User Guide

to

The Saudi Arabian Grid Code

(Based on Issue, 01; Revision, 00 of May 2007)

الشركة السعودية للكهرباء
Saudi Electricity Company

Transmission Regulation Department
Saudi Electricity Company

May 2009


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Introduction

About this User Guide

The Saudi Arabian Grid Code (SAGC) has been developed by the Transmission Regulation Department of the Saudi Electricity Company (SEC) to assist grid participants in their access and use of the transmission grid according to their contemplated roles in the restructured power market in the Kingdom. This User Guide is intended to further assist the grid participants in their interpreting and complying with the SAGC which otherwise is a technical and legal document.

The User Guide describes the arrangements of the major components of the SAGC and highlights the key obligations and responsibilities of each category of users. Narrated in a simple and non-technical language, it summarizes the major themes and contents of the SAGC. The aim is to help users to fully understand, grasp, and subsequently, comply with the SAGC.

Concerned Users

The users of the SAGC are as listed below:

(i) Transmission Service Provider (TSP): SEC's Transmission Business Unit which is licensed to own and operate the transmission system;

(ii) Generators: SEC's generators, Independent Power Producers (IPPs), Independent Water and Power Producers (IWPPs), as well as generation facilities of Saline Water Conversion Corporation (SWCC), Saudi Aramco, and any other entity which is licensed to generate electricity in the Kingdom and are or will be connected directly with the transmission system of SEC;

(iii) Distribution Entities: Distribution Business Unit of SEC and any other entity licensed to distribute and/or retail electricity supply in the Kingdom; and

(iv) Directly-connected Customers: Saudi Aramco, SABIC, or any other customer connected directly to the transmission system of SEC.

How is the User Guide organized?

User Guide's structure is shown in Figure IN.1. It is broadly organized into three sections. **Introduction** provides an overview of the User Guide. The second section, **Overview of the SAGC**, provides a comprehensive overview of the SAGC, its relation to other legal instruments, and the arrangement of its chapters. The third

section, **Inside the SAGC**, takes up each of the main chapters of the SAGC, one by one, and briefly describes the major themes and issues covered under each.

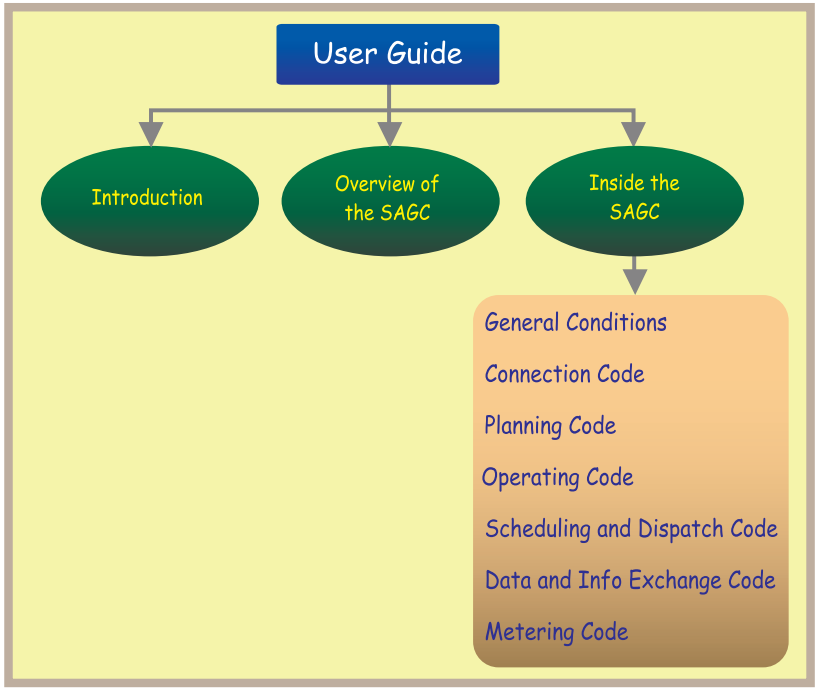

Figure IN.1: Organization of the User Guide

The topics discussed under these sections are arranged in a manner to help the users understand these in a logical sequence. Their arrangement in the User Guide, therefore, may not strictly follow the order in which these appear in the SAGC.

The User Guide highlights and describes briefly the major themes covered in the SAGC chapters in a typical order. For each chapter, the User Guide first provides an overview of the chapter's objectives and its layout. After that, it lists the respective responsibilities of both the TSP and users with respect to the main topics covered in the chapter. Next, it provides brief discussion of the major contents of the chapter. To facilitate understanding, the User Guide utilizes a number of flow charts and diagrams also.

Disclaimer

This User Guide is intended to be used as a guide document only. It is not a substitute for the SAGC, and readers should refer to the SAGC for complete detail.

Where to look for additional help?

Users can find further information on the SAGC and any associated issues from the Grid Code Supervisory Committee (GCSC), the SAGC webpage, the Transmission Service Provider (TSP), or the Electricity and Cogeneration Regulatory Authority (ECRA). Their contact details are as follows

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Name: Hamed A. Al-Saggaf
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Transmission Regulation Department,
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Overview of the SAGC

Organization of the SAGC

The SAGC is a legal and regulatory document that sets the rules and regulations for various grid participants to *connect to* and *use* the transmission system of SEC. It is prepared by the Saudi Electricity Company (SEC) and approved by the Electricity and Co-generation Regulatory Authority (ECRA). The SAGC starts with a Preface that summarizes the objectives of the SAGC and the arrangement and major themes of its various chapters. The main body of the SAGC contains seven chapters that cover all the important perspectives and topics related to grid access, planning, operation, and management. These topics include technical, design, and operational criteria for grid access and use, criteria and standards for system planning and operation, process for scheduling and dispatch of supply and demand resources, exchange of data and information, and policies and standards for metering of power and energy exchange. The Glossary and Definitions section at the end provides brief explanation of the various special terms used in the SAGC.

The organization of the SAGC is shown in Figure OV.1.

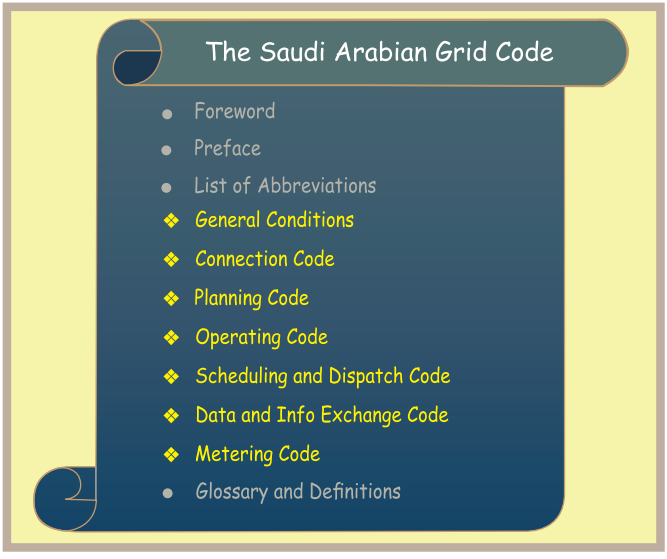

Figure OV.1: Layout of the Grid Code

Each chapter of the SAGC is structured in a typical style. It starts by introducing what the chapter contains, and then it lists the major objectives of the chapter. After that, it presents different provisions in a thematic fashion.

A list-style hierarchical numbering scheme is used for laying out the SAGC provisions. This scheme is shown in Figure OV.2 below. The first digit indicates the chapter number, the second one indicates the section number, the third one indicates the sub-section number, and the fourth one the number of the clause; the text shows the actual content of the provision.

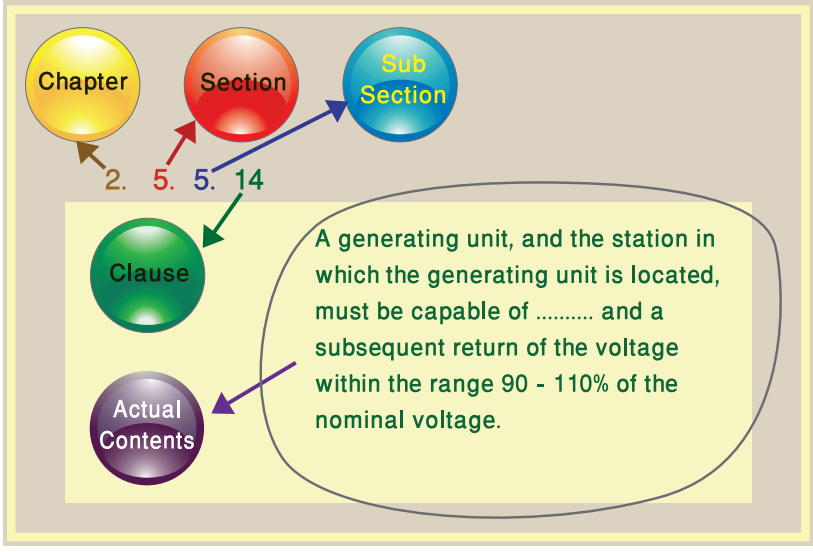

Figure OV.2: List-style hierarchical numbering scheme used for the SAGC

Summary of the SAGC Chapters

General Conditions: This chapter contains a set of general provisions that apply to all chapters of the SAGC. Their purpose is to ensure that the various chapters of the Code work collectively and in harmony with each other.

Connection Code: The Connection Code specifies the technical, design, and operational conditions for connecting to and using the transmission grid. Its purpose is to protect the facilities of both the transmission service provider (TSP) and users, for safe and stable operation of the system. This chapter defines the procedure for seeking new connection, or modification of an existing connection,

with the grid. This procedure includes conducting of grid impact studies by theTSP, making an offer of connection to the user, and signing of a formal connection agreement. This chapter also defines the standards for performance at the connection point and specifies site-related conditions to enable the TSP and users to design and operate their facilities properly. This chapter also specifies user system performance at connection point, as well as safety and maintenance conditions that are to apply. It also describes the main drawings and diagrams that will be required for connection sites and defines the numbering and nomenclature system and site responsibility schedule to be used at the connection point.

Planning Code: The Planning Code provides the criteria and procedures for the planning and development of the transmission system. It specifies the responsibilities of the participants towards grid planning and the mechanism for interacting with each other including the data and information that are to be exchanged among the grid participants for planning purposes. Two appendices to this chapter list the typical data that each user is expected to supply to the TSP.

Operating Code: The Operating Code covers a host of critical issues relating to proper operation and control of the grid, namely: (i) Operational Demand Forecasts; (ii) Outage Planning; (iii) Contingency Planning; (iv) Operational Liaison; (v) Operational Communication; (vi) System Services; (vii) Operational Testing; (viii) Testing to Monitor, Investigate, and Verify Performance; and (ix) Cross-boundary Safety Assurance.

Operational Demand Forecasts specifies the procedure for exchanging data among participants to enable the TSP to prepare demand forecasts as well as demand control requirements in the operational, programming, and control phases of grid operation. *Outage Planning* deals with submission of outage programs for both transmission system and generation facilities, and subsequent development of outage programs by the TSP for the whole system. The section on *Contingency Planning* lays down a formal mechanism to plan for, and deal with, any eventualities on the grid. For this purpose, it specifies the use of demand control strategies, the mechanism to manage partial or total breakdown on the grid, and the procedure to bring the system back to normal from such breakdowns.

Operational Communication and *Operational Liaison* describe the requirements and associated protocols for communication and liaison among the grid participants. *System Services* deals with providing of support (or ancillary) services for stable and secure functioning of the grid. *Operational Tests* describes the procedures to

be followed for carrying out operational tests that may be required on the grid, or the system of any user that can have implications for other users. Another section in this chapter deals with other type of tests that may be carried out by the TSP to monitor, investigate, and/or verify the performance of user's plants or apparatus. This chapter also provides a formal procedure for safety coordination among the TSP and other users when work is to be carried out *on* or *near* the connection point.

Scheduling and Dispatch Code: This chapter describes the responsibilities and obligations of the TSP and users concerning scheduling and dispatch of generating units and explains the procedures for preparing and issuing of generation schedules and subsequent dispatch instructions by the TSP to users. It also sets out the procedures and timeframes for supplying the required information by users to the TSP for such purposes.

Data and Information Exchange Code: The responsibilities of grid participants and the procedure to be used for exchange of data and information are detailed in this chapter. This chapter pools all data and information requirements mentioned in the other chapters of the Code and provides customized data schedules for various categories of grid participants.

Metering Code: Metering Code establishes the requirements for the grid participants for measuring the flow of electricity through the grid. It spells out the responsibilities of each participant in this regard and lays down the performance standards and the design and operational criteria to be complied with by users.

General Conditions

Overview

General Conditions comprises of provisions that are of a general nature and apply to all chapters of the SAGC. Their purpose is to make sure that the various chapters of the SAGC work in coherence and also complement each other. This chapter specifies the legal framework that will exist for executing the SAGC and overseeing its successful implementation. This is followed by specifying of the principle contacts for communication among grid participants and acceptable media for communication. This chapter also provides directions regarding settling of any disputes between the TSP and users, and establishes a framework for making amendments to, and granting derogations from, the provisions of the SAGC. It concludes by providing a few additional provisions that explain the construction of the Code and how its provisions are to be interpreted.

Figure GC.1 below shows the thematic arrangement of the key topics of General Conditions. Figure GC.2 illustrates the major topics covered in this chapter.

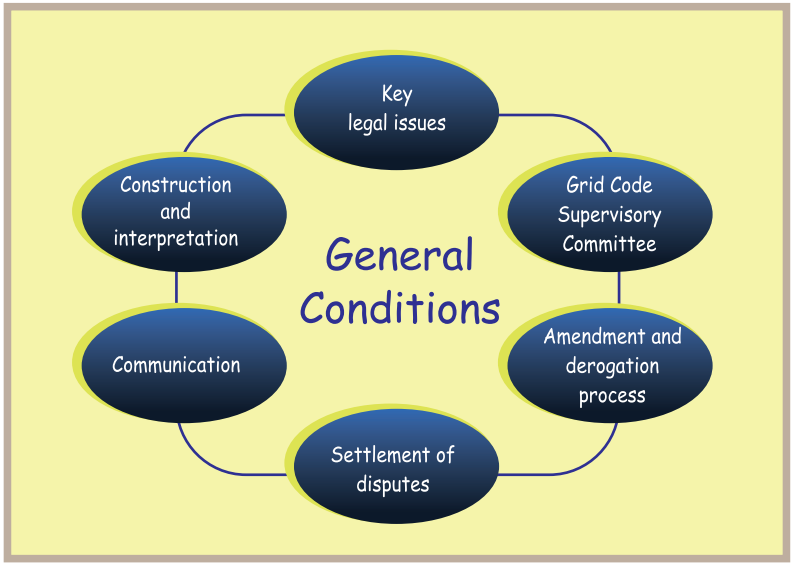

Figure GC.1: Thematic arrangement of General Conditions

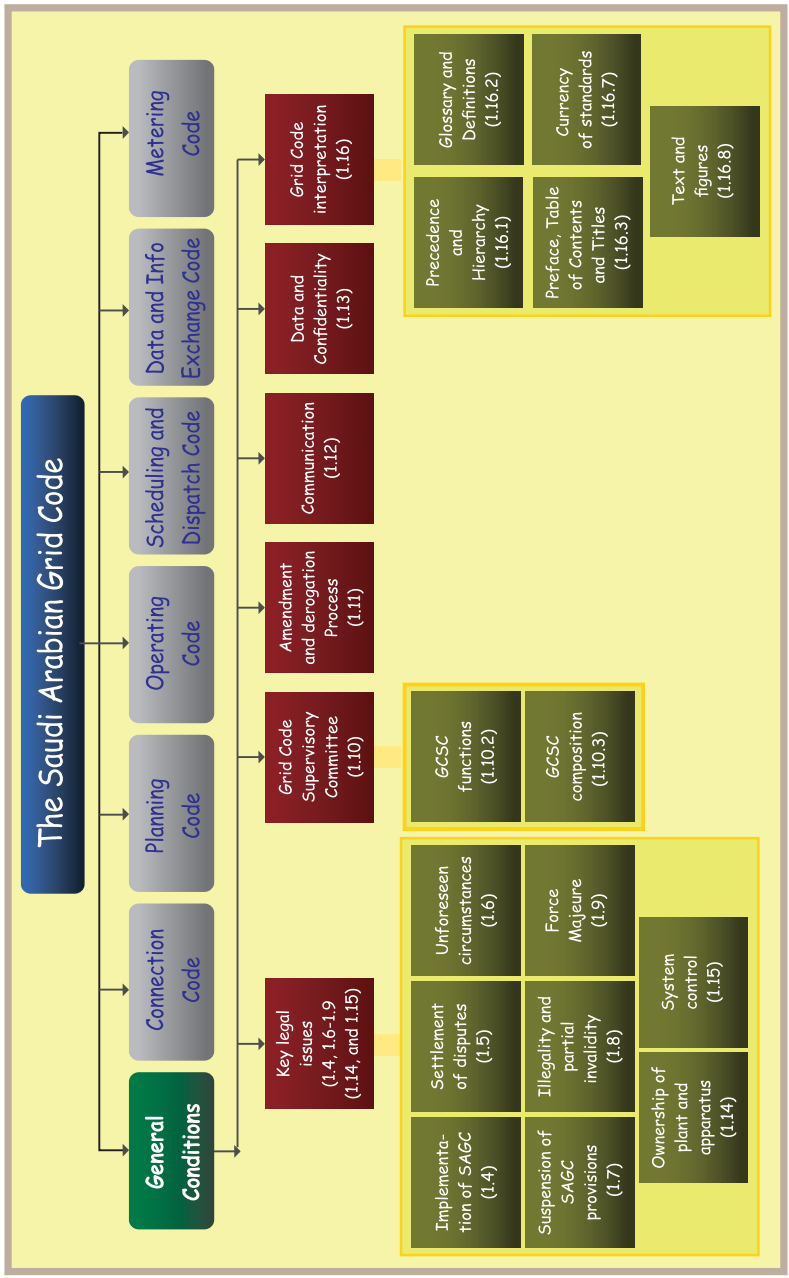

Figure GC.2: Major topics covered in General Conditions

Responsibilities

General Conditions sets the legal and regulatory setting in which the Code is to be interpreted and enforced. The Government will provide the legal framework and ECRA will further contribute by providing the enabling platform and regulatory support for the Code's effective implementation. A hallmark of this supporting framework is the *Grid Code Supervisory Committee (GCSC)* representing the major power sector stakeholders in the country. The GCSC will oversee and guide the effective implementation of the Code and will take care of any associated issues. The TSP will provide grid facilities and services; other users will make use of them in accordance their roles as contemplated in the SAGC. The GCSC will assist them in this endeavor by clarifying on any queries relating to the Code's provisions, allowing any derogations where necessary, and approving any changes or modifications to the Code, if and when required.

Main Topics

The main topics covered in General Conditions are briefly described below:

(i) Key legal issues

a. SAGC Implementation and Enforcement: The TSP will be responsible for the implementation and enforcement of the SAGC. In doing so, the TSP may need access to user facilities according to the connection agreement between them. Users are required to follow TSP's directions and instructions for this purpose.

b. Unforeseen Circumstances: Should a situation arise that has not been foreseen in the SAGC, the TSP will deal with it after consultation with the affected users. The TSP will then notify the GCSC with details of the situation and suggest a suitable strategy for dealing with it so that it can be properly covered in the next version of the SAGC.

c. Suspension of SAGC provisions: The provisions of the SAGC may be suspended partially or totally under some abnormal condition or pursuant to any direction by ECRA or the Government.

d. Illegality and partial invalidity: If any provision of the SAGC is declared unlawful or partially invalid by a competent court, the validity of SAGC's other provisions will not be affected and will continue to remain *in force*.

e. Force Majeure: If a *force majeure* event prevents a grid participant from fulfilling its obligations under the SAGC, that participant will notify other concerned participants as soon as possible. The notice will include full details of the

event, occurrence time, and expected duration. The grid participant will strive to remove his disability and fulfill his obligations under the SAGC as soon as is practicable for him.

(ii) Grid Code Supervisory Committee (GCSC)

The Grid Code Supervisory Committee (GCSC) is a stakeholder representative committee constituted to oversee and guide proper functioning of the SAGC. Its purposes include to supervise the regular updating and modification of the SAGC during the implementation stages, and evaluate any request of the grid participants for derogation from any provision of the SAGC or amendment to it and making appropriate recommendations to ECRA for a final decision. The composition and functions of the GCSC are shown in Figure GC.3 and Figure GC.4, respectively.

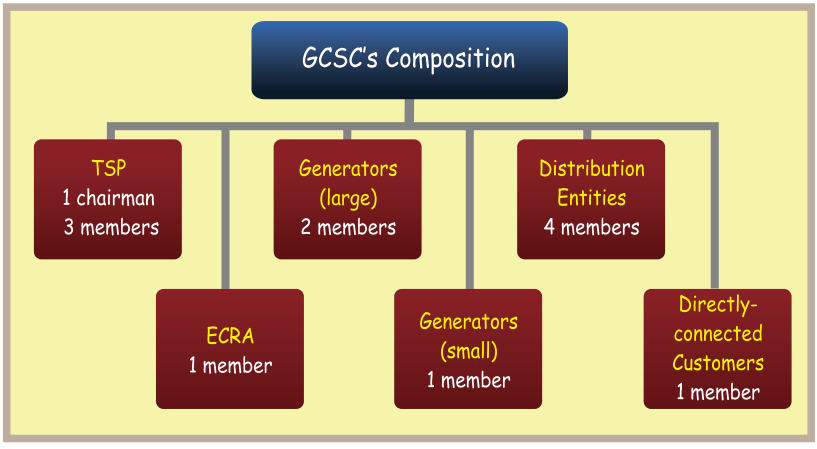

Figure GC.3: Stakeholders representation in the GCSC

(iii) SAGC Amendment/Derogation Process

Any grid participant, GCSC Member, or ECRA can seek derogation from any of the Code's provision(s) if compelling reasons exist. They can also propose amendment(s) to the SAGC. An *application form* for such derogation or amendment will be submitted to the GCSC. These forms are available from the GCSC Secretariat or can be downloaded from the SAGC website.

The derogation can be granted on the following grounds:

- to relieve the grid participant from complying with any of the SAGC provision(s) to deal with a temporary hurdle;

- to assist the participants in adopting to the SAGC from the existing situation; and/or
- to facilitate upgrading/modifying of existing Plant and/or Apparatus that has not been designed in line with requirements of the SAGC.

Figure GC.4: Functions of the GCSC

The request for derogation should include the following information:

- details of the applicant;
- related provision(s) of the SAGC and user's obligation with respect to it (them);
- explanation of the proposed alternative actions;
- details of the relevant plant/apparatus and nature and extent of non-compliance; and
- detail of the proposed strategy and a timetable to restore compliance.

The amendment/derogation process is shown in Figure GC.5.

(iv) The GCSC will consider the amendment or derogation request, by seeking expert advice, if deemed necessary, and submit its recommendations to ECRA for a

final decision. ECRA will take decision after considering the proposal and recommendation from the GCSC and will inform the GCSC about its decision. The GCSC will then inform the initiator whether his request has been accepted or not. For amendment proposals, the GCSC will keep a record of all approved amendments to be incorporated in the next revision of the SAGC. For a derogation request, if his proposal is accepted or modified then this user will not be required to comply with the relevant provision(s) of the SAGC but will instead comply with any alternate provision(s) mentioned in the derogation. It is important to note that an approved derogation from the SAGC will normally have an expiry date after which its continued need will require reevaluation by the GCSC. If a user's proposal is rejected, he shall comply with the existing provisions of the Code.

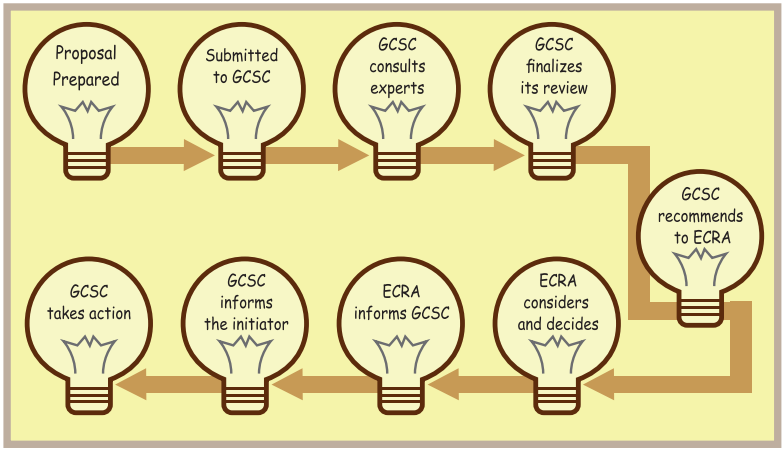

Figure GC.5: SAGC amendment/derogation process

(v) Communication between the TSP and Users

All communications (other than notices and data submissions) between the TSP and user will be through the TSP's control engineer and user's responsible engineer. The communication medium for such purposes may include telephone, fax or any other acceptable electronic means. All such instructions or communication will be recorded and kept for at least one year. The data and notices under the SAGC between the TSP and users will be submitted electronically or through any other appropriate means as agreed between them. The data submitted by a user to the TSP, either prior to connection or before the TSP's making a formal offer of connection to the user, will be treated as confidential.

(vi) Settlement of Disputes

In case a dispute arises on any issue relating to the SAGC, the TSP and user(s) are urged to resolve it amicably through bilateral negotiation. If they fail to do so, then they are required to resolve it according to the relevant procedure prescribed in the Electricity Law or in accordance with the guidelines from ECRA, as explained in Figure GC.6.

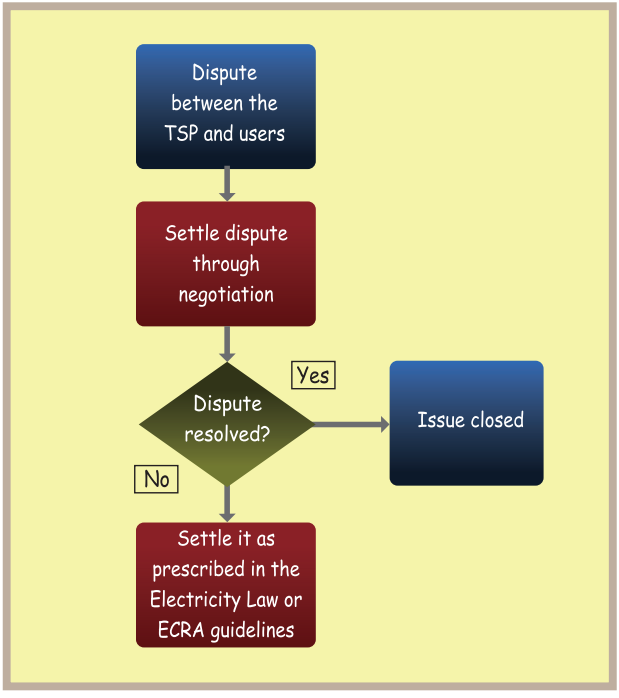

Figure GC.6: Settlement of SAGC-related disputes between the TSP and grid users

(vii) Code Interpretation

To aid users in the proper interpretation of the SAGC, section 1.16 of the General Conditions provides a few guiding rules on how to properly interpret the provisions of the Code. These rules illustrate and clarify on issues such as precedence of the SAGC over other agreements and contracts, mandatory nature of the SAGC provisions, definition of special terms, text's precedence over figures, and currency of the referred standards.

Connection Code

Overview

Connection Code lays down the terms and conditions that users are required to fulfill to get a new connection to the transmission grid, or make a modification to their existing connection. The objective is to provide a set of rules and standards for accessing and using the grid. It defines the performance standards for the transmission system as a whole as well as those at the connection point to enable the users to design their own facilities and systems accordingly. Besides, some site-related conditions such as responsibility of ownership, operation and maintenance of equipment at the connection point, drawings and diagrams for connection sites, and labeling of connection point equipment are also specified.

It should be noted that Connection Code only defines a set of general requirements for a user connection. More particular requirements will be determined by the TSP on a case to case basis after a thorough examination and study of the user application and his proposed development and, therefore, will be defined in the relevant connection agreement.

Figure CC.1 below shows the thematic arrangement of the key topics of Connection Code. Figure CC.2 illustrates the major topics covered in this chapter.

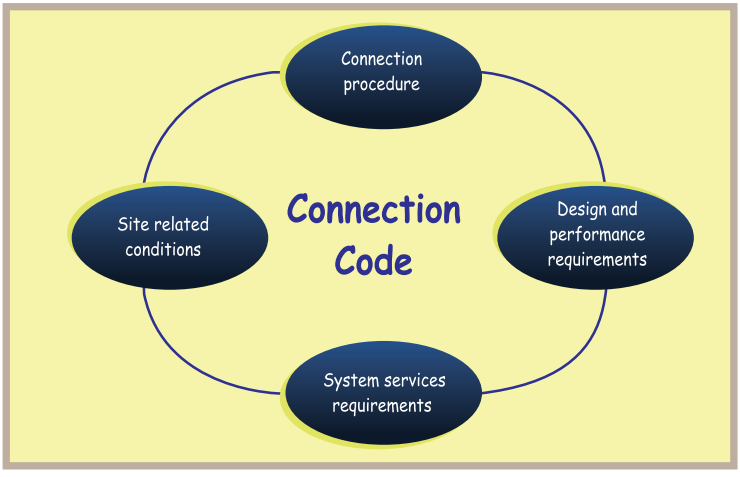

Figure CC.1: Thematic arrangement of Connection Code

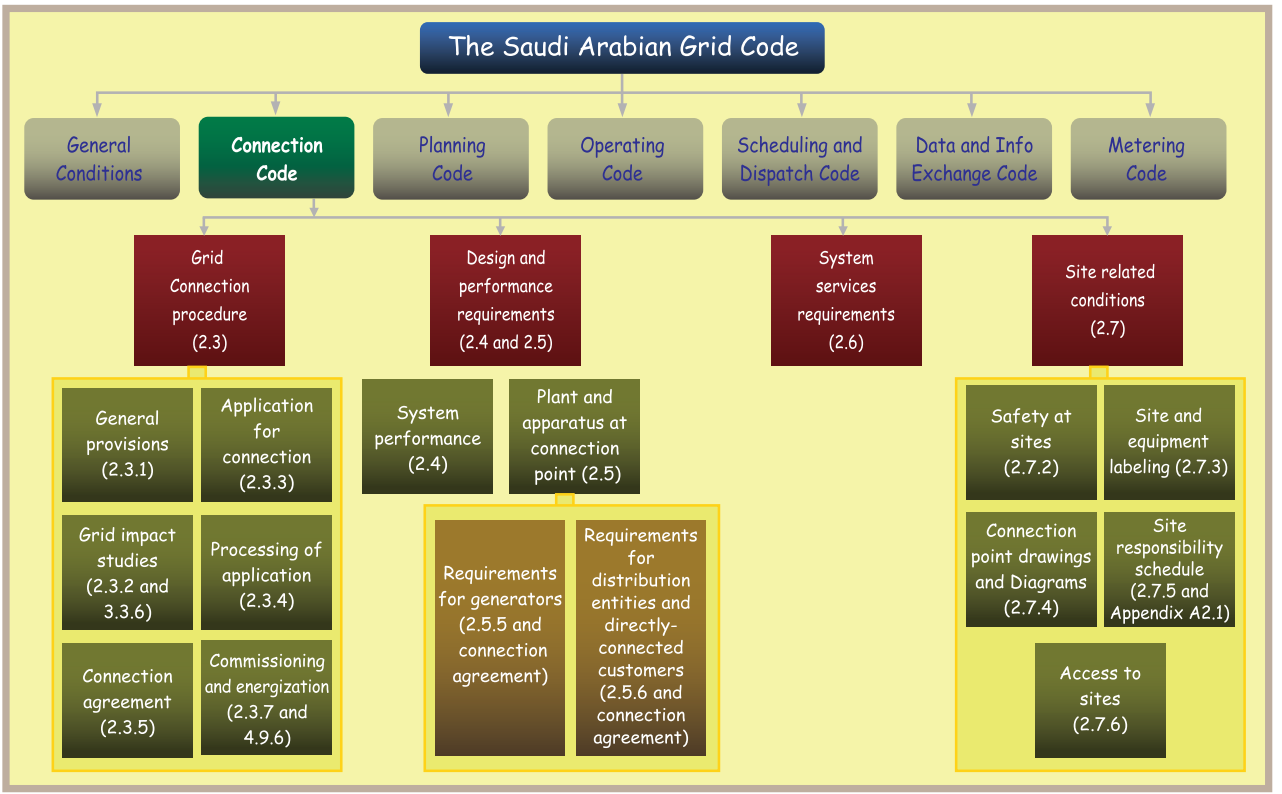

Figure CC.2: Major topics covered in Connection Code

Responsibilities

The responsibilities of the TSP and users are detailed in the Connection Code in both specific and general terms with respect to various aspects of their connection and day to day interaction. These responsibilities include issues such as submitting of a connection application by the user to the TSP and fulfilling of other requisite formalities. TSP's responsibilities include processing of a user's application *objectively* and *fairly* and guiding him in the entire process until a formal connection agreement is signed between them. After connecting with the grid, both the TSP and users will be responsible to operate and maintain their respective sides of the system according to the standards and terms and condition defined in the Connection Code and the individual connection agreement. TSP and users' responsibilities on other important issues such as providing of *system services*, preparing of site drawings and diagrams, and specifying of each party's obligations regarding the ownership, O&M, and safety for the connection point facilities are also described in this chapter.

Main Topics

The major topics covered in the Connection Code are briefly discussed below:

(i) Connection Procedure

a. Connection Application: Figure CC.3 shows the connection procedure that users are required to follow to get a new connection with the grid, or seek a modification of their existing connection. This procedure starts when a user submits a formal application to the TSP and pays the applicable fees. The application will include contact information and the required technical information such as description of the proposed development and the equipment to be connected with the grid, a sitemap, and the required planning data.

b. Grid Impact Studies: The TSP will study the impacts of the user development on the transmission system based on the data and information supplied in his connection application and make an offer for connection, either as originally requested by the user or as revised by him in accordance with TSP's suggestions as a result of the grid impact studies.

c. Connection Agreement: After the user accepts the TSP's connection offer, he will need to sign a formal connection agreement with the TSP. This agreement will define in detail the terms and conditions that will govern safety, technical, and financial aspects of the user's interface with the TSP.

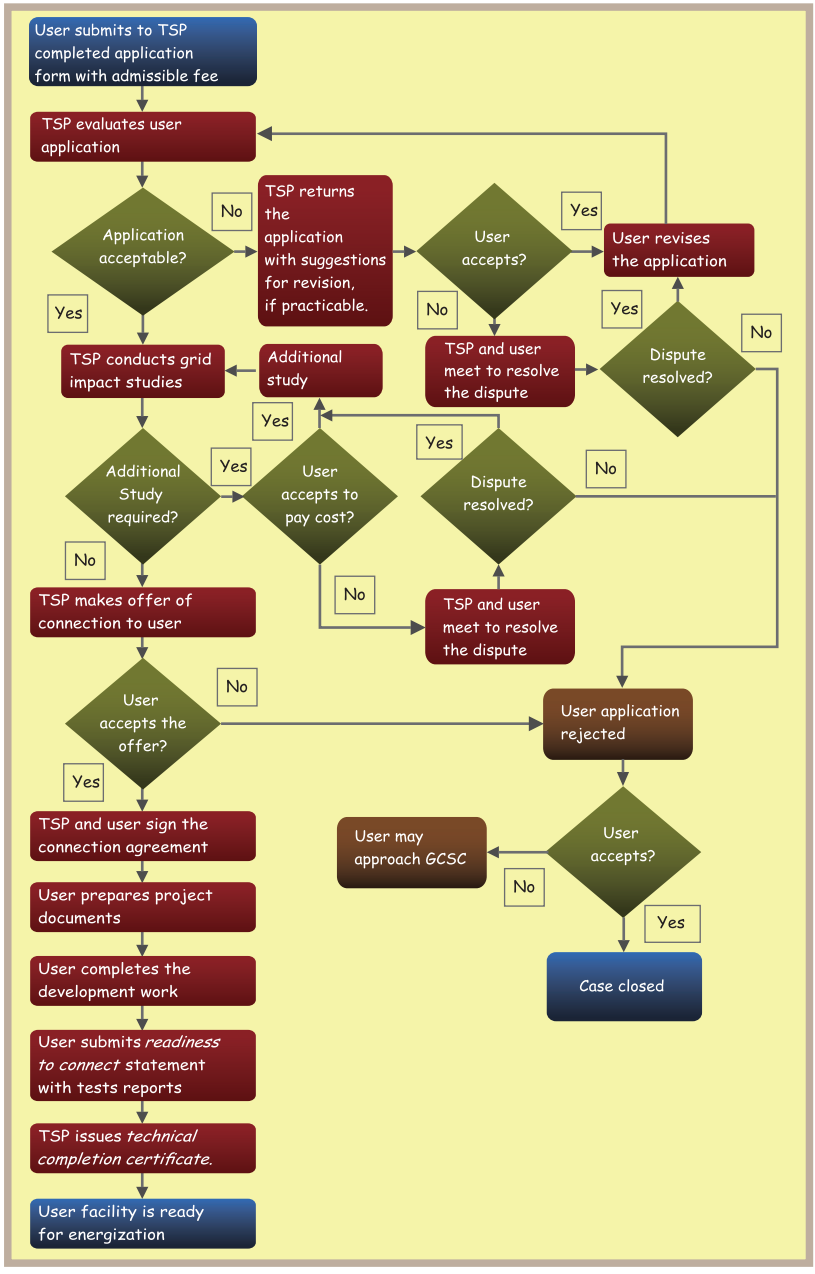

Figure CC.3: Procedure for Connection to the Grid

It will define, for example, the connection point, operation and maintenance boundaries, compliance with site technical conditions, land and building rights and services, outages and disconnection issues, liability insurance, payment of charges, and costs, etc.

d. Commissioning Process: Once the user completes the development work and successfully caries out the required commissioning tests for his facility, he will submit a *readiness to connect* statement to the TSP. The TSP, after satisfying that a user has fulfilled all the requisite requirements, will issue him a *technical completion certificate*. At this stage, the user facility will be ready for energization.

(ii) Design and Performance Requirements

a. Transmission System Performance in General: The transmission system is to be designed and operated according to the technical limits and standards specified in section 2.4. Users will also need to design their own systems and facilities according to these limits and standards to ensure that these function adequately.

b. System Performance at a Connection Point: The user's plant and apparatus at the connection point is to be designed as specified in section 2.5. This section describes fault clearance times for various network categories, different protection equipment/schemes and access to them, fault disconnection facilities, as well as operation and maintenance and safety conditions.

c. Special Requirements for Generators: Section 2.5.5 provides additional performance requirements for generators and also specifies the applicable standards. These requirements mainly pertain to issues such as power factor, active and reactive power, automatic voltage regulation (AVR) including power system stabilizing equipment, governor system, fault-ride-through requirements as well as other issues such as black start capability, and protection schemes.

d. Special Requirements for Distribution Entities and Directly-connected Customers: These are described in section 2.5.6 and relate to technical issues such as grounding, protection facilities at connection point, automatic low frequency disconnection of demand, power factor control, and location of reactive compensation equipment.

(iii) System Services Requirements

Section 2.6 lists the system support services that a user may be asked to provide to enable the TSP to maintain overall system reliability and stability. More details regarding their actual provision and procurement are to be provided in the relevant connection agreement. System services include frequency control, voltage control, black start, operating margin, and interruptible load, or any other service that the TSP may require from users. Section 4.4 of Operating Code further explains the policies and procedures that the TSP will use to maintain these system services.

(iv) Site Related Conditions

Operation and maintenance responsibility, in general, is to follow ownership. The TSP will own, operate, and maintain all facilities *up to* and *including* those at the connection point, whereas the user will own, operate, and maintain all the facilities *beyond* that point.

Section 2.7 deals with different issues that relate to connection sites. It explains the operation, maintenance, and safety obligations of the parties at the connection site. It also describes the mechanism for issuing, and subsequently changing, the identification and labeling of site equipment and apparatus. In addition, it describes how to prepare and subsequently modify connection point drawings and diagrams that are to be developed for every site.

The TSP and users are also required to develop a *site responsibility schedule* for each connection site. This schedule will specify the responsibility for safety, and operation and maintenance at the site. The details on how to prepare this schedule and what is to be covered in it are discussed in Appendix A2.1 of the Connection Code.

Planning Code

Overview

Planning Code sets the basis between the TSP and user to work together for planning the development of the transmission grid. Its objectives are to: (i) specify the responsibilities of all grid participants with respect to grid planning, (ii) provide a mechanism for coordination between the TSP and users with respect to any proposed user development; (iii) set planning criteria and standards; (iv) list the various power system studies that may be required for planning; and (v) specify the planning data and information to be exchanged between the users and the TSP.

Figure PC.1 shows the thematic arrangement of the key topics of Planning Code. Figure PC.2 illustrates the major topics covered in this chapter.

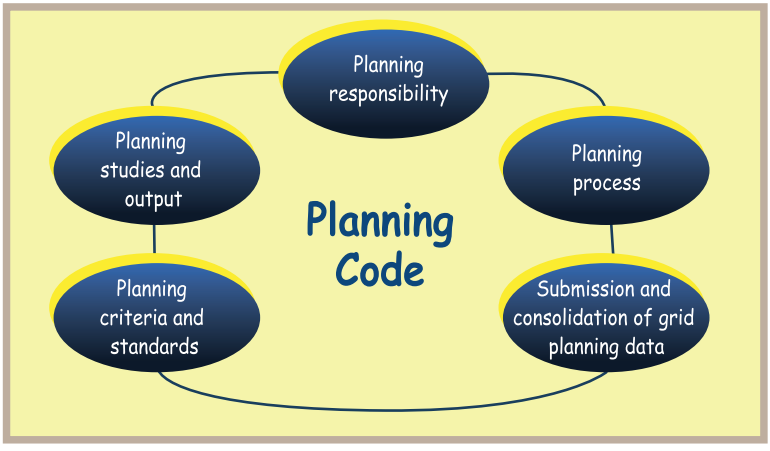

Figure PC.1: Thematic arrangements of Planning Code

Responsibilities

The TSP will be primarily responsible for planning and developing of the grid and also for preparing forecast statements and transmission development plans. Users will assist the TSP in this endeavor by providing the required planning data as well as informing it of any changes to their facilities or any significant alterations to their existing and future demand patterns.

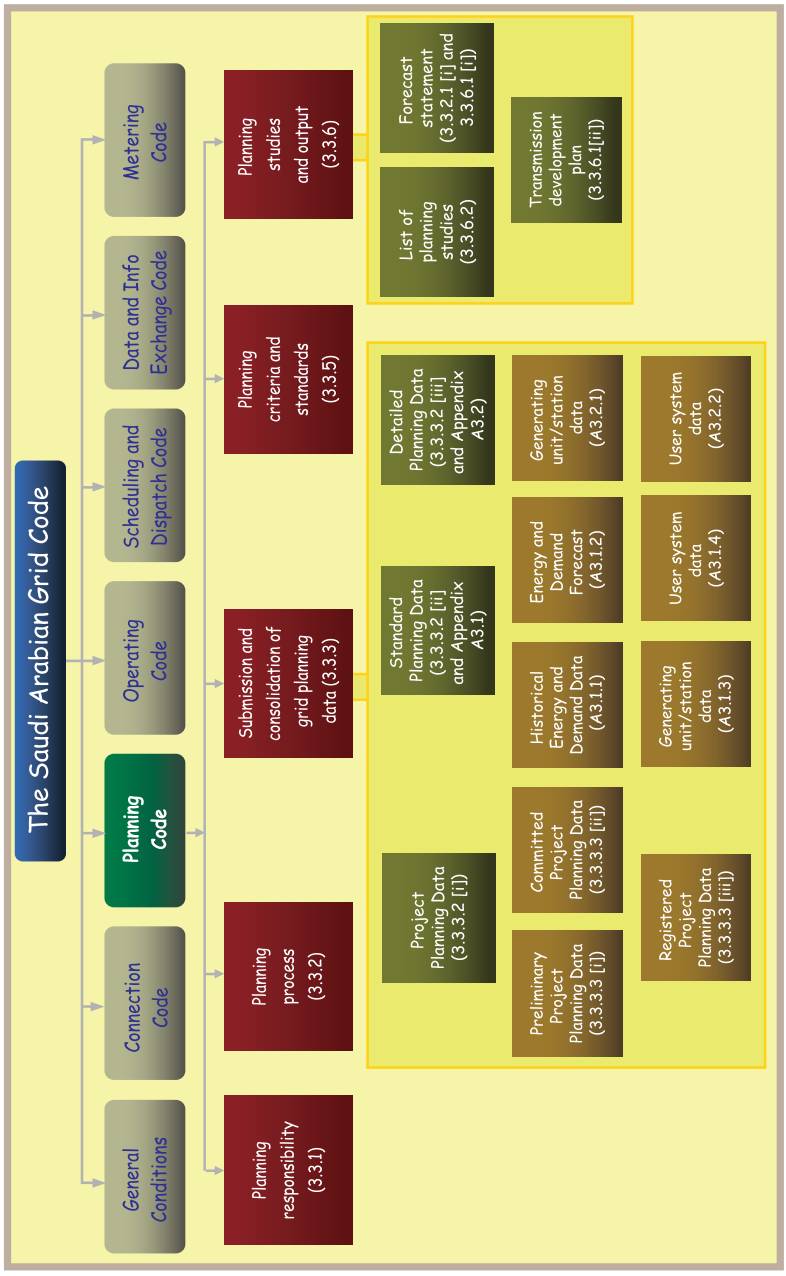

Figure PC.2: Major topics covered in Planning Code

Main Topics

The major topics covered in Planning Code are briefly discussed below:

(i) Planning responsibility

Primarily, the TSP will be responsible for grid planning and also for conducting any system studies, assessments, and evaluations for this purpose. The time required for planning and development of the Grid will depend on the type, complexity, and extent of the development work and the necessary permissions from relevant agencies. Users will assist the TSP in this regard by providing background data and information. If the TSP is not satisfied with the data supplied by a user, it may ask the user to verify or validate the data submitted by him.

(ii) Planning process

The grid planning process that the TSP will follow is depicted in Figure PC.3. The TSP will initiate this process every year by analyzing historical demand and energy trends and their future projections, outage history and plans for the grid, as well as planning data from the existing and new users.

Following this process, the TSP will prepare the *forecast statement* that will identify areas of the grid where additional capacity will be required in the next five years. The TSP will use the *forecast statement* to study demand-supply balances on the system and to explore options to meet the forecast demand either by increasing supply, modifying the existing system configuration, transferring load, or by any other feasible means. These options will be further studied to evaluate the adequacy and security of the system against the *system planning criteria and standards*. The feasible options will be next analyzed to choose the most economic option. After getting management's approval on this option, the TSP will issue the *transmission development plan* for the next five years.

(iii) Submission and consolidation of grid planning data

Users will provide *grid planning data* to the TSP, before connection as well as afterwards on regular intervals. Such data will be termed as *Project Planning Data*, if submitted by users with their application for a new connection, or a modification in their existing connection with the grid . These data will be termed as *Standard Planning Data* or *Detailed Planning Data*, if submitted by the existing grid users.

a. Project Planning Data: The TSP may require the users seeking a new connection with the grid or a modification to their existing connection to submit some or all the data listed under the Standard Planning Data (Appendix A3.1 of Planning Code)

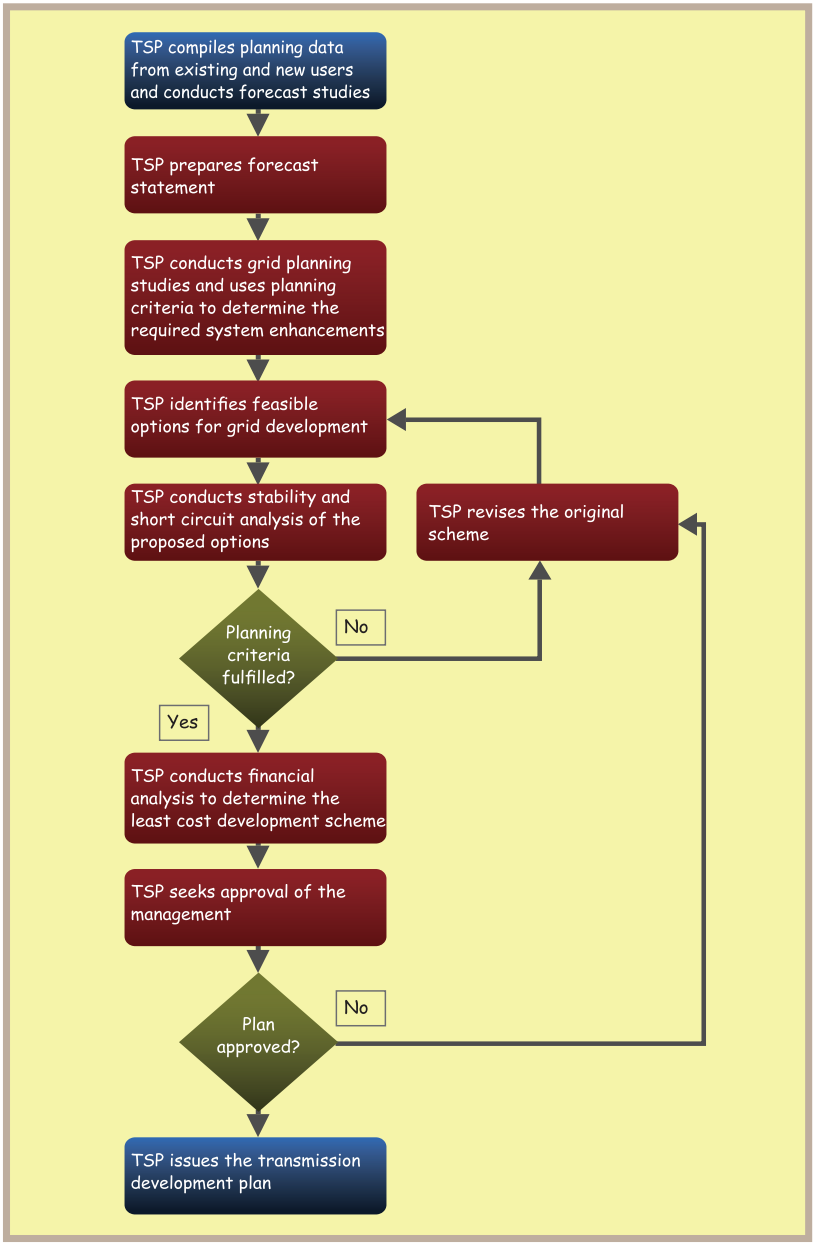

Figure PC.3: Grid Planning Process

and also Detailed Planning Data, if required, (Appendix A3.2 of Planning Code). These data will be termed as Project Planning Data and will be further classified into three sub-categories based on the stage of maturity of a user's connection application:

- Preliminary Project Planning Data: data submitted by a user relating to his proposed development at the time of applying for new, or modification of an existing, connection but before the TSP makes an *offer of connection* to him.
- Committed Project Planning Data: On accepting the TSP's offer of connection, the Preliminary Project Planning Data will become Committed Project Planning Data and will also include any subsequent data supplied by the user to the TSP in support of his application.
- Registered Project Planning Data: Upon connection to the grid, the Committed Project Planning Data will become Registered Project Planning Data. These will also include data and information that were not requested by the TSP before but are required prior to operation, and may require confirming or updating of the previously estimated values of the same data.

b. Standard Planning Data: Data that existing users are required to submit to the TSP at regular intervals regarding their system and demand to enable the TSP to prepare adequate plans for grid expansion, maintenance, and upgrading. Standard Planning Data must be submitted by users by
end-March each year. Standard Planning Data requirements are detailed in Appendix A3.1 of the Planning Code.

c. Detailed Planning Data: Additional data and information that the TSP may require from existing users for their system in addition to the Standard Planning Data. The TSP will require Detailed Planning Data only if such data are required for further studying the impact of the user system on the grid. The data should be submitted by the user within thirty days of the TSP's request or as agreed mutually between the TSP and the user. Detailed Planning Data requirements are listed in Appendix A3.2 of the Planning Code.

(iv) Planning criteria and standards

The TSP's transmission planning criteria and standards is a set of rules and standards that it will use to ensure adequacy and security of the transmission system and to plan for future reinforcements and expansions. Planning criteria will base on application of technical reliability considerations, economic factors, issues relating to transmission operations, maintenance and protection, and coordination

with generation and distribution functions, as well as strategic business and environmental considerations. The planning criteria will also indicate different contingency categories and the associated remedial actions for each, as well as thermal rating, voltage limits, and any other standards that are to be maintained during normal and abnormal conditions on the grid.

(v) Planning studies and output

The TSP will conduct grid planning studies such as *load flow studies, short-circuit studies, stability studies* and other relevant studies to evaluate the behavior of the grid under normal and contingency conditions and to ensure grid integrity and reliability during such conditions. These studies will be conducted periodically or as the situation may demand. With the help of these studies, the TSP will prepare the forecast statement and transmission development plan for the next five (5) years.

The forecast statement will detail the expected consumer demand in various parts of the Kingdom over the next five years and will also point out the opportunities available for connecting to, and using of, the grid for this period. The transmission development plan will include transmission forecast, planning criteria, and the process that the TSP has followed for developing the plan, as well as a list and brief description of the major projects planned over the next five (5) years.

(vi) Appendices A3.1 and A3.2

Standard Planning Data and Detailed Planning Data are important parts of the Planning Code. They are provided at the end of the Planning Code for convenience and list all the planning data that may be required from users. The users are required to submit these data using the especially designed schedules that are provided in Data and Information Exchange Code. Microsoft Excel based files of these schedules are also provided on the SAGC webpage.

a. Appendix A3.1: Standard Planning Data lists typical data that users will supply to the TSP periodically. Users will provide diagrams, parameters and configurations for their system showing transformers, overhead lines, underground cable, circuit breakers, load break switches, reactive power compensation equipment, grounding system and protection schemes.

In addition, distribution entities and directly-connected customers will provide historical active and reactive power and energy consumption data for the past year and current year, as well as for the next five years at each connection point. For the first year, energy and demand data will be provided on monthly basis

whereas for subsequent years the data will be provided on annual basis. If user facilities are connected at more than one point, user data should include the coincident peak active power demand, actual monthly energy and demand consumption at each connection point for the immediate past year. In addition, user will provide the actual hourly load profile for the week days, weekends, and holidays (to be specified by the TSP). They will also be required to provide data about captive/embedded generating stations installed in their system, if any. In such cases users will also provide short-circuit contribution of their captive/embedded generating units. Users will be required to supply to the TSP information relating to any fluctuating loads in their system including the short circuit current of their equipments.

Generators will be required to provide specifications and capabilities of their generating units/stations and their expected contributions to future system demand.

b. Appendix A3.2: Detailed Planning Data lists typical data that the TSP may demand from users in addition to Standard Planning Data. The TSP may ask users to supply data for their system including data for HV motors of size 10,000 HP and above and additional specifications of transformers that are placed between the transmission system and user system. Detailed Planning Data also include data regarding transient over voltages, insulation coordination, and user protection schemes that can have effects on the TSP's protection schemes.

The TSP may also ask generators to submit supplementary information for their generating units including parameters such as the excitation system, power system stabilizer, and speed governor system.

Operating Code

Overview

Operating Code defines the roles and responsibilities and associated mechanisms for grid participants to ensure safe, reliable, and economic operation of the grid. The objectives are to: (i) set procedures for developing demand forecasts, outage programs, and system restoration plans; (ii) provide for procurement and supply of system services; (iii) enable testing on the grid for operational and monitoring purposes; (iv) facilitate operational communication and liaison among participants; and (v) ensure safety when work is to be performed *on* or *near* the connection point.

Figure OC.1 and OC.2 show the thematic and topical arrangements of this chapter, respectively.

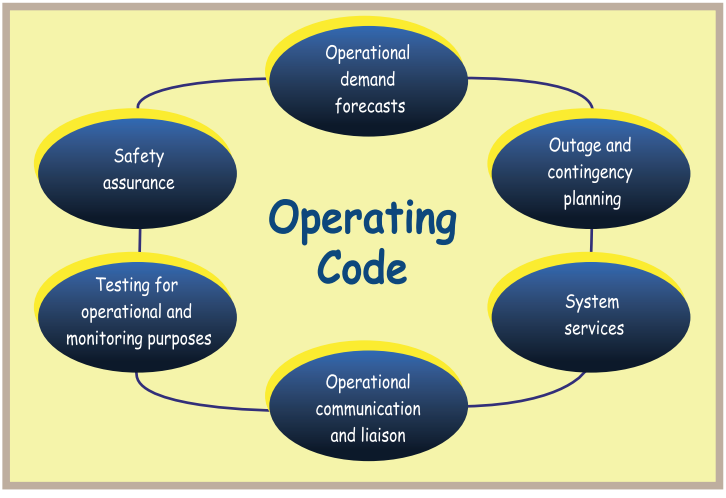

Figure OC.1: Thematic arrangement of Operating Code

Operational Demand Forecasts specifies the procedure to be followed and the data to be exchanged among the participants to enable the TSP to prepare demand forecasts for the grid over different operational time horizons. It also deals with providing of data by users to the TSP to enable it to plan and execute demand control in the *operational, programming,* and *control phases* of grid operation.
Outage Planning deals with submission of outage programs by generators and other Users for their facilities and the subsequent development of outage programs for

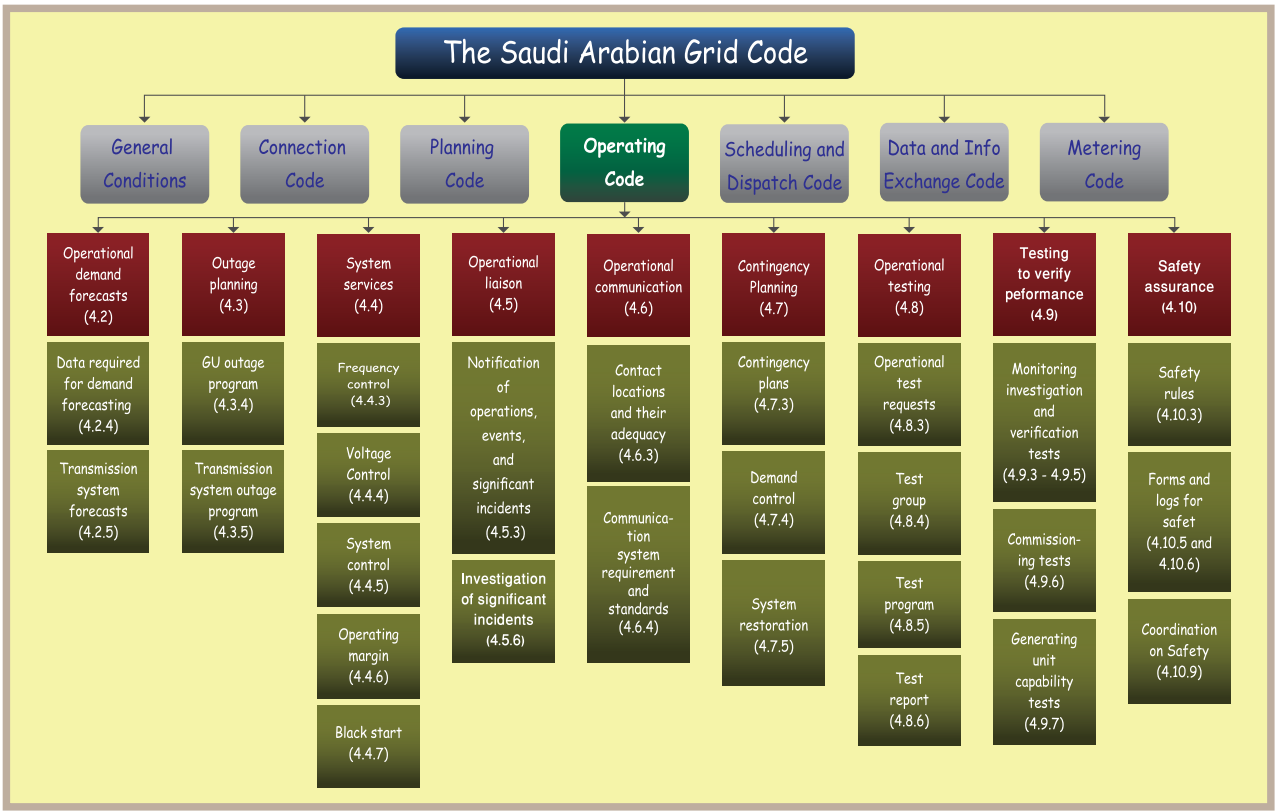

Figure OC.2: Major topics covered in Operating Code

the entire system by the TSP. **Contingency Planning** lays down a formal mechanism for dealing with partial or total breakdowns on the grid and specifies a mechanism to restore the system back to normal from such breakdowns. **Operational Communication** details the requirements for communication facilities and links among grid participants. **Operational Liaison** deals with terms and procedures for notifying the occurrence of operations, events, and significant incidents on the grid and investigation of significant incidents. **System Services** deals with arranging and providing of support (ancillary) services that are essential for ensuring the stability and security of the grid. **Operational Testing** describes the procedures for conducting operational tests on the grid or the system of any user. **Testing to Monitor, Investigate, and Verify Performance** deals with testing of a user's plant or apparatus by the TSP to verify the user's compliance with the SAGC or other applicable contracts. Finally, **Cross-boundary Safety Assurance** provides a formal procedure for coordination among the TSP and other grid users for carrying out work *on* or *near* the connection point.

Responsibilities

The responsibilities of the TSP and users with respect to Operating Code relate, generally, to timely submission of demand forecast data and outage programs by users for their facilities to enable the TSP to prepare operational demand forecasts and outage program for the entire grid over different operational planning horizons. Operating Code also specifies responsibilities of the TSP as well as generators and other users for maintaining system services, notifying and reporting of significant incidents on the grid, conducting of tests for operational and monitoring purposes, and adhering to proper safety procedures during repair and maintenance work at or around the connection point.

Main Topics

The major topics of Operating Code are briefly described below:

(i) Operational Demand Forecasts

In order to meet the demand for power and energy on an instant by instant basis, the TSP must maintain sufficient generation capacity and operating margin in the grid at all times. For this purpose, the TSP will develop demand forecast for a period of 5 years with the help of data supplied by users over 3 planning phases, *operational planning phase, programming phase,* and *control phase*. The description and time flow of various operational planning phases is depicted in Figure OC.3.

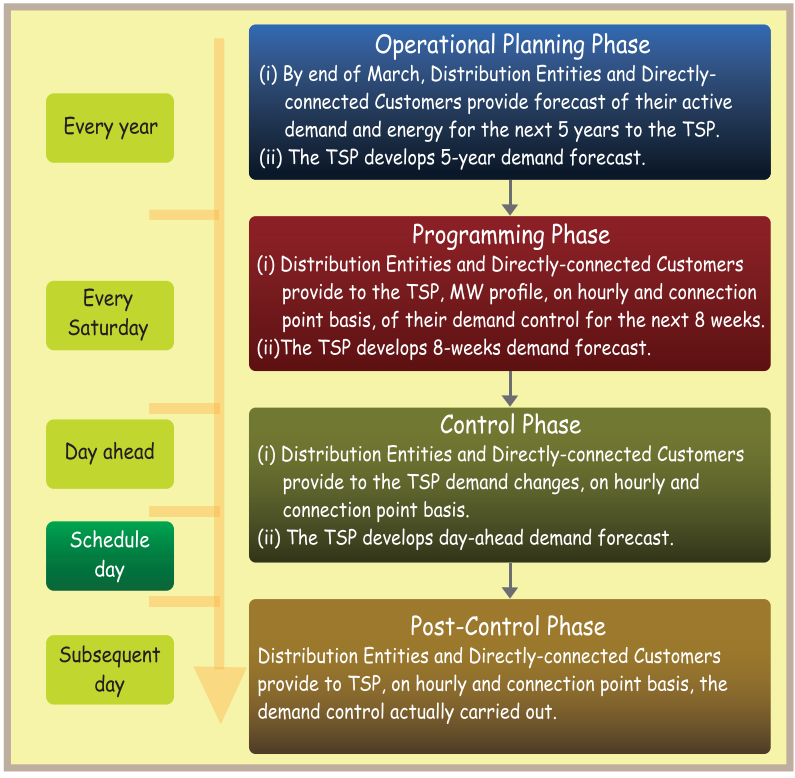

Figure OC.3: Description and time flow of various operational planning phases

Annually, the TSP will develop forecast of active peak demand and energy requirements for the transmission system for the next five years by considering data supplied by distribution entities and directly-connected customers. They will submit these data to the TSP by the end of March each year. This phase is termed as the *operational planning phase*.

Every Saturday, the TSP will develop demand forecast for the following eight weeks, on hourly and connection point basis, by considering the data supplied by distribution entities and directly-connected customers. This phase is termed as the *programming phase*.

In the *control phase*, the TSP will develop demand forecast for the next *schedule day*. This forecast will be based on the daily data supplied by the distribution entities and directly-connected customers regarding any changes to their previously notified schemes.

In the *post control phase*, the distribution entities and directly-connected customers will provide load profile of the last *schedule day*, including demand reduction actually carried out, to the TSP. These data will help the TSP in optimizing demand forecasts for the next schedule days and making any necessary adjustments to them.

The TSP is mandated to prepare unbiased forecasts of the system demand using a sound forecast methodology and by considering the factors shown in Figure OC.4.

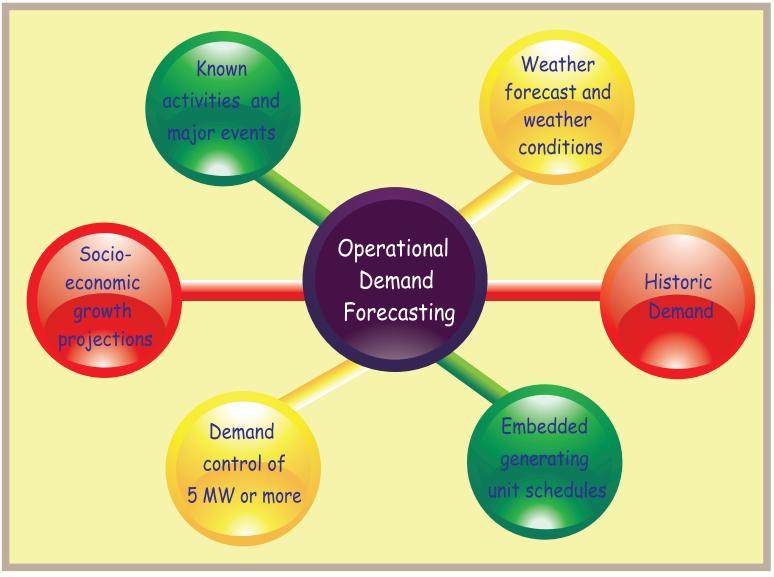

Figure OC.4: Determinants of operational demand forecast

(ii) Outage Planning

The section on Outage Planning deals with planning and executing of scheduled and un-scheduled outages of generating units and transmission system components over different time horizons. This planning will be undertaken by the TSP in consultation with and cooperation of grid users.

a. Planning of generating unit outages: The planning of generating unit outages will be conducted for the next five years in three time horizons as shown in Figure OC.5. *Indicative outage program* will cover the outages of generating units for year 4 and 5; *Provisional outage program* will include the outages of generating units for year 2 and 3. *Committed outage program* will cover the outages of generating units from March of the current year (year 0) up to end of the next year (year 1).

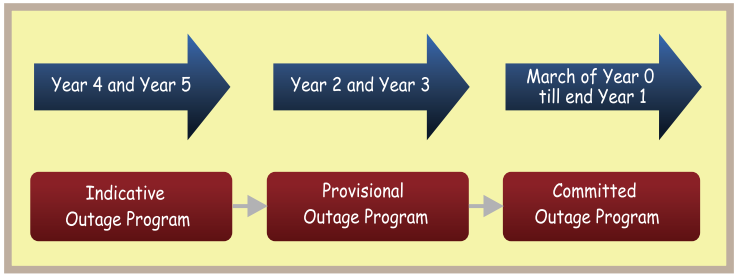

Figure OC.5: Program horizon for generating unit outages

During implementation of the outage program, the generators will notify the TSP for any changes to their programs. The generators will also notify to the TSP any unplanned outages, forced outages, or short term planned maintenance (STPM) outages for their units/stations. They will notify the TSP about events such as *release of generating units for outage, return of the generating units to service from outage,* and *any overruns*.

b. Planning of transmission system outages

The program will comprise outages on three time horizons as shown in Figure OC.6. *Indicative outage program* will cover year 2 and 3's expected outages. *Provisional outage program* will be the transmission outage program for year 1. *Committed outage program* will be the transmission outage program for the current year.

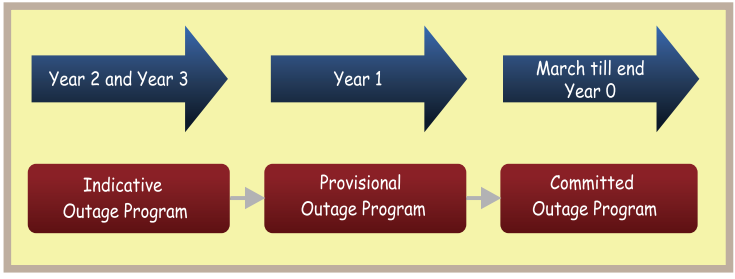

Figure OC.6: Program horizon for transmission system outages

Indicative outage program will become the provisional outage program after update and adjustment when, with the passage of time, year 2 becomes year 1. Similarly, provisional outage program, after update and adjustment, will become the committed outage program when, with the passage of time, year 1 becomes year 0.

(iii) System services

The TSP will determine the system services requirements for the proper functioning of the grid and also as to when, where, and by whom any of these services are to be provided. System services sets out policies and procedures for providing these services by grid participants, as shown in Figure OC.7.

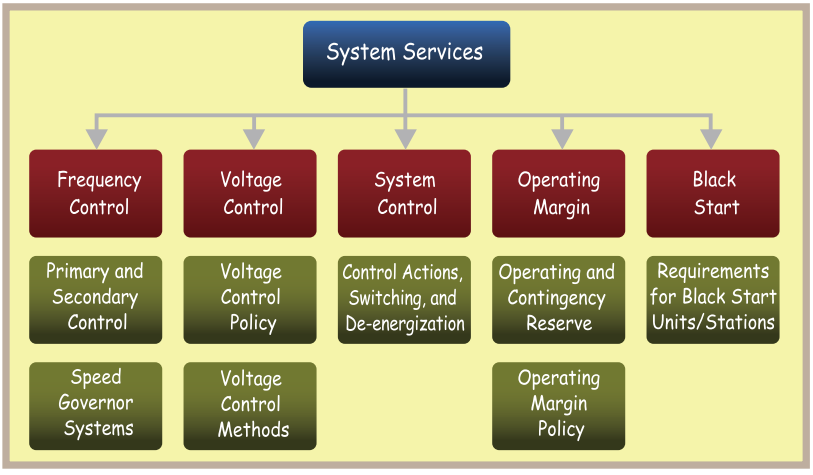

Figure OC.7: System services required for the transmission system

a. Frequency Control: To control and regulate frequency on the transmission system, generators will be required to provide *primary* and *secondary frequency control*. For this purpose, the generators will maintain sufficient frequency regulation capability in their plants with the help of suitably designed speed governor and automatic generation control systems. Primary frequency control will be achieved within 30 seconds after a change in system frequency is noticed. Secondary frequency control will be achieved after 30 seconds of frequency change's occurrence, will take over from the primary frequency response, and must be sustainable for at least 10 minutes.

b. Voltage Control: To avoid damage to the transmission system as well as to user's system and plant, the TSP will strive to control the system voltage within ±5% of the nominal voltages by adopting a sound and transparent voltage control policy and also by closely monitoring the transmission system conditions during system operation. In case of an emergency during which extra voltage control measures may be called for, the TSP may ask the generators to operate their units at Mvar production or absorption levels outside their declared operating

characteristics, or to change the taps of their unit transformers to keep the system voltages within the specified limits. Figure OC.8 shows methods that may be used by the TSP to control the voltage.

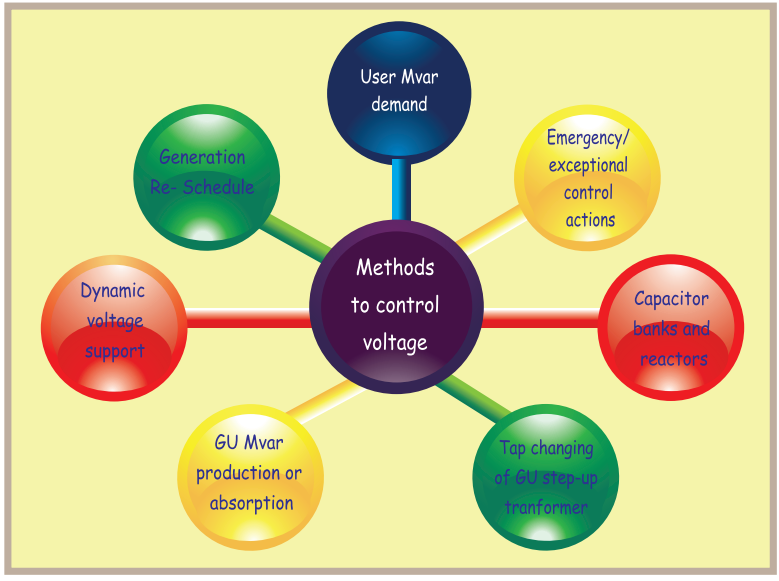

Figure OC.8: Voltage Control methods

c. System Control: The TSP may perform network switching and control actions on the transmission system to maintain system integrity and reliability during normal or emergency conditions. Such actions may include manual and automatic system switching, voltage control, frequency control, demand control or de-energizing of any plant or equipment. The TSP may also take these actions to implement the transmission outage program, contingency program, or to conduct operational or commissioning tests. The TSP will perform network switching automatically or by giving dispatch instructions to a specified user. The system switching may occur without prior warning, and can affect operations of users to some extent. The TSP will inform the user before taking any such action only if that action can cause material effect to the user. The TSP may not be able to inform users under fault or emergency condition when a quick response is required to ensure grid's stability.

d. Operating Margin: The operating margin is the margin of generation over total demand plus losses that the TSP will maintain in the system to ensure quality of

supply and security of the grid. This will be necessary to cater to situations when demand exceeds available supply due to a gap between the forecast and actual demand or as a result of sudden loss of a generating unit. The operating margin will include *operating reserve* and *contingency reserve*.

Operating reserve is the additional output from generating units or the reduction in demand that is realizable in real-time and can be used to maintain system frequency. It is further classified into *primary, secondary*, and *tertiary reserves*. The *primary operating reserve* is the automatic change in active power output of a generating unit within 5 seconds in response to a change in system frequency. The *secondary operating reserve* is the additional reserve available which is fully available and sustainable over 15 to 90 seconds following an event. *Tertiary operating reserve* is the reserve which is fully available and sustainable over 90 seconds up to 30 minutes after initiation of a frequency change event on the grid. *Contingency reserve*, on the other hand, is the extra available generation or demand reduction which can be called to service 24 hours ahead down to real time.

The TSP will determine the quantity of operating reserve and contingency reserve required on the grid by considering the various important factors as shown in the Figure OC.9 and OC.10, respectively.

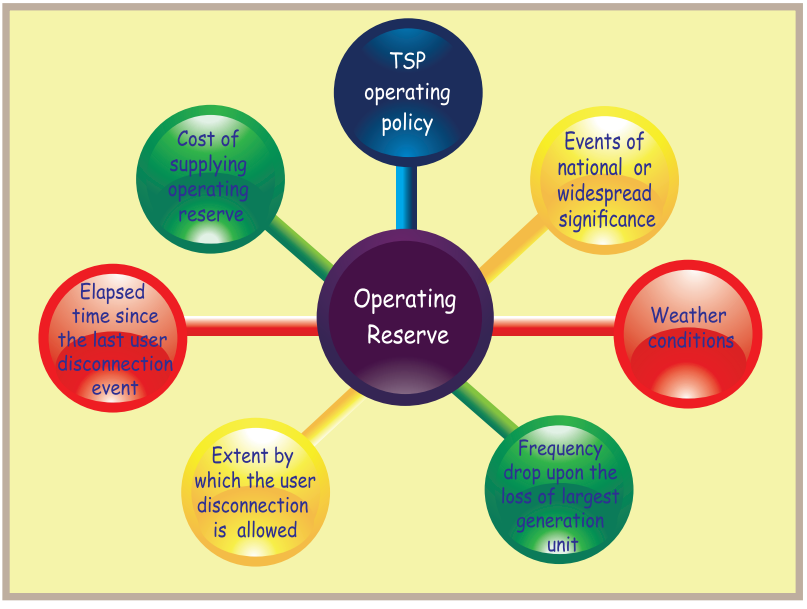

Figure OC.9: Factors for determining the operating reserve

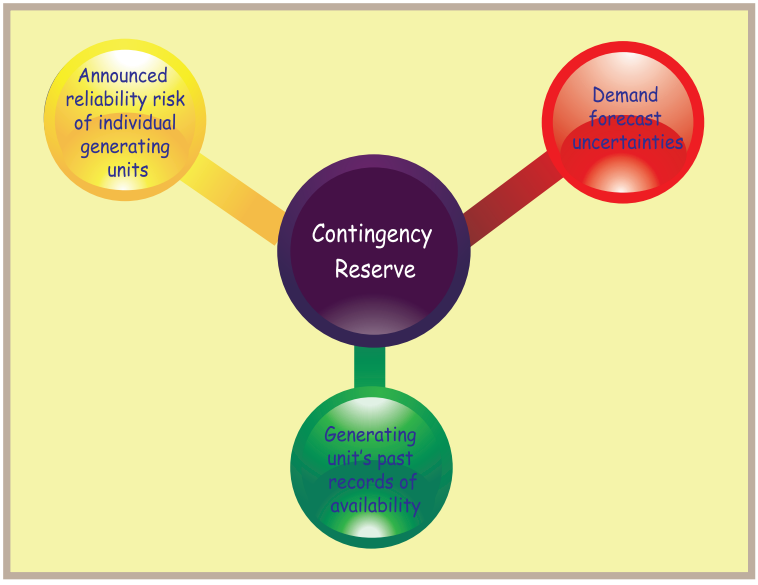

Figure OC.10: Factors for determining the contingency reserve

e. Black Start: The TSP will require black start capability from certain strategically located generating stations to be termed as *black start stations* (generators that have the facility to start from complete shutdown, without depending upon any external source of power supply, and can synchronize with the system). The TSP will use this service to recover from partial or total shutdowns on the grid. These generators must provide frequency and voltage within the standard limits. They must also be equipped with appropriate voice and communication facilities that are reliably linked with the TSP system and capable of operating without any external power supply.

(iv) Operational communication

This section of the Operating Code details the requirements, standards and procedures to ensure that adequate and reliable communication facilities and links exist between the TSP and users to enable trouble free operation of the grid. The objectives are to ensure clarity regarding contact locations, adequacy of communication facilities, and availability of clearly defined protocols for information exchange for system operation.

For communication during system operation, contact location for the TSP will be the *TSP's control center* and for the user it will be the *user's control center*. All

communication except that relating to submission of data and notices between the TSP and user will be done through the TSP's control engineer and user's responsible engineer. The responsible engineer will receive and execute TSP's instructions through these communication links. Operational data communicated between the TSP and user will be treated as confidential.

For operational matters, the TSP and users may communicate with each other by means of telephone, fax, SCADA, or any other acceptable communication medium. All communication facilities are to be designed, operated and maintained to TSP or other international standards.

The TSP will provide SCADA system to users on mutually agreed cost for monitoring the equipment at user's facilities. Users will establish approved voice communication facilities to provide *primary* and *backup* communication link between their facility and the TSP system, as well as monitoring and recording instruments at their side of the transmission system. The SCADA system should be capable of exchanging system status and data between the TSP and users. The TSP will be responsible for providing the SCADA outstation interface equipment; users will provide voltage, current, frequency, active and reactive power signals, plant status indicators and alarms for his equipment and facilities as required by the TSP from time to time in accordance with the relevant connection agreement. For recording the performance of the transmission system, the TSP will also install and operate data acquisition systems, disturbance recorders, and event loggers.

(v) Operational Liaison

The objectives of Operational Liaison are to: (i) provide a formal mechanism for interaction among grid participants to maintain integrity of the grid; and (ii) specify the procedure to be used between the TSP and users for reporting and investigating significant incidents on the system.

The TSP and users will notify to each other of *operations, events,* and *significant incidents* as soon as practicable after their occurrence. Subsequently, the TSP will also notify the other users, if these have, or may have, operational effects on their system. Figure OC.11 shows what may constitute a significant incident.

Both the TSP and users will notify each other immediately if a significant incident occurs on the system. The incident report will provide the following information:

- brief description of the incident;
- date, time and location of the incident;

- expected time to restore;
- cause of the incident; and
- expected impact of the incident

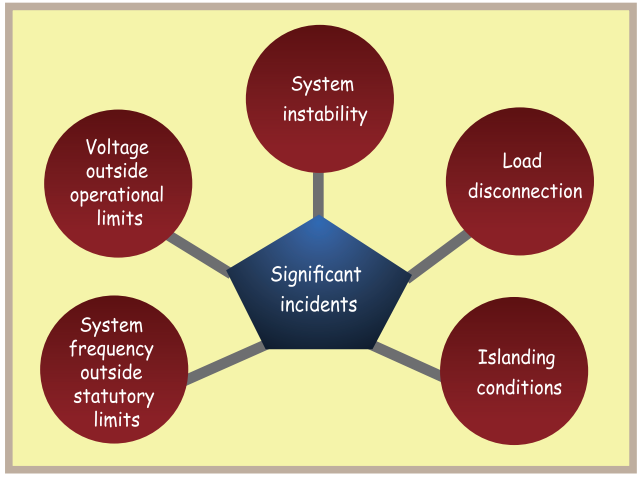

Figure OC.11: Significant incidents on the transmission system

The TSP will commence investigation on the significant incident, in coordination with the relevant users, and will prepare a preliminary report within fifteen working days and a final report within two months. The TSP may provide these reports to concerned users if this does not violate the confidentiality limitations.

Users are also required to submit to the TSP *monthly* reports on operations and events on their respective systems. These reports will include evaluation of operations, events, or any other problems occurring on their side of the grid. Users will also prepare *quarterly* and *annual* operational reports and submit these to the TSP. These reports will include details of the operations, events, and significant incidents that have material effect on the transmission system or systems of other users in that quarter or year.

The reporting responsibility of the TSP and users regarding notifying of significant incidents and preparing of operational reports is illustrated in Figure OC.12.

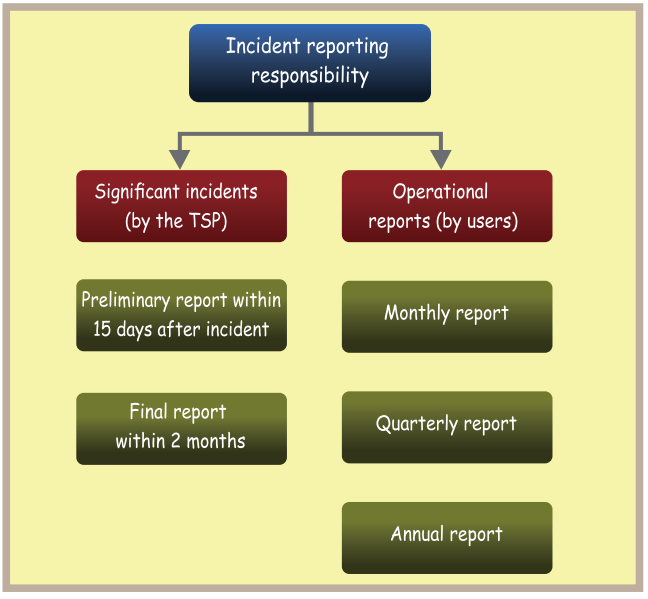

Figure OC.12: Responsibility for reporting significant incidents and preparing of operational reports

(vi) Contingency Planning

Contingency Planning lays down a mechanism to plan and deal with partial or total breakdowns on the grid. The objectives are to maintain transmission system integrity under abnormal stresses and to restore power supply to all the users as soon as practicable after the occurrence of such events. The TSP will develop contingency plans to deal with possible emergency situations on the transmission system using the building blocks as shown in Figure OC.13.

The TSP will manage system contingencies and emergencies in collaboration with other grid users. Users will comply with the TSP instructions for the purpose of executing these contingency or emergency plans. To enhance emergency preparedness, the TSP and users will also coordinate to conduct drills on how best to re-energize the system after events of partial or total shutdown. All contingency or emergency plans will ensure prompt and systematic recovery of the system from partial or total shutdown, without adversely and unnecessarily affecting any grid participant. The contingency plans will be verified periodically by the TSP in coordination with all the relevant users by actual tests, if practicable.

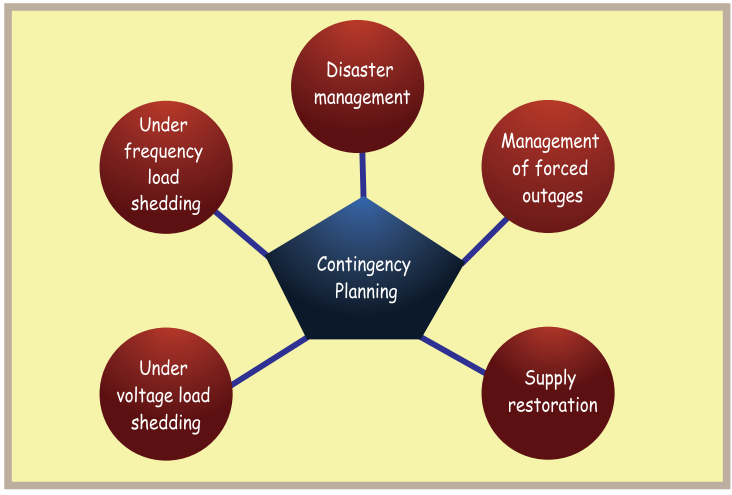

Figure OC.13: Building blocks of contingency planning

The TSP will use a color-based *alert scheme* to warn grid users whenever there is a deficiency of generation or some other serious occurrence on the system. The system *alerts* will include *amber alert, red alert, blue alert*, or any additional *alerts* as the TSP may agree with users in advance.

The reasons for issuing each type of alert and the actions required pursuant to their issuance are summarized in Figure OC.14.

(vii) Operational Testing

Operational Testing specifies responsibilities and procedures for conducting operational tests on the grid to obviate any impending dangers to the system or the equipment connected to it. The objective is to test and assess the security of the grid against certain special conditions that may pose risks for grid participants. However, tests of a routine nature, commissioning tests, or other tests of a minor nature are not included in Operational Testing.

Figure OC.15 shows the procedure for conducting operational tests on the grid. This procedure consists of five steps: submitting operational test request, establishing a test group, preparing a test program, conducting the test, and preparing a test report. Each of these steps is briefly described below.

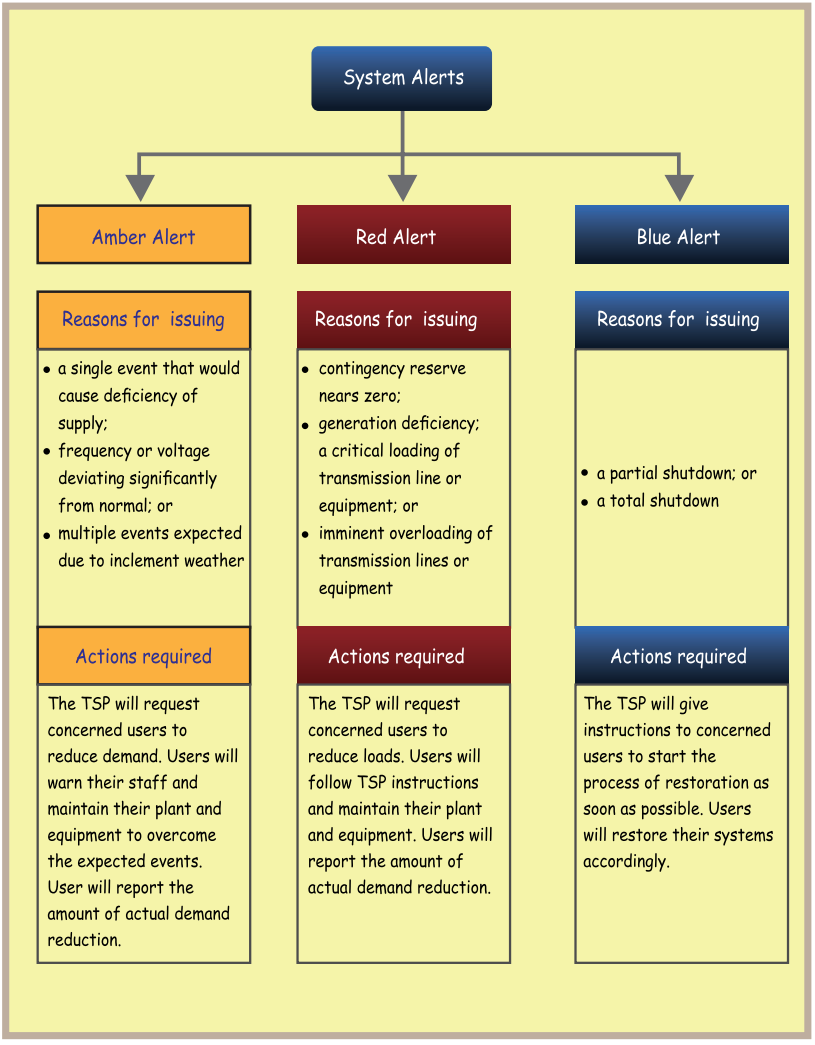

Figure OC.14: Various system alerts to be issued by the TSP to users

Figure OC.15: Five-step process for conducting operational tests on the grid

The user will submit operational test request to the TSP along with complete details of the procedure to be used for the proposed test, reasons for conducting the test, place, time, and duration of the test, and the equipment that will be involved during the test. Upon receipt of the request, the TSP will determine the time required for the proposed test, as well as the associated cost that may be involved. The TSP may ask the test proponent for any additional information that may be required. If the proposed test can affect other users, the TSP will notify them also.

After accepting the test request, the TSP will establish a test group that will consist of members drawn from the test proponent and the affected users. The TSP will also appoint a test coordinator for the group. In case an affected user does not nominate his representative despite receiving a reminder from the TSP for this purpose, the TSP will nominate another person on his behalf to protect the interests of the affected user in the group.

The test coordinator will convene the test group as often as may be necessary to discuss matters like economics, operational effects, and risks, etc., before finalizing a formal program for the proposed test. The test group will submit its proposed test program to the TSP, test proponent, and affected users. If any of them has objection on the proposed program, then the test group will revise the program to make it acceptable for all the parties. If the test group does not reach a consensus, then the TSP will take an appropriate decision to conclude the issue. The test will then be conducted as per the approved program. After successful completion of the test, the test proponent will prepare and submit a test report within one month to the TSP, members of the test group, and affected users.

(viii) Testing to Monitor, Investigate, and Verify Performance

To ensure safe, secure, and economic operation of the grid, the TSP may have to conduct certain tests to monitor, investigate, or verify the performance of a user's plant or equipment. The objective is to verify whether the user is complying or not with his contractual obligations. The procedure to be followed by the TSP for monitoring the user's plant and apparatus is shown in Figure OC.16.

The TSP will monitor the plant and apparatus of the user either continuously or for certain duration of time, by recording and analyzing data, or any other method which the TSP may consider suitable. The parameters to be monitored may include: (a) compliance with dispatch instructions; and (b) compliance with declarations. Users should note that an advance notification from the TSP to users for such purposes may not always be given for such tests.

In case of non-compliance, the TSP will provide evidence of non-compliance to the user. The result of the test to verify performance will be obtained by monitoring the performance of the user plant or equipment during the test. If a subcontractor is engaged to conduct testing work on the user site, the subcontractor will be selected by mutual agreement of the TSP and the concerned user.

Two additional type of tests that the TSP will conduct are *commissioning tests* on user facilities prior to energization and *generating unit capability tests*. These

tests are listed in sections 4.9.6 and 4.9.7 of the Operating Code. The commissioning tests will be conducted to ensure correct functioning of the user equipment, protection schemes, and other associated systems on a user project prior to energization.

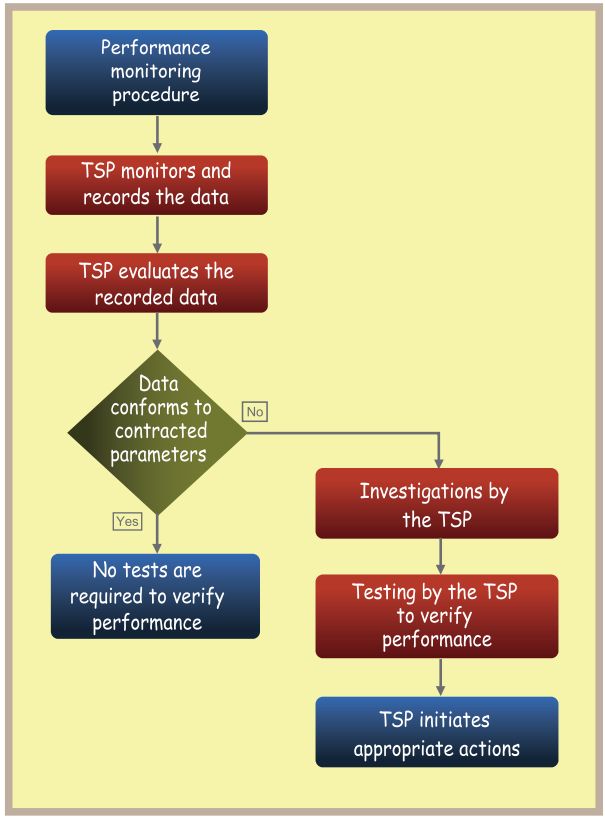

Figure OC.16: Procedure for monitoring user's plant/equipment

The generating unit capability tests will be conducted to confirm a generator's compliance with the provisions of the SAGC, its capability to be in accordance with registered planning parameters, delivery of the system services as per the agreement, or its availability in accordance with declaration. If a generating unit does not pass the capability test, then the owner will have to take the required remedial measures and re-submit its units for the re-testing by the TSP.

(ix) Cross-boundary Safety Assurance

Chapter 4, Operating Code concludes by providing a formal procedure for safety coordination among the TSP and other grid participants when work or testing is to be carried out *on* or *around* the connection point. The objective is to specify the safety procedures that the TSP and users will use to achieve safe working conditions for their workforce and apparatus during such work or testing.

The connection site safety will be governed in most cases by TSP's safety rules as detailed in the TSP safety manual. This manual is available from the TSP. However, the TSP may follow user safety rules also, in addition to its own rules, if at a particular user site the TSP staff could be exposed to some special risks.

For each connection site, the TSP and user will supply to each other a copy of their safety rules relating to their side of the connection point. The TSP will prepare the site responsibly schedule for each connection point in coordination with the relevant user, as explained in Connection Code. The site responsibly schedule will specify the safety representatives for the parties for each connection point.

The TSP and users are required to maintain proper logs, in a chronological sequence, to record all the safety messages exchanged between them during the last three years. These logs may have to be used in case an accident occurs and there is a need to investigate its causes and fix responsibility.

Scheduling and Dispatch Code

Overview

Scheduling and Dispatch Code defines the responsibilities and obligations of the TSP and users regarding the scheduling and dispatch of available generation supplies and demand resources to satisfy power and energy demand on the grid. The objectives are to specify the processes that the TSP will follow to prepare and issue generation schedules and, later, dispatch instructions in coordination with generators, distribution entities, and directly-connected customers to achieve demand-supply balance on the grid with minimum cost and maximum reliability and quality of supply.

Figure SDC.1 below shows the thematic arrangement of Scheduling and Dispatch Code. Figure SDC.2 illustrates major topics that are covered in this sub-code.

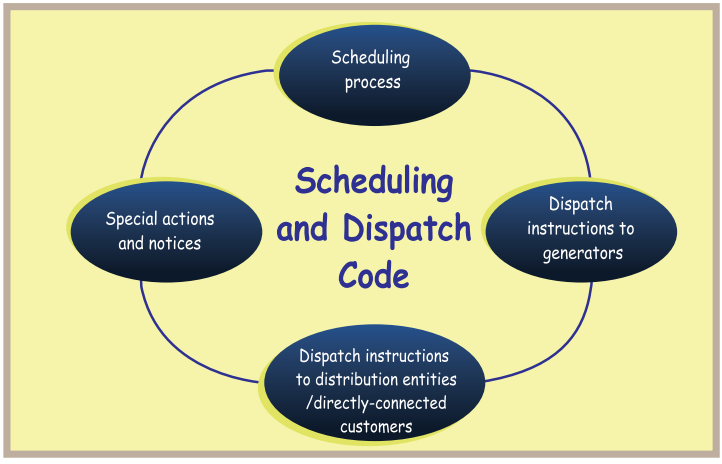

Figure SDC.1: Thematic arrangement of Scheduling and Dispatch Code

Responsibilities

The TSP will prepare and issue generation schedule for the next schedule day by 15:00 hours every day. The TSP will also specify any required special actions from generators, distribution entities and directly-connected customers in the wake of the generation schedule. Subsequently, the TSP will issue dispatch instructions to users during execution of generation schedule to achieve demand-supply balance on the grid during normal and unexpected conditions. Generators are required to declare/nominate their available generating units and to submit scheduling and

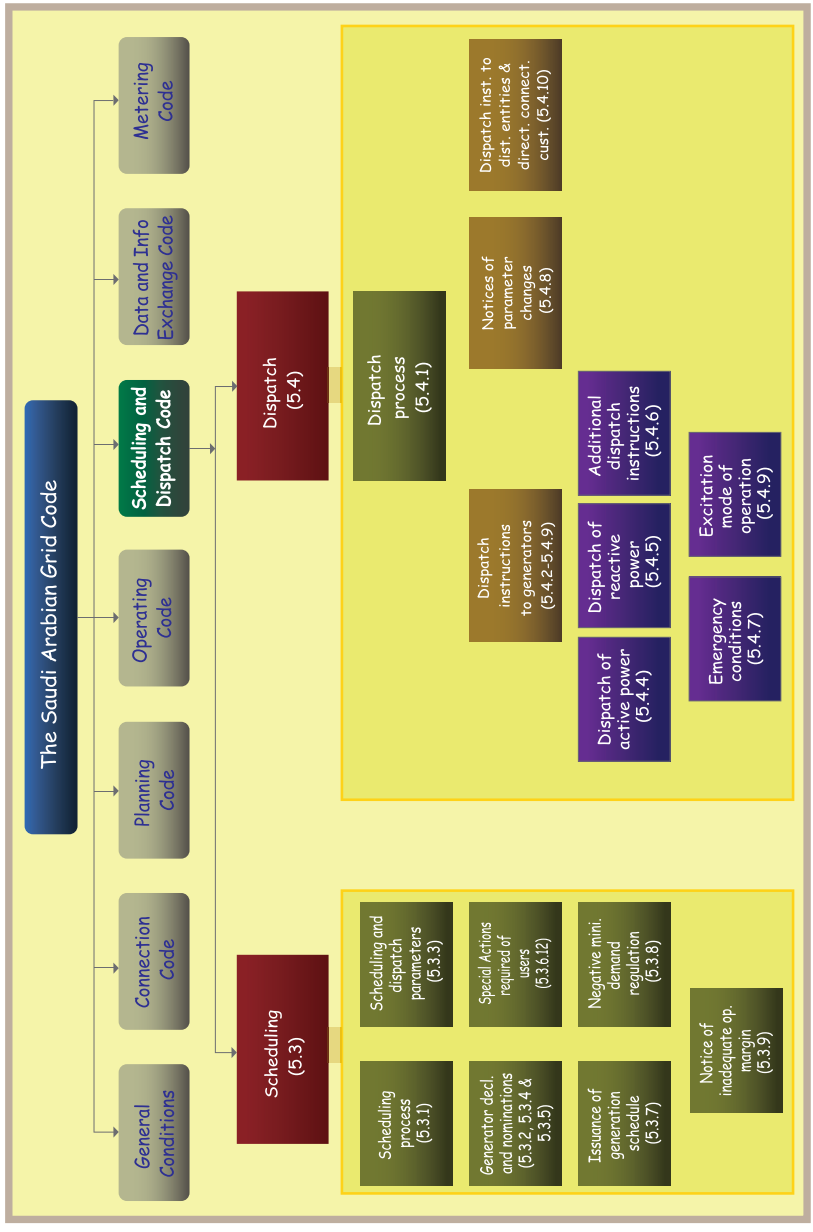

Figure SDC.2: Major topics covered in Scheduling and Dispatch Code

dispatch parameters regarding the units/stations and to apprise the TSP of any subsequent changes to these units/stations' availability characteristics. The generators as well as distribution entities and directly-connected customers are responsible to execute dispatch instructions that will be issued by the TSP after issuing of the generation schedule. They will confirm to the TSP once they have successfully achieved the required targets.

Main Topics

The main topics of Scheduling and Dispatch Code are briefly discussed below:

(i) Generation Scheduling process

Generation scheduling is the process that the TSP will carry out daily to allocate the generation that has declared itself available for the next schedule day to match supply with expected demand. The generation schedule will cover a period of 24 hours, from 6:00 hours of the schedule day to 6:00 hours of the next following day. The *generation scheduling* process starts at 10:00 hours every day at which the TSP will receive *availability notices* and *scheduling and dispatch parameters* from generators as are detailed in Appendix A5.1 of Scheduling and Dispatch Code and shown in Figure SDC.3 and SDC.4.

These data and information will be submitted by them through facsimile or by any other means as mutually agreed. If the TSP does not receive these data and information by 10:00 hours, it will contact the concerned generator to get these data before 12:00 hours. If the TSP still does not receive these by 12:00 hours, the TSP will estimate these data in accordance with the previously submitted data by that generator. The TSP may impose appropriate sanctions or penalties, as approved by ECRA, on a generator which repeatedly fails to submit nominations or does not submit nominations in time.

The TSP will then prepare the generation schedule by considering factors such as those shown in Figure SDC.5 and by following the process shown in SDC.6.

After completion of the scheduling process, but before issuing the schedule, the TSP may consider it necessary to modify the schedule in accordance with the TSP's operational policies after consulting generators and other users. By 15:00 hours, however, the TSP will issue the final generation schedule. Generators can still submit revised data to the TSP at any time after issuance of the schedule and before the end of the schedule day if a change has occurred to the availability parameters or operating characteristics of their generating units. Accordingly, the TSP will try to modify the generation schedule, if necessary and practicable for it.

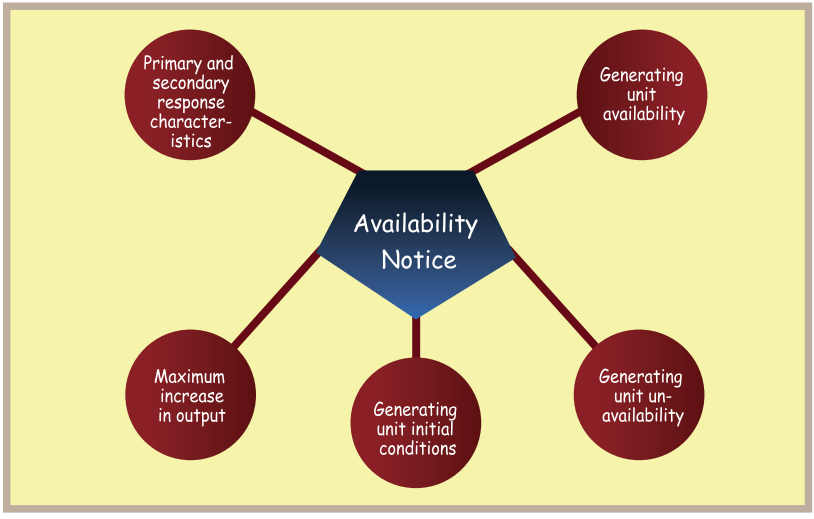

Figure SDC.3: Parameters to be included in the Availability Notice

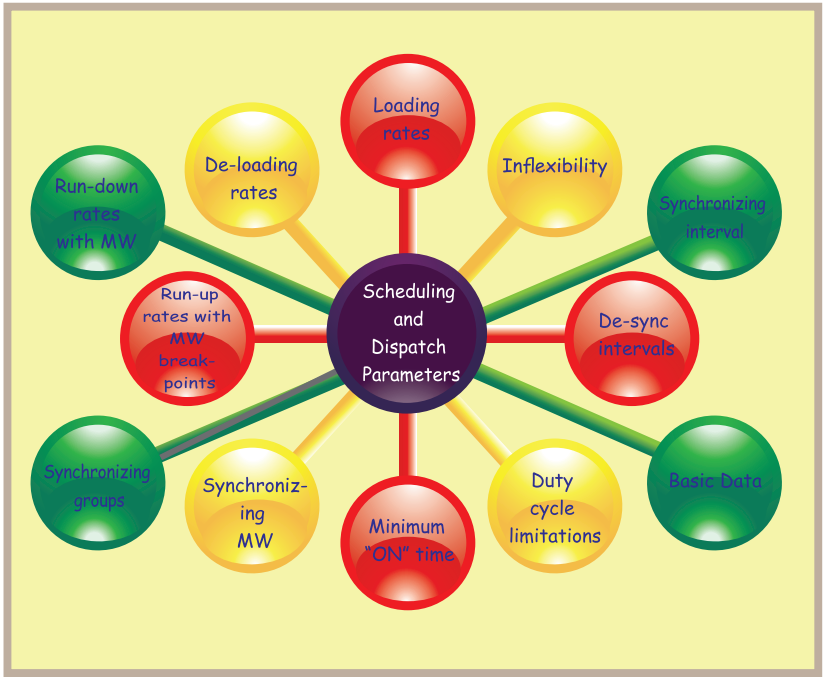

Figure SDC.4: Scheduling and dispatch parameters to be provided by generators

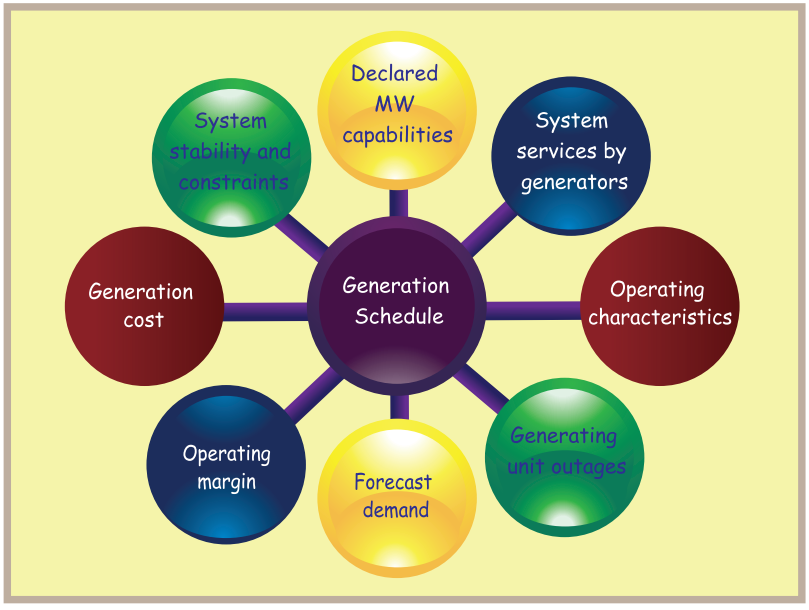

Figure SDC.5: Factors to be considered by the TSP in preparing generation schedule

The generation schedule may be followed by a list of *special actions* that the TSP may require from generators, distribution entities, or directly-connected customers. These actions aim to keep demand-supply balance on the grid and system reliability during any expected threat or contingency, and will be discussed and agreed with the concerned users as much as possible. The actual implementation of these actions will be part of the dispatch process. Special actions for generators may involve a load change or a change of required notice to synchronize. These actions aim to ensure sufficient supply resources to meet any expected demand. Special actions for distribution entities and directly-connected customers may include a load transfer or an arrangement for demand reduction. These actions will aim to maintain nominal voltage and frequency on the transmission system.

The TSP may also need to issue *special notices* to users, such as the following:

a. *Negative Minimum Demand Regulation (NMDR)* to ensure synchronized generating units' capability to reduce their output sufficiently to compensate for

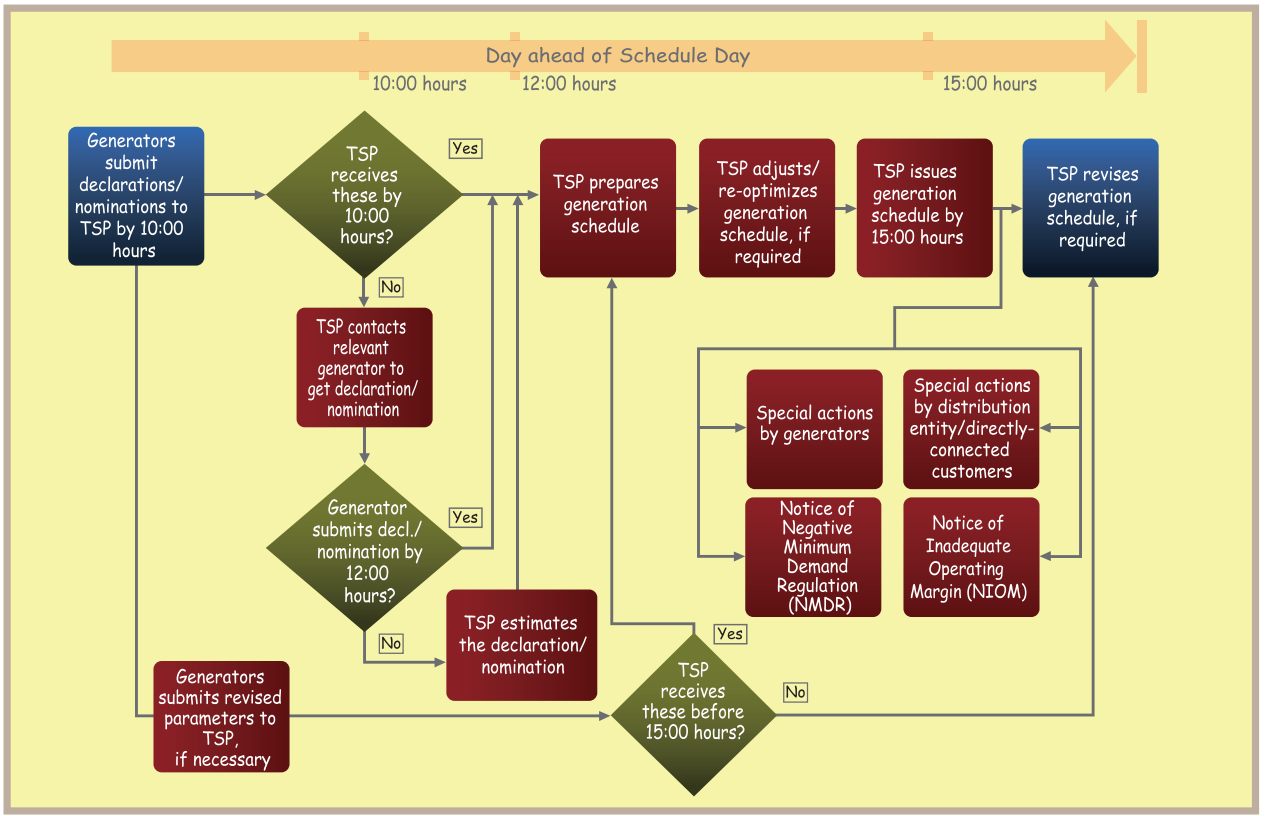

Figure SDC.6: Overview of the Generation Scheduling Process

the loss of the largest demand on the system and to sustain this response. For this purpose, the TSP will continuously monitor the output data of the generation schedule against forecast demand to see whether the level of NMDR is sufficient or not. If it is insufficient, the TSP will contact generators to discuss any possible changes to the generating unit inflexibility or declared availability.

b. *Notice of Inadequate Operating Margin (NIOM)* will be issued by the TSP to a generator or distribution entity if the level of operating margin on the system is found to be insufficient. The TSP is responsible for monitoring the output data of the generation schedule against forecast demand to see whether the level of operating margin is adequate or not. NIOM will indicate the magnitude and the period for which insufficient level is expected. As part of the NIOM, the TSP may ask a user to change its declared availability or reduce the demand.

(ii) Dispatch process

At any time during implementation of the generation schedule, the TSP may issue *dispatch instructions* to generators, distribution entities, or directly- connected customers. These instructions are to achieve demand-supply balance on the system in real time and maintain integrity and stability of the grid during normal as well as unforeseen circumstances. Such circumstances may result from load variations, delay of generation dispatches, change in mode of operation, adverse weather conditions, or unexpected system outages.

Figure SDC.7 provides an overview of the dispatch process. Dispatch instructions may be given by the TSP orally, in writing, or by any other mutually agreed means. The TSP may also revise, modify or cancel any dispatch instruction when it considers this to be necessary. If a user faces any unexpected hurdle or problem in executing the instruction given to him, he is expected to discuss this with the TSP immediately. The TSP will try to issue a new instruction to that user to tackle the problem. The users should inform the TSP once they successfully achieve the action that was required of them in the dispatch instruction.

Nature of dispatch instructions issued by the TSP

a. Dispatch instructions to generators: The dispatch instructions issued to generators may include instructions to synchronize or de-synchronize a generating unit, change active and/or reactive power output, change mode of operation, or provide one or more of the contracted system services.

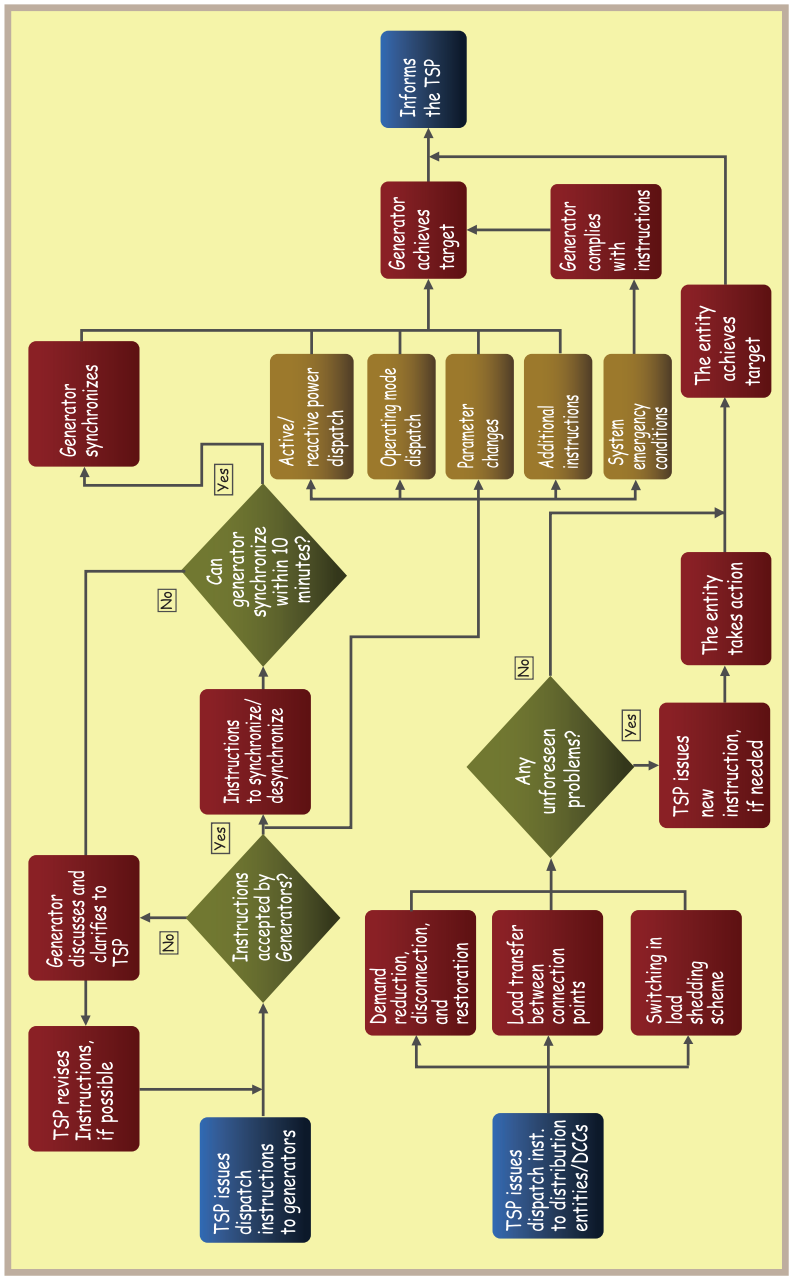

Figure SDC.7: Overview of Dispatch Process

b. Dispatch instructions to distribution entities and directly-connected customers: The dispatch instructions issued to distribution entities and directly-connected customers may involve instructions for reducing demand, restoring demand, transferring load between connections points, or switching in the load shedding scheme.

The format and terms to be used by the TSP for issuing dispatch instructions are available from the TSP.

Data and Information Exchange Code

Overview

Data and Information Exchange Code specifies obligations and responsibilities of grid participants regarding supply of data and information to enable proper and effective planning, operation, and management of the grid by the TSP. All data and information requirements specified in other chapters of the SAGC are collated in this chapter and are organized in a tabular form to facilitate grid participants in this exchange. The objective is to formalize the data exchange procedure and also to list the data and information that are to be exchanged.

Users should, however, note that if there is any discrepancy between the provisions of Data and Information Exchange Code and those of any other chapters of the SAGC, the provisions of the other chapters, where such data and information requirements are specified in greater detail, shall prevail.

Figure DEC.1 below shows the thematic arrangement of Data and Information Exchange Code. Figure DEC.2 illustrates the major topics that are covered in this sub-Code.

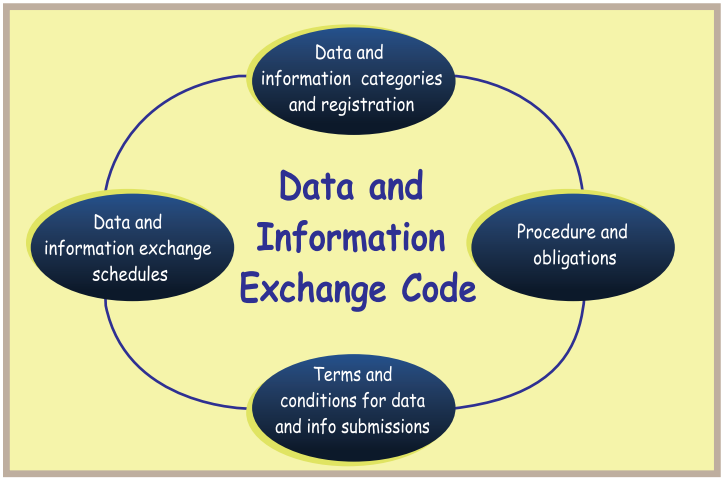

Figure DEC.1: Thematic arrangements of Data and Information Exchange Code

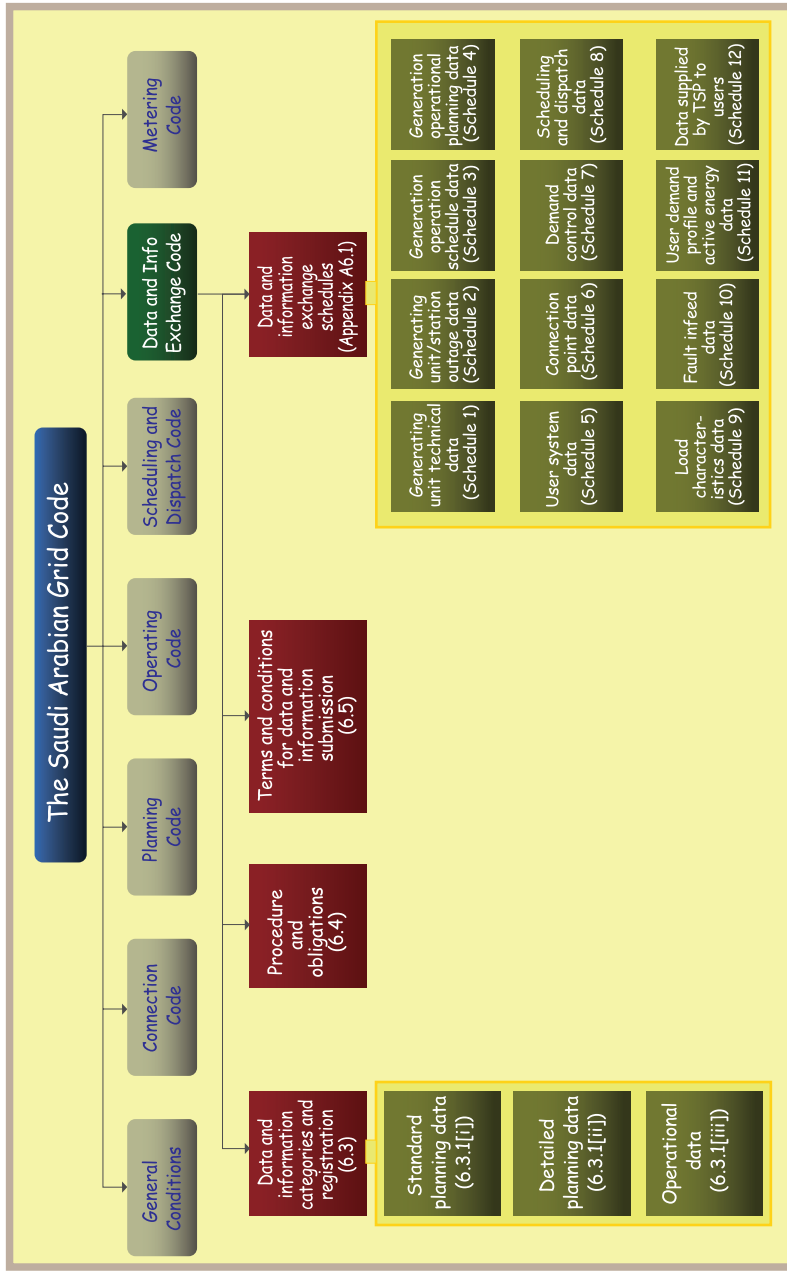

Figure DEC.2: Major topics covered in Data and Information Exchange Code

Responsibilities

The TSP will be responsible for providing any required data and information to users as per Schedule 12 of this chapter. The TSP will also be responsible to store and archive all planning and operational data and information for at least five years. Users will be responsible to submit data and information to the TSP using Schedules 1 to 11 of this chapter. The users will also retain their planning information for at least five years.

Main Topics

The major topics of Data and Information Exchange Code are briefly described below:

(i) Data and Information Categories and Registration

Users will provide three categories of data to the TSP: (a) Standard Planning Data- the data for users' equipment already connected to the transmission system. These data will be submitted by users to the TSP for planning of the grid; (b) Detailed Planning Data - the additional data that the TSP may require from users to further study the impact of the user system on the grid; and (c) Operational Data - the operational parameters of the users' plant and equipment connected to the transmission system. These are required by the TSP to ensure stable and secure operation of the grid.

(ii) Procedure and Obligations

Grid participants will store and archive their planning and operational data and information for at least five years. This will include electronic as well as paper based information. The TSP and users will ensure that adequate backup of their data and information is always available in their respective system. As all data and information is required to be auditable by ECRA, the TSP and user should maintain a proper audit trail of all changes made to their archived data, as well as the time and date of these changes. This audit trail should show both *before* and *after* values of all content and structure changes to the data.

(iii) Terms and Conditions for Data and Information Submission

Each user will submit the data electronically, if possible, or by any other means as agreed with the TSP. Each user will submit data for its plant and equipment (either already connected to the transmission system or prior to such connection) to the designated office of the TSP. Each user, when supplying data to the TSP, will also identify the national or international standards to which his plant or equipment is

designed. The user will also notify any changes to its previously submitted data to the TSP, whenever such changes are made.

If a user fails to supply the required data, the TSP will estimate such data, if necessary, based on the relevant data previously submitted by the user. Similarly, in case the TSP fails to supply the required data to a user, the user will estimate these data, if necessary. However, the TSP or a user (as the case may be) will inform the other in writing before using estimated data. Any risk associated with the use of estimated data will be borne by the party who fails to provide the required data.

(iv) Data and Information to be Registered (Appendix 6.1: Schedule Forms)

This section of Data and Information Exchange Code provides the schedules that participants should use for exchanging data and information among them. Schedules 1 to 11, as described in Table DEC.1 below, are to be submitted to the TSP by generators, distribution entities, and directly-connected customers. Schedule 12 will be used by the TSP for supplying data to users. These schedules are provided to facilitate grid participants for exchanging the required data and information among them in a consistent manner and in a standardized format. Grid participants should use Microsoft Excel based schedules for data and information exchange with each other that are available on the SAGC webpage. The diagrams required in these schedules should be provided in a standard format like JPEG, GIF, BMP, TIFF, etc., and arranged on a standard paper size. Users can always add any additional data/information that may have been missed in these schedules but, in the user's opinion, will be of vital importance to the TSP.

Table DEC.1 provides brief descriptions of each schedule and also refers to the relevant sections of the SAGC where users can find additional details regarding the data and information being required in each of these schedules. It also indicates applicability of different schedules to each category of users.

Table DEC.1: Applicability of the schedules to each category of grid participants

Title of the Schedule	Type of Data	Description of the Required Data	SAGC Cross Reference
Generators will use these schedules to submit data to the TSP			
1- Generating Unit Technical Data	Planning	Generating units/stations fixed parameters involving capacities, ratings, impedances, time constants, step up transformers, excitation systems, stabilizers, protection settings, flexibility performances, and auxiliary demand.	Sections 3.3.3.4, 3.3.3.5, and Appendix A3.1, and A3.2
2- Generating Unit/Station Outage Data	Operational	Outage program for the next five years, and *Short term Planned Maintenance Outage* for the current year.	Section 4.3
3- Generation Operation Schedule Data	Operational	Data required for preparing generation schedules according to programming, control, and post control phases.	Section 4.3.6
4- Generation Operational Planning Data	Operational	Generating unit/station parameters for operational planning including synchronizing times and loading rates for each steam turbine or gas turbine unit.	Section 4.3.6
8- Scheduling and Dispatch Data	Operational	Output power and duration of generating unit availability, unavailability, inflexibility, synchronizing intervals, and other basic ratings.	Section 5.3.3.1 and Appendix A5.1
Distribution Entities and Directly-connected Customers will use these schedules to submit data to the TSP.			
5- User System Data	Planning	Electrical parameters relating to user plant and apparatus connected to the transmission system including electrical drawings, line impedances, specifications of transformers, switchgear, grounding, protection and reactive power compensation. Also includes data regarding embedded generating units, fluctuating loads, commutating power electronic loads, high voltage motors of 10,000 HP or above, and transient over-voltages.	Sections 3.3.3.4, 3.3.3.5, and Appendix A3.1 and A3.2

Title of the Schedule	Type of Data	Description of the Required Data	SAGC Cross Reference
6- Connection Point Data	Planning	Data relating to peak demand and demand transfer capability, including user demand at maximum and minimum conditions on the grid, and magnitude and mechanism of demand transfer.	Section 3.3.3.4 and Appendix A3.1
7- Demand Control Data	Operational	Demand profiles during programming, control, and post control phases. Demand profiles during operational planning phase are included in schedule 11 below.	Section 4.2
9- Load Characteristics Data	Planning	Estimated parameters like demand sensitivity, load criticality, harmonic content.	Section 3.3.3.5 and Appendix A3.2
11- User Demand Profiles and Active Energy Data	Planning and Operational	Demand profiles including forecast of power and energy for the next five years on hourly basis and segregated by usage categories.	Section 3.3.3.4, Section 4.2 and Appendix A3.1

Generators, Distribution Entities and Directly-connected Customers will use this schedule to submit data to the TSP.

10- Fault Infeed Data	Planning	Data relating to short circuit infeeds to the transmission system from user facility.	Section 3.3.3.5 and Appendix A3.2

The TSP will use this schedule to share data with Generators, Distribution Entities and Directly-connected Customers.

12- Data to be Supplied by the TSP to Users	Planning and Operational	Date and timing of the TSP's maximum and minimum demand. These will also include outage program and data regarding short circuit infeeds to users system.	Sections 1.13.3 and 2.3.5

Metering Code

Overview

Metering Code establishes the requirements, obligations, and standards for recording and metering the flow of electricity on the grid. It also prescribes the procedure to record, store, and communicate metering data. The objective is to define the responsibilities of the grid participants regarding measuring and recording the flow of active and reactive power and energy on the grid. It further aims to specify the terms and conditions to establish, maintain, test, and certify the metering facilities at the connection points.

Figure MC.1 below shows the thematic arrangement of Metering Code. Figure MC.2 illustrates the major topics that are covered in the Metering Code.

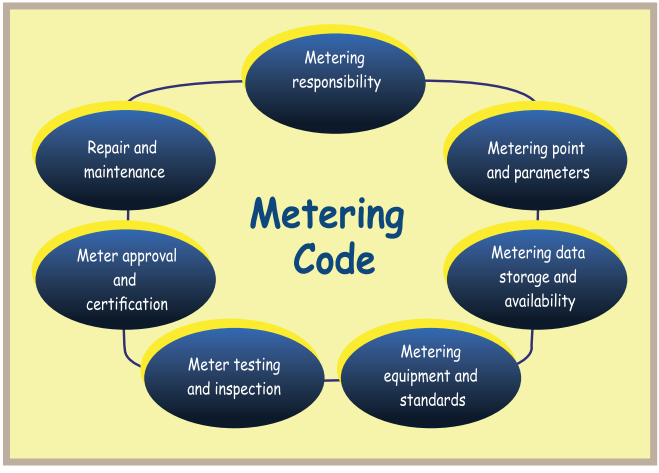

Figure MC.1: Thematic arrangement of Metering Code

Responsibilities

The TSP will be responsible to ensure that all metering points have proper metering facilities and to collect and manage information from them. The TSP will also ensure that installation, maintenance, auditing and testing of metering equipment are carried out in accordance with the Metering Code. Further, the TSP will be responsible for approving the meter types and verifying of metering facilities'

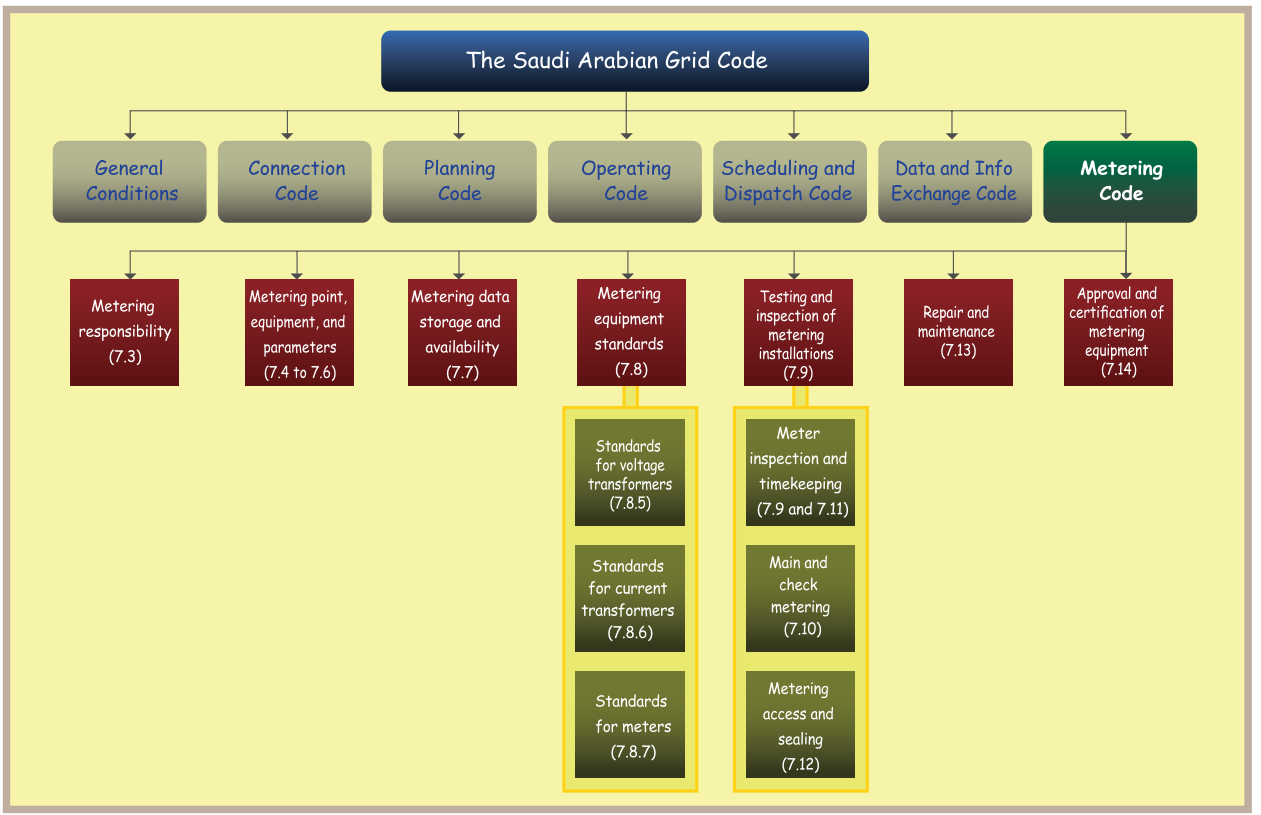

Figure MC.2: Major topics covered in Metering Code

compliance with the prescribed metering standards. Users will be responsible to provide meters and associated equipment and facilities at the connection point(s) and offer these for installing and sealing by the TSP along with proofs of certification from an accredited laboratory in respect of their meters and CTs and VTs. Users will also be responsible to provide any information that the TSP may require from them to perform its metering duties.

Main Topics

The major topics covered in the Metering Code are briefly described below:

(i) Metering equipment standards

All metering equipment should comply with the provisions of the Metering Code. The accuracy of metering equipment must conform to the relevant IEC, Saudi national, or TSP standards as specified in section 7.8 of the Metering Code.

(ii) Metering equipment

The metering equipment includes meters, instrument transformers, lightning protection, and all other interconnecting electric or telecommunication cables, wires, and associated devices, etc. Meters at the metering point will include *main* meters and *check* meters. Main meters will provide primary measurements at a metering point for billing purposes. Check meters will act as a backup for the main meters, and will be used for verification or substitution purposes. If a main meter becomes defective, the check meter at that point will be used to estimate power and energy flow until the main meter is repaired or replaced. The provisions of Metering Code will apply equally to both the main and check meters. Main and check meters should be from different manufacturers and should operate from separate CT and VT windings.

(iii) Metering point

The metering point will be the connection point, in most cases. However, in some special cases, the metering point may differ from the connection point, if mutually agreed by the TSP and a user. In such cases, compensation for any power transformer or line losses will be provided either internally in the metering system by making adjustments to the multiplying factors, or externally by using an appropriate formula to estimate the losses.

(iv) Metering parameters

Figure MC.3 shows the parameters that meters should be capable of measuring.

(v) Metering data storage and availability

The TSP will establish and manage a database for all metering installations. This database will include information such as the name and date of the installation, date of commissioning and energization, fault and maintenance history, type of the meter, and calibration certificates for the metering equipment. The data storage capability of the metering equipment is shown in Figure MC.4.

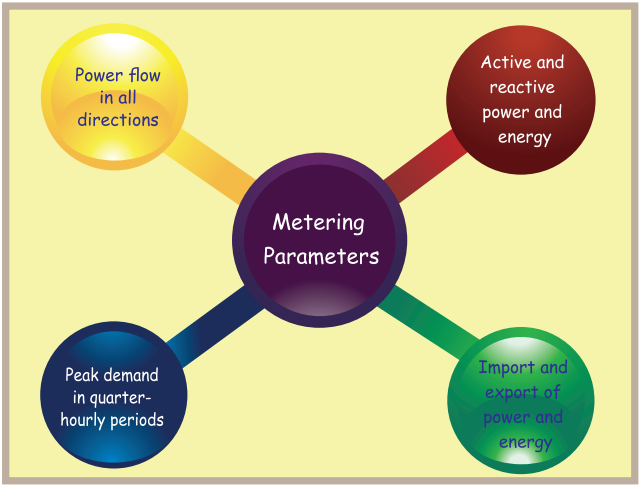

Figure MC.3: Metering parameters to be measured at every metering point

User's metered data will be considered confidential and will not be disclosed to anyone, except that user or ECRA. The TSP will maintain a log for monthly demand and energy reading at each metering point. Such logs will include brief information on interruption or other unusual events that affected the service. A user may request the TSP for a copy of such logs. The TSP will also provide a user direct access to his meter data, if requested by him. However, this access will be restricted to check meter's data only and will be in the same format as that of main meter.

(vi) Testing and inspection of Metering Installations

All meters, CTs, and VTs, will be tested for accuracy before initial commissioning and also afterwards. These tests will be carried out at intervals not less than every twelve (12) months for main meters and not less than six (6) years for CTs and VTs,

or as specified in the relevant connection agreement to verify that their operation is within the accuracy limits.

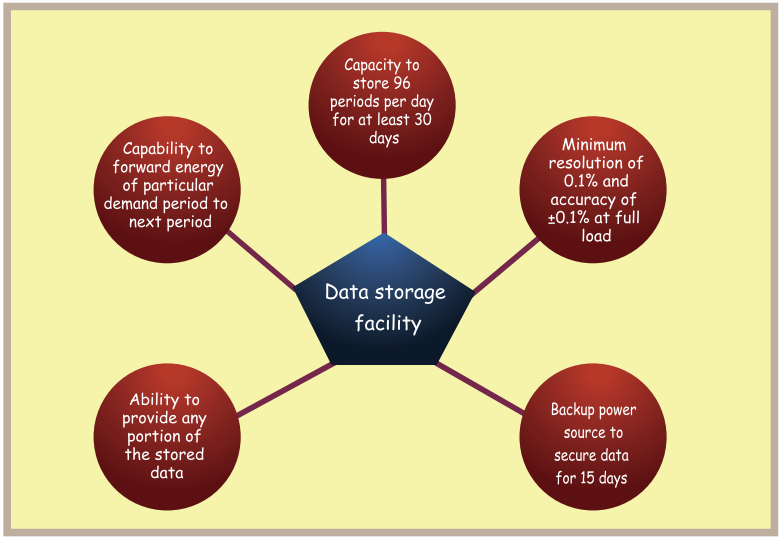

Figure MC.4: Data storage capability of meters

(vii) Metering access and sealing

User will make all necessary arrangements to facilitate the TSP or its representative's access to metering equipment and the associated communication equipments at the user site. The cabinet that is to house the metering equipment must be equipped with proper lock and will be sealed by the TSP.

(viii) Repair and maintenance of Metering Equipment

The metering equipment at the connection point will be maintained by the TSP at the witness of relevant user. The TSP will keep a record of all test results, maintenance programs, and sealing records relating to the metering equipment at each connection point. If a metering system malfunctions or requires maintenance, the TSP will repair it as soon as is practicable.

(ix) Approval and Testing of Metering Equipment

Users will only use the types of meters that are approved by the TSP and also from manufacturers pre-qualified by the TSP for this purpose. All new metering equipment should be certified in accordance with the relevant international, Saudi national, or TSP standards. The meter certificates will be issued for a limited

period only. This period may differ for different meter types and may change from time to time. The TSP will also maintain a record for all metering equipment relating to their calibration including the dates and results of any test, readings, and adjustments.

(x) Meter Reconciliation

For reconciliation purposes, each month the TSP will read the values of metered cumulative energy through remote communication means. In case such remote reading is not possible, the TSP will read the meters manually.

The TSP will prepare a *meter reconciliation statement* within three weeks of the above reading to record any difference between two successive readings and then compare it with the total energy recorded electronically for the same period. If a difference of more than 0.1% between the two readings is observed, it will be highlighted for further investigation. If the difference is confirmed after investigation, then the TSP will inform the relevant user and take appropriate action to deal with the situation in accordance with applicable rules and regulations.

For further information, please contact:
Transmission Regulation Department
Transmission Business Unit
Saudi Electricity Company
P. O. Box 57, Al-Riyadh 11411
Kingdom of Saudi Arabia