generation Schedule shall indicate the hourly output of each Generating Unit/Plant and hourly injection by Embedded Generating Plant/ External Interconnectors for the next day. It shall also indicate the Generating Units that are providing specific Ancillary Services. The generation Schedule for the next day shall be issued by the Control Centre normally by 16:00 hours.

5.5.5 The Dispatch Instruction may be issued at any time after issue of the Generation Schedule. If required, a Dispatch Instruction may be issued even before issue of the Generation Schedule for the next day.

5.5.6 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. Start and synchronizing time of Generating Units

d. Desynchronizing or shutdown time of Generating Units

e. The Dispatch Instruction issuance time.

The Dispatch Instruction shall be recorded in a log book or other means of recording.

The Control Center shall issue the Dispatch Instruction to a Generation Licensee through an appropriate means of communication. Written confirmation shall be issued promptly for all oral instructions through appropriate means of communication.

5.5.7 The Dispatch Instruction shall remain valid unless superceded by another Dispatch Instruction. The Control Center can revise a dispatch instruction any time as required.

5.6 Response of Users to Dispatch Instructions

The User shall acknowledge immediately and comply with the Dispatch Instruction including oral instructions.

In the event there is any problem in carrying out the Dispatch Instruction, the User shall notify the Control Center without delay.

Chapter 6

FREQUENCY AND VOLTAGE MANAGEMENT CODE

6.1 Introduction

This Chapter describes the method by which all Users of the CTS shall co-operate with the Control Centre in contributing towards effective control of the system frequency and managing the voltage of the CTS.

6.2 Objective

In order to maintain the security and integrity of the CTS, to avoid damage to the CTS and to User Equipment, and to maintain Voltages at User Connection Points within the limits specified in the Connection Code, it is necessary that the Control Center operates the Transmission System, Dispatches and manages Voltages in such a manner as to achieve operation within applicable Frequency and Voltage limits at all times. The objective of this chapter is to define the actions required to enable the Control Center to maintain Cambodia Transmission System frequency and voltages within acceptable levels.

6.3 Methods of Frequency control

System Frequency is a continuously changing variable that is determined and controlled by the balance between System Demand and total energy available. If Demand is greater than generation, the Frequency falls while if generation is greater than Demand, the Frequency rises. The immediate second-by-second balancing (fine tuning) is provided by generating units through automatic control systems (such as governor action) in conjunction with the Operating Margin. The automatic control systems continuously modulate the outputs of the Generating Unit to provide corrective damping to the many System Frequency variations. Sometimes there may be a sudden and significant mismatch between Demand and Generation which may be caused by tripping of transmission line or Generating Unit or rapid change in Demand. A sudden reduction in generation will cause the System Frequency to fall rapidly and sufficiently such that it crosses the pre-set levels of the low-frequency relays. The low-frequency relays operate to provide coarse automatic energy balancing by Demand reduction and/or increase in generation. The governor action together with the action of the low-frequency relay will provide the corrective action to restore the frequency to normal level. When these actions are not sufficient Control Center shall issue instructions to achieve manual Demand reduction and/or increase in generation. For rapid and sufficient increase in System Frequency, the Control Center shall issue

instructions to reduce generation. The Control Center shall restore the Operating Margins as soon as possible.

6.4 Requirements of Generating Unit Governor system

6.4.1 Other than as permitted in accordance with Section

6.4.2, Generation

Units when synchronized to the CTS shall operate at all times under the control of a governor control system (or frequency control device). No time delays other than those necessarily inherent in the design of the governor control system shall be introduced. The design, implementation and operation of the governor control system shall be agreed with the NTL prior to the commissioning of the Generating Unit.

6.4.2 The provisions of Section 6.4.1 may be contravened where:

a. The action is essential for the safety of personnel and/or to avoid damage to Equipment, in which case the Generation Licensee shall inform the Control Center of the restriction without delay; or

b. In order to (acting in accordance with Good Industry Practice) secure the reliability of the Generation Unit; or

c. The restriction is agreed by the Control Center in advance; or

d. The restriction is in accordance with a Dispatch Instruction given by the Control Center.

6.5 Load Reduction

In the event sufficient generation capacity is not available to match the load, it will be necessary to reduce the load to maintain the balance. The load reduction may be done automatically through operation of Under-frequency relays or may be done manually on instruction from Control Center. The automatic load reduction scheme may be implemented by the User with load or can be provided by the transmission system owner on the main Subtransmission feeders to reduce the load as a single block.

6.6 Methods of Voltage control

The strategies used for Voltage control include:

a. Transformer tap-changing, reactor and capacitor switching, and other control methods which involve utilization of Transmission System Equipment only;

b. Tap-changing on Generating Unit Transformers;

c. Demand power factor correction;

d. Utilization of Generating Unit Reactive Power capability, both by means of AVR control and also MVAr Dispatch Instructions issued by the Control Center to Generation Licensees.

6.7 Requirements of Demand Power Factor correction and Capacitor Switching

6.7.1 Demand power factor correction

The reactive power compensation should be provided near the load so that the load at the load bus is close to unity power factor and the reactive capacity of Generating Units is available to meet the VAr requirements Version 0 – 36 – May 22, 2009 Cambodia Grid Code during a contingency. Hence where possible, the reactive power compensation may be provided near the load.

6.7.2 Capacitor switching

Reactive compensation at the substations should be provided, as far as possible, on the medium voltage system with a view to meeting the reactive power requirements closer to the load and to avoid the need for VAr transfer from high voltage system to the medium voltage system.

6.8 Requirements of Generation Unit AVR control

6.8.1 The excitation system of each Generation Unit shall normally be operated under the control of a continuously acting AVR, which shall be set so as to maintain a constant terminal voltage. The Generation Licensee may not disable or restrict the operation of the AVR except in accordance with Section 6.8.2, in which event the Generation Licensee shall notify the Control Center without delay.

6.8.2 The Generation Licensee may only disable or restrict AVR action where:

a. The action is essential for the safety of personnel and/or Equipment;

b. In order to (acting in accordance with Prudent Utility Practice), secure the reliability of the Generation Unit;

c. The restriction is agreed between the Control Center and the Generation Licensee in advance.

6.8.3 The Control Center shall, by means of Dispatch Instructions, instruct Generation Licensees to adjust the Reactive Power output of Generating Units.

6.8.4 Other facilities which shall be utilized by the Control Center, where appropriate, in order to exercise Voltage Control shall include:

a. Switching in or out of dedicated Voltage Control facilities, such as capacitor banks and reactors;

b. Tap-changing on 230/115 kV Transmission System transformers;

c. Switching out of transmission lines in order to reduce the capacitive contribution of the CTS.

Chapter 7

CONTINGENCY PLANNING CODE

7.1 Introduction

In the operation of a transmission system, there will be emergency situations when security of the transmission system is subject to abnormal levels of risk. Such emergency situations may arise due to natural disasters, civil disturbance, severe weather conditions, mal-operation of protection system or other unplanned events and may cause disruption of electric supply. Experience has shown that electricity supply systems can suffer partial or total shutdown. For quick and safe recovery of the supply system, comprehensive restoration plans should be in place.

7.2 Objective

The objective of this Chapter is to ensure that in the event of a Partial Shutdown or Total Shutdown of the CTS, normal supply is restored to all consumers as quickly and as safely as practicable.

This objective can be subdivided:

a. To outline the general restoration strategy which will be adopted by the Control Center in the event of a Partial or Total Shutdown of the CTS;

b. To establish the responsibility of the Control Center to produce and maintain a comprehensive Power System Restoration Plan, covering both Partial and Total Shutdowns;

c. To establish the responsibility of Users to co-operate with the formation and execution of the Power System Restoration Plan,

d. To ensure that the Control Center and User personnel who will potentially be involved with the Power System Restoration Plan, should be adequately trained and fully familiar with the relevant details of the plan.

7.3 Generating Units with Black Start capability

The NTL shall establish the capacity and strategic location of the Generating Units capable of providing Black Start services and shall ensure that such Generating Units are installed and maintained to be used for restoration of the System after a Total or Partial Shutdown.

The Control Center shall ensure that Generating Units providing Black Start services are periodically tested to ensure that the generating units are in working order, can be loaded to rated capacity and will be able to provide the required power to restore the System after a Total or Partial Shut Down

7.4 Restoration Strategy

The situation prevailing prior to the occurrence of the contingency, e.g. availability of specific Generating Units, transmission circuits and load demands, will largely determine the restorations process to be adopted in the event of a total

shutdown. Control Center shall advise all Users of the situation and follow the strategy as outlined below for restoration.

User's persons authorized for operation and control of User System shall be available at User's end for communication and acceptance of all operational communications throughout the contingency. Communication channels shall be restricted to operational communications only till normalcy is restored.

The Control Center shall instruct all relevant Generation Licensees having Generating Plants with Black Start capability to commence their pre-planned Black Start procedure. Supply shall be extended to Grid substations and Generating Plants requiring start-up power. Control Center may require licensees with Embedded Generating Units to extend start-up power supply to Generating Plants as may be feasible.

The Control Center shall prepare the CTS for restoration by creating discrete power islands with no interconnection. Close co-ordination with concerned Users with load shall be maintained during the restoration process to arrange for discrete demand blocks becoming available to stabilize Generating Units, as these become available in individual islands. Generating Plants to whom start up power supply is made available shall sequence their start up to match their auxiliary power demand with supply available.

Generation Licensees shall inform Control Center as Generating Units become available to take load, in order that the Control Center may assess the MW demand which the Generating Unit is likely to pick up on circuit breaker closure.

The control Center shall co-ordinate with Generation Licensees and Users with load to:

a. Form discrete power islands with one Generating Unit feeding some local demand.

b. Extend islands by adding more Generating Units and more demand in a coordinated manner, maintaining load generation balance.

c. Synchronize islands to form a larger, more stable island.

The Control Center shall, taking into account sites where system synchronizers are available, gradually extend the synchronization until all demand is restored.

The Control Center shall utilize any assistance available from External Inter-connectors, if appropriate, at any time to assist in the above process.

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In case of a Partial Shutdown, the Control Center shall ensure with Users that security of the healthy part of the CTS is maintained.

The Control Center shall gradually extend the healthy system to provide start-up power to appropriate Generating Units.

The Control Center with close co-ordination with Users with load and Generation Licensees shall gradually restore demand to match generation as it becomes available.

All Users shall take care to ensure load generation balance is maintained at all times under the direction of Control Center.

7.5 Restoration Plan

The Power System Restoration Plan for Total Shutdown and Partial Shutdown will be developed and maintained by the Control Center in consultation with the Users as appropriate. A set of basic restoration scenarios will be developed. The procedure for Power System Restoration shall be that notified by the Control Center to the User at the time of a Partial or Total Shutdown. Each User shall abide by the instructions of the Control Center during the restoration process, subject to safety of personnel and of the Equipment.

It shall be the responsibility of the User to ensure that any of its personnel who may reasonably be expected to be involved in Power System Restoration are familiar with, and are adequately trained and experienced in their standing instructions and other obligations so as to be able to implement the procedures and comply with any procedures notified by the Control Center.

7.6 Responsibilities

The Control Center shall maintain a record of Generating Plant Black Start capability and associated Black Start plans.

The Control Center shall be responsible for directing the restoration process by co-ordination with all Users.

Users with load shall be responsible for sectionalizing the Subtransmission/ Distribution System into discrete, unconnected blocks of demand. They shall advise the Control Center of the amount of MW likely to be picked up by the synchronizing Generating Units.

Generation Licensees shall be responsible for commencing their planned Black Start procedure on the instruction of Control Center and for steadily increasing

their generation according to the demand which the Control Center is able to make available.

7.7 Special considerations

During the restoration process following Partial or Total Shutdown, normal standards of voltage and frequency shall not apply.

All Users shall pay special attention in carrying out the procedures so that secondary collapse due to undue haste or in-appropriate loading is avoided.

Despite the urgency of the situation, careful, prompt and complete logging of all operations and operational messages shall be ensured by all Users to facilitate subsequent investigation into the incident and the efficiency of the restoration process. Such investigation shall be conducted promptly after the incident.

Chapter 8

SAFETY COORDINATION CODE

8.1 Introduction

In order to adequately maintain and repair the Transmission System Equipment it will be necessary for the Transmission System Owner and/or its agents to work on or in close proximity to Transmission System Equipment, or in close proximity to User's Equipment.

For repair and maintenance of its equipments, Users and/or their agents will similarly need to work on or in close proximity to User's Equipment which is connected to, or capable of being connected to, in an approved manner, the Transmission System, and from time to time to work in close proximity to Transmission System Equipment.

It will also be necessary to facilitate work by third parties in close proximity to Transmission System Equipment.

Safety coordination between Transmission System Owners, Users and third parties will be required to perform the above stated works with full safety.

8.2 Objective

The objective of this Chapter is to ensure that the Transmission System Owner, Users and their respective agents operate in accordance with approved safety rules, which ensure the safety of personnel working on or in close proximity to Transmission System Equipment or User's Equipment at the Connection Site. This will normally involve deenergizing electrical Equipment and suitably isolating / disconnecting (from all sources of Energy) and Earthing that Equipment such that it cannot be made live.

8.3 Control Persons

All Users shall nominate suitably authorized persons suitably authorized to be responsible for the co-ordination of safety at each Connection Site. These persons shall be referred to as Control Persons. Normally the person in charge of operations of equipments at the Connection Site during each shift of operation may be nominated as Control Persons. Where operating persons are not working in shifts, suitable responsible persons (if required more than one) who are in charge of operations of equipments at the Connection Site and available for coordination may be nominated as Control Persons. All Users shall issue a list of Control Persons (names, designations and telephone numbers) to all Users who have a direct control boundary at the User's Connection Point. This list shall be

updated promptly whenever there is change of name, designation or telephone number.

8.4 Procedure

Whenever work at a Connection Site is to be carried out, the Control Person, of the User, wishing to carry out work shall directly contact the other relevant Control Person. Code words (passwords to ensure that the interaction relating to the operations is with an authorized person) will be agreed at the time of work to ensure correct identification of both parties.

Contact between the Control Persons shall normally be by direct telephone.

Should the work extend over more than one shift, the Control Person shall ensure that the relief Control Person is fully briefed on the nature of the work and on the code words in operation.

The Control Persons shall co-operate to establish and maintain the precautions necessary for the required work to be carried out in a safe manner. The precautions to be taken may be according to a safety procedure in force or as agreed between the parties and may include display of caution signs, use of locking arrangements, providing connections to the earth system etc. Both the established isolation and the established earth shall be locked in position, where such facilities exist, and shall be clearly identified.

Work shall not commence until the Control Person, of the User, wishing to carry out the work, is satisfied that all the safety precautions have been established. This Control Person shall issue agreed safety documentation to the working party to allow work to commence.

When work is completed and safety precautions are no longer required, the Control Person who has been responsible for the work being carried out shall make direct contact with the other Control Person to request removal of those safety precautions.

The equipment shall only be considered as suitable for return to service when all safety precautions are confirmed as removed, by direct communication using code

word contact between the two Control Persons, and return of agreed safety documentation from the working party has taken place.

Any dispute concerning Safety Coordination shall be resolved at an appropriate higher level of authority of both parties.

8.5 Special Considerations

For work at Connection Site all Users shall comply with the agreed safety rules.

All equipment on Connection Site which may be used for the purpose of safety

co-ordination and establishment of isolation and earthing, shall be permanently and clearly marked with an identification number or name, that number or name being unique on that Connection Site. This equipment shall be regularly inspected and maintained in accordance with manufacturer's specification.

Each Control Person shall maintain a legibly written safety log, in chronological order, of all operations and messages relating to safety co-ordination sent and received by him. All safety logs shall be retained for a period of not less than 2 years.

Chapter 9

CODE ON REPORTING OF EVENT AND ACCIDENT

9.1 Introduction

This Chapter sets out the requirements for the reporting of Events on the CTS or User's System which have had an Operational Effect,

a. on the CTS – in the case of an Event occurring on the System of a User or Users; and

b. on the System of a User or Users – in the case of an Event occurring on the CTS.

This Chapter also sets out the requirements for reporting Accidents on the CTS.

9.2 Objective

The objective of this Chapter is to provide for the exchange of information so that the implications of an Event can be considered, possible risks arising from it can

be assessed and appropriate action taken by the relevant party in order to assist in maintaining the integrity of the CTS.

9.3 Reportable Events

Typical examples of reportable incidents that could affect the Transmission System are the following:

a. Exceptionally high/low system voltage or frequency.

b. Serious equipment problem, e.g. transmission circuit, transformer or bus-bar.

c. Tripping of Generating Unit.

d. System split, Transmission System breakaway or Black Start.

e. Major fire incidents.

f. Failure of protection.

g. Equipment and transmission line overload.

h. Minor equipment alarms.

The last two reportable incidents are typical examples of those, which are of lesser consequence, but which still affect the Transmission System and can be reasonably classed as minor. They will require corrective action but may not warrant management reporting until a later, more reasonable time.

9.4 Reporting Procedure

9.4.1 All reportable events occurring in lines and equipment of 22 kV and above at grid substations and Generating Plants shall promptly be reported orally by the User whose equipment has experienced the incident (The Reporting User) to any other significantly affected Users and to the Control Center.

9.4.2 If the reporting event cannot be classed as minor, then within 1 (one) hour of being informed by the Reporting User, Control Center may ask for a written report on any incident.

9.4.3 The Reporting User shall submit an initial written report within two hours of asking for a written report by Control Center. This has to be further followed up by the submission of a comprehensive report within 48 hours

of the submission of the initial written report.

In other cases the Reporting User shall submit a report within 5 (five) working days to Control Center.

9.4.4 Control Center may call for a report from any User on any reportable incident affecting other Users and the Transmission System Owner; in case the same is not reported by such User whose equipment might have been source of the reportable incident.

9.4.5 The format of such a report will be as agreed at the Grid Code Review Panel, but will typically contain the following information:

a. Location of incident.

b. Date and time of incident.

c. Equipment involved.

d. Supplies interrupted and duration, if applicable.

e. Amount of generation lost, if applicable.

f. Brief description of incident.

g. Estimate of time to return to service.

h. Name of originator.

9.5 Major Failure

Following a major failure, the NTL and other Users shall co-operate to inquire and establish the cause of such failure and produce appropriate recommendations. The NTL shall report the major failure to EAC immediately for information and shall submit the enquiry report to EAC within 2(two) months of the incident.

9.6 Accident Reporting

In both fatal and non-fatal accidents, the User, whose equipment is involved in the accident, shall furnish a report to EAC in the prescribed form. The report on fatal accident shall be furnished to EAC within 3 working days and the report on non-fatal accident shall be furnished to EAC within 10 working days.

Chapter 10

PROTECTION CODE

10.1 Introduction

The transmission system in Cambodia will consist of transmission systems owned and operated by more than one transmission licensee. It is expected to be connected with the transmission system of neighboring countries also. The Generating Plants connected to the system are/ will be owned by more than one licensee. In order to safeguard the transmission system as well as a Users system from faults, which may occur on another User's system, it is essential that certain minimum standards of protection are adopted. The settings of the protection system should remain properly coordinated at all times to ensure speedy isolation of faulty equipment.

10.2 Objective

The objective of this Chapter is to define the minimum protection requirements for any equipment connected to the CTS and thereby minimize disruptions due to faults.

10.3 General Principles

No item of electrical equipment shall be allowed to remain connected to the CTS unless it is covered by appropriate protection aimed at reliability, selectivity, speed and sensitivity.

All Users shall co-operate with the NTL to ensure correct and appropriate settings of protection to achieve effective, discriminatory removal of faulty equipment within the maximum time for fault clearance specified in Section 10.5.

Protection settings shall not be altered, or protection bypassed and/or disconnected without consultation and agreement of the NTL and all affected Users. In the case where protection is bypassed and / or disconnected, by agreement, then the cause must be rectified and the protection restored to normal condition as quickly as possible. If agreement has not been reached the electrical equipment will be removed from service forthwith.

10.4 Protection Coordination

The NTL shall be responsible for arranging periodical meetings between all Users to discuss coordination of protection including coordination of relay settings. The NTL may arrange separate meetings for the Users of each separate system, if the CTS consist of more than one separate system. The NTL shall investigate any mal-function of protection or other unsatisfactory protection issues. Users shall Version 0 – 47 – May 22, 2009 Cambodia Grid Code take prompt action to correct any protection mal-function or issue as discussed and agreed to in these periodical meetings.

10.5 Maximum Time for Fault Clearance

From a stability consideration, the maximum time for clearance of faults (from fault inception to circuit breaker arc extinction) by primary protection on any User's system directly connected to the CTS, or faults on the CTS itself, for different system voltages shall be as follows:

a. 230 kV 100 milliseconds

b. 115 kV 140 milliseconds

Slower fault clearance times for faults on a User's system may be agreed to, but only if, in the opinion of the NTL, system conditions allow this.

The maximum time for clearance of faults by back up protection, on failure of the primary protection, shall be 300 milliseconds.

10.6 Protection Requirements

10.6.1 Generating Plant

All Generating Units and all associated electrical equipment of the Generating Plant connected to the CTS shall be protected by adequate protection so that the CTS do not suffer due to any disturbance originating from the Generating Unit.

Apart from other suitable protection, the Generating Unit shall have loss of excitation protection, over/under frequency protection.

10.6.2 Transmission Line

Every High Voltage line taking off from a Generating Plant or a substation shall have protection consisting of at least a primary protection scheme and a back up protection scheme. The recommended protection schemes for lines of different voltages are stated below. The Transmission Line owner may provide different protection scheme than stated below only in consultation with and approval of the NTL.

230 kV lines – Primary Protection – Current differential protection relay in conjunction with optical fiber communication from the transmission line.

Back up Protection – Three or more zone distance protection with phase fault and earth fault measuring elements and with permissive inter trip for accelerating tripping at remote end in case of zone-2 fault. Reclosing

provision shall be high speed first shot for single phase and three phase re-closing and further delayed multiple shot three phase re-closing.

115 kV lines – Three or more zone static distance protection with permissive inter-trip for accelerating tripping at remote end in case of a zone-2 fault shall be provided as primary protection. The backup protection will be directional three poles over current and earth fault protection.

10.6.3 Subtransmission Line

All 22 kV lines at Connection Point shall be provided with a minimum of over-current and earth fault protection. Parallel feeders or ring feeders shall be provided with directional time lag over-current and earth fault relays. Other feeders may be provided with non-directional time lag over-current and earth fault relay with suitable settings to obtain discrimination between adjacent relay stations. For long feeders, the relay should incorporate a high set instantaneous element.

10.6.4 Transformers (230/115 kV, 230/22 kV and 115/22 kV)

All windings of HV/HV and HV/MV power transformers shall be protected by differential relays and REF relays. In addition there shall be back up time

lag over current and earth fault protection. For transformers operating in parallel, such back up protection shall have directional feature. For protection against heavy short circuits, the over current relays should incorporate a high set instantaneous element. In addition to electrical protection, gas operated relays, winding temperature protection and oil temperature protection shall be provided.

10.6.5 Substation Bus-bar and Fire Protection

All Users shall provide adequate bus zone protection for substation busbars in 230 kV substations.

Adequate precautions shall be taken and protection shall be provided against fire hazards to all Equipment of the Users.

Chapter 11

METERING, COMMUNICATION AND DATA ACQUISITION CODE

11.1 Introduction

It is necessary that adequate communication facilities and procedures are established between the Control Center and Users to allow the timely transfer of information, in order that the Control Center may fulfill its obligations with regard to the operation of the CTS. In Cambodia, if there is more than one Control Center, the communication has to be between the Users and respective Control Center which controls the operation relating to the User.

11.2 Objective

The objective of this Section is to define the minimum acceptable metering, communication and data acquisition requirements to enable the Control Center to manage the CTS in a safe and economic manner.

11.3 Metering

The Meter and metering equipment shall confirm to the provisions of Technical standards issued by MIME. The Commercial Metering shall be provided and operated as per the provisions of the respective agreements. Suitable additional metering shall be provided to measure operational data.

11.4 Contact Location

11.4.1 Control Center – The contact location for Control Center for communication on matters pertaining to the real-time operation of the CTS shall be the Control Center located at Phnom Penh or the Regional Control Center of the region as notified to each User by the NTL. The NTL will, from time to time, notify to Users the contact location for the relevant Control Center and any changes to such contact locations, and the User shall, as required, contact the relevant notified Control Center.

11.4.2 Generation Licensees – The Generating Plant contact location and personnel shall be notified by the Generation Licensee to the relevant Control Center prior to connection and thereafter updated as appropriate. The Generation Licensee is required to provide a control facility staffed at appropriate staffing levels at all times for each Generating Plant.

11.4.3 External Inter-connector – The External Inter-connector contact location, which may be its control center, shall be notified by the external Inter-connector to the Control Center.

11.4.4 Transmission Licensees with HV system – The NTL and Special Purpose Transmission Licensees shall notify their attended HV Substations as contact location to the Control Center.

11.4.5 Users with load – The NTL and Special Purpose Transmission Licensees with MV Subtransmission system connected directly with CTS, Distribution Licensees and Consumers connected directly with CTS are required to provide the Control Center with the contact information of a Responsible Operator(s) who shall respond to communications from the Control Center without undue delay.

11.5 Communication Facilities

The minimum communications facilities which are to be installed and maintained between the Control Center and the User are described below:

11.5.1 Supervisory control and Data Acquisition (SCADA)

All equipments for SCADA provided by the Users shall comply with International Electrotechnical Commission (IEC) Standards for SCADA and Communications Equipment and shall meet such standards notified by the Control Center, acting reasonably, in advance of their design and procurement.

SCADA remote terminal unit (RTU) shall be required at the User Site for the transmission of signals and indications to and from the Control Center. Interface cabinets shall be installed in the User's Equipment room if required. The Transmission System owner shall provide the cables to interconnect User's interface cable with the Control Center. The provision and maintenance of wiring and signaling from the User's Equipment to the User's interface cable shall be the responsibility of the User.

The signals and indications which must be provided by Users for transmission by SCADA equipment to the Control Center are the signals and indications as the Control Center may from time to time by notice to Users reasonably require. (The information will be required from Generating Plants, substations and HV consumers). The information from Generating Plant may include switch gear positions, Unit voltage, MW-MVAr generation, unit transformer tap position, Equipment voltage, MW-MVAr generation, from substations may include switch gear positions, HV/LV voltage, MW-MVAr flow in HV feeders and MV feeders, frequency etc)

11.5.2 Telephone and Facsimile

Each User (generating plant and substation and HV consumer) shall be responsible for the provision and maintenance of no fewer than one telephone and one facsimile unit on separate lines that shall be reserved for operational purposes only, and shall be continuously attended to and answered without undue delay.

11.5.3 Electronic Mail

The Users shall provide the Control Center with the electronic mailing address of the contact person as defined in this Chapter and vice versa. The provider of this service shall be selected to meet the real-time operational requirements of the Control Center.

Chapter 12

GLOSSARY AND DEFINITIONS

12.1 Definitions

In the Grid Code the following words and expressions shall, unless the subject matter or context otherwise requires or is inconsistent therewith, bear the following meanings:

Active Energy The electrical energy produced, flowing or supplied by an electric circuit during a time interval, being the integral with respect to time of the instantaneous active power, measured in units of watt-hours (Wh) or standard multiples thereof, i.e. :

1000 Wh = 1 Kilo Watt-hour (kWh)

1000 kWh = 1 Mega Watt-hour (MWh)

1000 MWh = 1 Giga Watt-hour (GWh)

1000 GWh = 1 Tera Watt-hour (TWh)

Active Power The product of voltage and in-phase component of alternating current measured in units of Watts or standard multiples thereof.

Amended Connection Agreement

An agreement between a User and NTL (or User, NTL and SPTL) which specifies the terms and conditions relating to the renovation or modification of the User System or Equipment at an existing connection point on the CTS

Ancillary Service Support services such as Frequency Regulating Reserve and Contingency Reserve, 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 CTS

Automatic Voltage Regulator (AVR)
A continuously acting automatic excitation control system so as to maintain a Generating Unit's terminal at a desired set-point

Black Start The procedure necessary for a recovery from a Total Shutdown or Partial Shutdown

Cambodia Transmission System (CTS)
Each of the interconnected Transmission System owned or operated by the National Transmission Licensee and/or Special Purpose Transmission Licensees in Cambodia taken individually and collectively.

Central Dispatch The process of scheduling and issuing Dispatch Instruction in relation to Generating Units direct to a Generating Plant by the Control Center pursuant to the Grid Code

Commercial Metering The metering, based on whose meter readings the bills are raised for the service provided in accordance with the respective agreements

Connection Agreement
An agreement between a User and NTL (or User, NTL and SPTL) which specifies the terms and conditions relating to the connection to and/or use of the CTS

Connection Point The physical point where the User's Equipment or System is connected with the CTS and includes the Connection Point where the Transmission Systems of two or more owners are joined

Connection Site The site owned (or occupied) by a Transmission System owner or a User in which there is a Connection Point.

Contingency Reserve The margin of available generation capacity over Demand Forecast which is required to cover against uncertainties in availability of generation capacity and against Demand Forecast errors or variations

Control Center A location used for the purpose of control and operation of the Cambodia Transmission System or a part of it and the connected User's System

Control Person A person identified as having responsibility for coordination of safety at Connection Site under Section 8.3

Degradation of the CTS
A condition resulting from a User Development or a CTS expansion project that has a material effect on the CTS or the System of other Users and which can be verified through technical 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 standard multiples thereof.

Demand Forecast The projected Demand and Active energy related to a Connection Point or CTS

Detailed Planning Data
As referred in Chapter 2: Planning Code

Dispatch The issue of instruction by Control Center to Generation Licensees in respect of operation of Generating Units under their control

Dispatch Instruction An instruction given by the Control Center to the Generation Licensee to change output or manner of operation of the Generating Unit

Distribution Licensee The licensee who has been issued distribution license by EAC

Distribution System The system consisting mainly of electric lines and associated facilities operating at MV and LV owned by a Distribution Licensee, extending between the delivery points on the transmission, subtransmission system or Generating Plant connection and the consumer's installation.

Earthing The provision of an electrical connection between one or more conductors and earth

Electricity Authority of Cambodia (EAC)
The regulator for electricity sector in Cambodia, established under the Electricity Law

Electricité Du Cambodge (EDC)
The wholly state owned utility established by Royal Decree No. ChS/RKT/0396/10 dated March 09, 1996.

Embedded Generating Plant
A Generating Plant that has no direct connection to the CTS but that is connected to a Subtransmission System or Distribution system connected to the CTS or the system of any User

Energy Unless otherwise qualified, refers to the Active Energy

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

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

External Interconnection Equipment for the transmission of electricity to (from) the CTS from (to) a transmission or distribution system located outside the Kingdom of Cambodia

External Interconnector The party which controls an External Interconnection

Frequency The number of alternating current cycles per second (expressed in Hertz) at which a System is running

Frequency Regulating Reserve Refers to a Generating Unit that assists in Frequency control by providing automatic Primary and/or Secondary Frequency Response

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 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 Licensee The licensee who has been issued generation license by EAC

Generation Schedule Refers to the schedule that indicates the hourly output of the Generating Units and the list of the Generating units that will provide ancillary Services for the next scheduled day or for the rest period of the day

Grid The High Voltage backbone System of interconnected

transmission lines, substations, and related facilities for the conveyance of bulk power. Also known as Transmission System

High Voltage (HV) A voltage level exceeding 35 kV

Hydro Generating Unit A Generating Unit having generation of electricity through water power

IEC Standard Standard issued by International Electrotechnical Commission

Load Shedding The reduction in System Demand brought about by the controlled disconnection of consumers

Medium Voltage (MV)

A voltage level exceeding 600 Volts but not exceeding 35 kV

Merit Order A list of Generating Units in ascending order of marginal operating cost taking fuel constraints and other operating constraints into consideration

Merit Order Table Refers to the list showing the marginal operating costs in ascending order and the corresponding available capacities of the Generating Units taking fuel constraints and other operating constraints into consideration

Meter A device for measuring and recording units of electrical energy

Minimum Stable Loading

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

National Plan The overall plan for development of electricity sector in Cambodia prepared by MIME

National Transmission Licensee (NTL)

EDC – the licensee who has been issued National Transmission License by EAC

Operating Margin The margin of generation over the total Demand (including losses) that is necessary for ensuring power quality and the Security of the CTS. Operating Margin is the sum of the

Frequency Regulating Reserve and the Contingency Reserve.

Outage The state of Equipment when it is fully or partly non-operational to allow for construction, maintenance or due to some event directly associated with the Equipment. An Outage may or may not cause an interruption of supply of electricity to consumers.

Outage Plan A plan showing the expected Outages.

Partial Shutdown The condition when a part of the CTS is isolated from the rest of the CTS and in that part of the CTS, all generation has shutdown and there is no electricity supply from External Interconnection

Planned Outage An Outage included in the approved Outage Plan

Power System The CTS and all User Systems in Cambodia

Power System Restoration The restoration of the Power System or part of the Power System to a state of normal operation from a state of Total Shutdown or Partial shutdown as the context requires

Power System Restoration Plan A plan, prepared and maintained by the Control Center pursuant to Chapter 7: Contingency Planning Code, setting out guidelines assisting those involved in Power System Restoration to achieve Power System Restoration as safely and as quickly as possible.

Prudent Utility Practice The standards, practices, methods and procedures, confirming to safety and legal requirements, attained by exercising that degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected from skilled and experienced

operatives engaged in the same type of undertaking under the same or similar circumstances

Reactive Power The product of voltage and quadrature component of the current or the product of voltage and current and the sine of the phase angle between them. It is measured in units of volt-amperes reactive (VAr) and standard multiples thereof.

Reactive Power Capability Curve

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

Reliability It is the ability of a power System to continuously provide service to its consumers

Scheduling The process of compiling and issuing a Generation Schedule, as set out in Chapter 5: Scheduling and Dispatch Code

Section A Section or part of this Grid Code, which is identified as covering a specific topic

Security The continuous operation of a power System in the normal state, ensuring safe and adequate supply of power to consumers, even when some components of the System are on Outage

Site Responsibility Document

As referred in Section 3.6 of Chapter 3: Connection Code

Special Purpose Transmission Licensee (SPTL)

The licensee who has been issued Special Purpose Transmission License by EAC

Standard Planning Data

As referred in Chapter 2: Planning Code

Subtransmission System

The System consisting of Medium Voltage electric lines

used in connection with transmission of electricity from a substation or Power Station to different Distribution Licensees and Medium Voltage consumers including the Equipments and Meters owned or operated by the SPTL and designated as Subtransmission lines in the license of the SPTL.

System Refers to a Transmission System or User System as the case may be System Security The continuous operation of a power system in the normal state, ensuring safe and adequate supply of power to consumers, even when some components of the system are on outage

Technical Standard The standards for the electricity sector of Cambodia Issued by MIME

Total Shutdown The condition when all generation in the CTS has ceased and there is no electricity supply from External Interconnection

Grid Code The code covering all activities relating to the connections, the operation and use of the Transmission System in Cambodia including the operation of electric lines and plant connected to the Transmission System in Cambodia

Grid Code Review Panel/ Panel

The Panel set up under Chapter 1: General Provisions of the Grid Code

Transmission System The system consisting of High Voltage electric lines used in connection with transmission of electricity from one Power Station to a substation or to another Power Station or between substations or to or from any External Interconnection including any Equipments (including the Medium Voltage bays in substations) and meters owned or operated by the National Transmission Licensee or a Special Purpose Transmission Licensee in connection with the transmission of electricity.

Transmission System in relation to the National Transmission Licensee or a Special Purpose Transmission Licensee means the system, owned or operated by that licensee.

Transmission System Owner

The NTL or SPTL who owns the relevant Transmission System

User A person, including the NTL, SPTL, who uses the CTS and

who must comply with the provisions of the Grid Code

User Development The System or Equipment to be connected to the CTS or to

be modified

User System A system owned or operated by a User comprising:

a. Generating Units; and/or

b. Transmission System; and/or

c. Subtransmission System; and/or

d. Distribution system; and/or

e. Equipments of a consumer connected to the CTS

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 retention of the Voltage on the System within

acceptable limits

12.2 Abbreviations

A Ampere

AVR Automatic Voltage Regulator

CTS Cambodia Transmission System

DC Direct Current

EAC Electricity Authority of Cambodia

EDC Electricité Du Cambodge

HV High Voltage

IEC International Electrotechnical Commission

kV Kilo Volts

LV Low Voltage

MIME Ministry of Industry Mines and Energy

MV Medium Voltage

MVA Megavolt-ampere

MVAr Megavolt-ampere reactive

MW Megawatt

NTL National Transmission Licensee

REF Restricted Earth Fault

RMS Root-mean-square

RTU Remote terminal unit

SCADA Supervisory Control and Data Acquisition

SPTL Special Purpose Transmission Licensee

TS Transmission System

VAr Volt-Ampere-Reactive