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المؤسسة العامة القطرية للكهرباء والماء
Qatar General Electricity & Water Corporation

ES-M4

QATAR TRANSMISSION GRID CODE

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PREFACE

This document is the Qatar Transmission Grid Code.

It is provided for all electricity grid stakeholders in Qatar, particularly for Grid Users involved in power generation and power consumption connected from 11 to 400 kV networks of the Electricity Transmission Network (ETN).

The Grid Code describes the main activities performed by Kahramaa for planning and operating the Electric Power System (EPS) and involving Grid Users.

The Grid Code also lays down the mandatory requirements for the connection and the operation of Generating and Demand Facilities.

The application of the Grid Code contributes significantly to the Security of the ETN, provides for the operation of the EPS a secure framework when integrating new power generation (intermittent or dispatchable) and favors fair conditions for the competition in the electricity market.

The Grid Code facilitates the safe, economic, equitable, and efficient planning, development, operation, and maintenance of the ETN for the benefit of all Grid Users.

The Grid Code aims to establish discipline among the Grid Users for reliable and stable operation of the EPS.

CONTENT OF THE GRID CODE

The Qatar Grid Code covers:

a) this General Provisions (GP) section A, describing the regulatory regime of the Grid Code, the responsibilities of the involved parties, the scope of application, the general rules for communication, for data exchange and for arbitration, the principle and the provisions necessary to manage the Grid Code changes and various chapters as definitions and interpretation;

b) a Planning Code (PC) section B, describing the long run generation planning, the Demand Forecast, and the transmission development processes performed by Kahramaa to instruct Grid Users to provide Kahramaa with timely and accurate data and information necessary to plan the future development of the EPS;

c) a Connection Code (CC) section C, regulating and standardizing the grid connection processes for power producers and for Bulk Consumers;

d) a Requirements for Generators and for Bulk Consumers Code (RGCC) section D, setting up the technical requirements and the compliance process for connection and for operation ensuring that technical and operational conditions are met by Generating Units or Facilities and by Demand Facilities;

e) an Operating Code (OC) section E, defining the system Security Standards and the general rules used by Kahramaa to operate the EPS in Normal and Alert States of the EPS. This section defines the information exchanged between Kahramaa and the Grid Users in operation for short run planning and scheduling as well as for real-time operation; and

f) an Emergency and Restoration Code (ERC) section F, setting out the essential provisions necessary for Kahramaa to operate the EPS in Emergency or Restoration States. This section also defines the requirements for Grid Users to contribute to Defense and to Restoration Plans.

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A. GENERAL PROVISIONS (GP)

A.1 REGULATORY FRAMEWORK

a) The Grid Code is under the responsibility of the Director of Electricity Network Affairs of Kahramaa.

b) "Authority" as used in this Grid Code refers to nominated individuals or bodies that have been designated by the Ministry of Energy for the implementation, for the enforcement and for the control of the Grid Code.

c) The Grid Code is monitored and updated by the Grid Code Review Panel (GCRP). The role of the GCRP is described in A.6 Grid Code Review Panel.

d) Each party shall, at all times in its dealings with the other parties to the Grid Code, act in good faith and in accordance with the established good industry practices.

e) The latest issues of the following rules and regulations shall be applied for all activities related to the Grid Code:

1. Safety Rules for the Control, Operation and Maintenance of Electricity Transmission & Distribution System of Qatar General Electricity & Water Corporation;
2. System Operation Memorandum (SOM);
3. Kahramaa interlocking document, (Qatar Power Transmission System Expansion – Latest phase – Substations);
4. ET-P26-G1 Guidelines for Protection Requirements;
5. ES–EST-P1-G1 Guidelines for System Control Requirements for Power Supply to Bulk Customers;
6. ET-P20-S1 Transmission Protection Standards for TA and ET Projects;
7. ES-M2 Qatar Power System Restoration Plan; and
8. ES-M3 System Emergency, Categorization, Communication & Restoration Responsibility.

A.2 SCOPE OF APPLICATION

a) The requirements set out in the Grid Code apply to:

1. Generating Units, according to their category as defined in chapter A.2.2;
2. Generating Facilities formed in Generating Units, according to their category;
3. Generating Units embedded in the networks of industrial sites;
4. Demand Facilities with a maximum demand capacity equal of greater to 5 MW; and
5. Power Storage Units with a generating capacity greater than 2 MW which are part of Generating Facilities.

b) The Grid Code does not apply to electricity networks forming electrical islands, that are not permanently connected with the Electricity Transmission Network (ETN).

A.2.1 APPLICATION TO GRID USERS

For the purposes of the Grid Code, a Generating Unit or a Demand Facility shall be considered existing if:

a) It is already synchronized or connected to the ETN on the date of entry into force of the Grid Code; or

b) not later than 1 years after the issuance of the Grid Code, the Final Completion Certificate of the Generating Unit is pronounced or the Bulk Supply Agreement of the Demand Facility is signed.

A.2.1.1 EXISTING GENERATING UNITS AND DEMAND FACILITIES

a) On the date of entry into force of the Grid Code:

1. requirement B.2.3 is applicable to all existing Generating Units or Demand Facilities;
2. power quality measurements can be requested by Kahramaa and performed according to RGCC requirements D.2.6 on Generating or D.4.11 on Demand Facilities;
3. testing can be requested by Kahramaa and performed according to RGCC requirements D.2.8 or D.3.7 on Generating or D.4.13 on Demand Facilities. In such case, RGCC testing acceptance criteria are not applicable; and
4. RGCC and ERC requirements considered necessary by Kahramaa for the implementation of the Defense Plan and the Restoration Plan of the ERC are applicable to the concerned Generating Units and Demand Facilities.

b) On the date of entry into force of the Grid Code with regard of paragraph a), existing Generating or Demand Facilities are not subject to the requirements of the Grid Code, except for these that will be modified after the publication of the Grid Code in accordance with the following procedure:

1. Facility Owners who intend to undertake the modernization of a plant or to replace equipment impacting the technical capabilities of the units shall notify their plans to Kahramaa in advance at least one year before;
2. If Kahramaa considers and demonstrates that the modernization or replacement of equipment may cause a security issue, then the unit shall fully comply with the Grid Code requirements; and
3. If Kahramaa considers and demonstrates that the modernization or replacement of equipment requires an update of the technical provisions of the existing PWPA, then the Generating Unit shall comply with the Grid Code requirements related to the update of the above technical provisions.

c) After the date of entry into force of the Grid Code, Facility Owners who intend to abandon a plant or individual unit of the plant due to obsoleting of technology shall notify their tentative plans to Kahramaa in advance at least one year before.

A.2.1.2 FUTURE GENERATING UNITS AND DEMAND FACILITIES

a) On the date of entry into force of the Grid Code, a Generating Unit or a Demand Facility shall be considered future if:
   1. The Grid Impact Study for a Generating Unit/facility or the Consultancy Service Agreement for a Demand Facility has not been accepted by Kahramaa; or
   2. The PWPA of the Generating Unit or the BSA of the Demand Facility is not signed;

b) Future Generating Unit/facility or Demand Facility Owners shall apply and comply with all the processes, procedures and requirements set out in the Grid Code:
   1. to participate to EPS planning (Planning Code);
   2. to implement harmonized and standardized grid connection activities (Connection Code);
   3. to contribute to system Security and Reliability (Requirements for Generators and Consumers Code);
   4. to be accepted in the electricity market as producer or consumer (Operation Code); and
   5. to participate, according to their role and capability, to the safeguard and to the restoration of the EPS (Emergency and Restoration Code).

A.2.1.3 EMBEDDED GENERATING UNITS CONNECTED TO NETWORKS OF INDUSTRIAL SITES

a) Requirements of the Grid Code relating to the capability to maintain constant Active Power output or to modulate Active Power output shall not apply to Generating Units of Facilities for combined heat and power production embedded in the networks of industrial sites where heat and power is inextricably interlinked, that is to say any change in heat generation results inadvertently in a change in Active Power and vice versa.

b) Owners of industrial sites with embedded Generating Units shall have the right to agree on conditions for disconnection of such Generating Units with critical loads,

which secure production processes. The exercise of this right shall be coordinated with Kahramaa.

A.2.2 DEFINITION OF CATEGORIES FOR GENERATING UNITS AND SIGNIFICANT GRID USERS

A.2.2.1 CATEGORIES OF GENERATING UNITS

To allocate technical requirements to the characteristics and to the capabilities of the Generating Units and according to their relevance with regards to system security, Generating Units are grouped into categories based on technology, power and voltage.

a) The Generating Units shall comply with the requirements on the basis of the voltage at the Connection Point and of the maximum capacity according to the categories set out in Table A.2-1

b) The categories are:

1. Any Generating Unit connected at 11 kV with a capacity between 2 and 10 MW is considered category D;
2. Synchronous Generating Unit connected above 11 kV and with capacity above 10 MW, are considered category S; and
3. Non-Synchronous Generating Unit connected with power electronics systems above 11 kV and with capacity above 10 MW, are considered category P.

c) Synchronous machines include all the components of a Generating Facility that normally run indivisibly, such as separate alternators driven by separate gas and steam turbines of a single combined-cycle gas turbine installation. For a facility including several such combined-cycle gas turbine installations, each unit is assessed on its size, and not on the whole capacity of the facility.

d) Non-synchronously connected Generating Units (or Power Park Modules, PPM), where they are collected together to form an economic unit and where they have a single Connection Point are assessed on their aggregated capacity.

Categories	D All generators	S Synchronous generators	P Non-synchronous generators (PPM)
Power capacity	Between 2 and 10 MW	> 10 MW	> 10 MW
Connected voltage	11 kV	>11 kV	

Table A.2-1: Definition for thresholds for categories D, S and P Generating Units

A.2.2.2 SIGNIFICANT GRID USERS

a) A Significant Grid User (SGU) is a Generating Facility or a Demand Facility significant for important system operation matters (for instance: power capacity, grid stability, Ancillary Services, grid location, priority load centre, etc.).

b) Significant Generation Facility (SgF) is an attribute for Generating Facilities particularly important for system Security or Reliability matters (for instance due to significance power capacity, grid stability, Ancillary Services, contribution to system restoration, etc.).

c) Significant Demand Facility (SdF) is an attribute for Demand Facilities particularly important for system Security or Reliability matters (for instance due to demand capacity, contribution to Defense Plan, priority load centre, etc.).

d) SGUs are identified and nominated by Kahramaa six months after the entry in force of the Grid Code or after the acceptance of the commissioning phase. Kahramaa shall inform SGUs of the technical characteristics of their facilities that have been selected for SGU classification.

A.3 COMMUNICATION BETWEEN KAHRAMAA AND GRID USERS

a) The communication channels between Kahramaa and Grid Users shall cover all operation needs in normal and abnormal situations.

b) For operation, unless otherwise specified in the Grid Code, all instruction given by Kahramaa and communications (other than relating to the submission of data and notices) between Kahramaa and Grid Users will be given by means of the Control Telephony.

c) The recording (by whatever means) of instruction or communications given by means of Control Telephony will be accepted by Kahramaa and Grid Users as evidence of those instruction or communications and it shall be preserved for at least one year.

d) Any changes in Control Telephony either by Kahramaa or users shall be communicated to each other as the case may be.

e) If the NCC is moved to another location, whether due to an emergency or for any other reason, Kahramaa shall notify the Grid Users of the new location and any changes to the Control Telephony necessitated by such move, as soon as practicable following the move.

f) If the externally interconnected party's Control Centre is moved to another location, whether due to an emergency or for any other reason, Kahramaa shall be notified by the Externally Interconnected Party of the new location and any changes to the Control Telephony necessitated by such move, as soon as practicable following the move.

A.4 DATA EXCHANGE

A.4.1 INTRODUCTION

The objective of this chapter is to list the typical range of information and data that the Grid Users are required to submit to Kahramaa and to define the principles for exchange data and information exchange between Kahramaa and Grid Users.

The proper and timely exchange of data and information between Kahramaa and Grid Users is critical for ensuring non-discriminatory access to the ETN and the safe and reliable operation.

The data listed in the various chapters of the Grid Code contain only the typical range of data which may be required by Kahramaa. The actual data required will be advised by Kahramaa at the time of assessment of the User application for new, or modification of an existing connection.

A.4.2 DATA AND INFORMATION CATEGORIES AND REGISTRATION

The following types of data and information shall be required to be registered by the Grid User:

a) Planning and committed Data: Each Grid User shall provide to Kahramaa the data of the equipment connected to the ETN for planning purposes. The detail of the required data is provided in Planning Code schedules.

b) Connection Data: Each Grid User shall provide to Kahramaa the data and parameters of the Generating Facility, the Generating Unit and the equipment connected to the ETN to comply with the Connection Code (section C). The detail of the required data is provided in the Planning Code schedules.

c) Operational Data: Each Grid User shall provide to Kahramaa the operational parameters of the equipment connected to the ETN for the safe and reliable operation of the system. The detail of the required data is provided in the Operation Code schedules.

A.4.3 PROCEDURE AND OBLIGATIONS

a) In accordance with the provisions of the various sections of the Grid Code, each User shall submit data and information as listed in Schedules.

b) Kahramaa shall be responsible for data and information storage and archiving.

c) All the data and information systems must be auditable by the Authority. Information systems must provide for clear and accessible audit trails on all relevant operational transactions. All requests that require an audit on a system shall be undertaken with reasonable notice to the Grid Users.

d) It is responsibility of either party Kahramaa or user for maintaining security of data exchanged between them, any consequences due to breaching of data will be borne by the party who fails to maintain the data security.

e) Grid Users shall ensure reasonable security against unauthorized access, use, and loss of information (i.e. have a backup strategy) for the systems that contain the information.

f) Grid Users shall store planning information that is kept electronically for at least five (5) years.

g) Kahramaa shall archive operational information, in a historical repository sized for five (5) years' data. These data shall include the following:

1. Status information change of state alarms, and event messages;
2. Hourly Scheduling and Energy accounting information; and
3. Operator entered data and actions.

h) An audit trail of all changes made to the archived data shall be maintained. This audit trail shall identify every change made, and the time and date of the change. The audit trail shall include both before and after values of all content and structure changes.

A.4.4 DATA AND INFORMATION SUBMISSIONS

a) The data must be submitted to Kahramaa's relevant contact as specified in the concerned section of the Grid Code. The name of the person who is submitting each schedule of data must be included.

b) The data may be submitted via electronic means (if such a data link exists between the User and Kahramaa after obtaining prior written consent from Kahramaa), or through a computer-readable medium.

c) The Grid Users must notify Kahramaa of any changes to data which are already submitted and registered in accordance with the various provisions of the Grid Code.

d) If a Grid User fails to supply data, Kahramaa will estimate such data, in the view of Kahramaa, to not jeopardize system Security.

e) If Kahramaa fails to supply data to a Grid User, the Grid User to whom that data ought to have been supplied, will estimate such data if and when, in the view of that Grid User, it is necessary to do so.

f) Such estimates will, in each case be based upon data supplied previously for the same plant or apparatus or using corresponding data for similar plant and/or apparatus or such other information as Kahramaa or Grid User, as the case may be, deems appropriate.

g) Kahramaa will advise a Grid User in writing of any estimated data it intends to use relating directly to that Grid User plant and/or apparatus in the event of data not supplied.

h) The Grid User will advise Kahramaa in writing of any estimated data it intends to use in the event of data not supplied.

i) Any risk associated with the use of estimated data will be borne by the party that has failed to provide the required data.

j) Wherever practicable, Grid Users, while submitting data, should identify the recognized national or international standard to which their plant, equipment, and/or apparatus was designed.

A.4.5 LIST OF SCHEDULES

Code	Name	Title	Content
PC	SPD	Standard Planning Data (Generators)	Capacities and performances
PC	BC	Data from Bulk Consumers	Capacity, settings and controls
OC	DF	Operational Demand Forecast	Demand Forecast
OC	MS	Maintenance Scheduling	Outage planning
OC	OP	Operational Planning	Changes in forecast, costs
OC	GP	Generation Planning	Availability, restrictions

Table A.4-1: List of Schedules

A.5 LEGAL PROVISIONS

A.5.1 GRID CODE DEVIATIONS OR NON-COMPLIANCES

a) All Grid Code deviations identified by Kahramaa or by the Grid User shall be analysed by the Grid User and the clearance conditions (time period, technical solutions, etc.) shall be submitted and approved by Kahramaa.

b) At the request from a Generating or Demand Facility or a prospective owner, Kahramaa may consider, analyze and grant or reject Derogations for one or more provisions in this Grid Code.

A.5.2 GRID CODE DEROGATIONS

a) A request for a Derogation shall include:

1. an identification of the facility owner, or prospective owner, and a contact person for any communications;
1. a description of the unit for which a Derogation is requested;
2. a reference to the provisions of the Grid Code from which a Derogation is requested and a detailed description of the requested Derogation;
3. a detailed reasoning, with relevant supporting documents; and
4. a demonstration that the requested Derogation would have no adverse effect on System Security.

b) Where a request for a derogation is rejected, Kahramaa have the right to refuse to allow the operation of the Generating or Demand Facility Owner until the Generating or Demand Facility Owner resolve the incompatibility and Kahramaa considers that the Generating Unit or the Demand Facility complies with the provisions of the Grid Code.

c) Within two weeks of receipt of a request for a Derogation, the Authority shall confirm whether the request is complete. If the Authority considers that the request is incomplete, the facility owner, or prospective owner, shall submit the additional required information within one month from the receipt of the request for additional information. If the facility owner, or prospective owner, does not supply the requested information within that time limit, the request for a Derogation shall be deemed withdrawn.

d) Within six months, Kahramaa analyses the Derogation and submits the Derogation request completed by Kahramaa's assessment to the Authority for decision.

e) The Authority shall notify the decision within 3 months to concerned parties.

A.5.3 SETTLEMENT OF DISPUTES

In case of a dispute between Kahramaa and a Grid User about any provision of the Grid Code or any issue relating to that provision, Kahramaa and the Grid User shall first try to settle it bilaterally by making all reasonable endeavours for resolving the dispute. If they cannot resolve the dispute bilaterally not later than six months after the notification of the

rejection of the request for a derogation, the dispute parties must proceed to deal with the dispute according to the procedure mutually agreed through legal agreement between Kahramaa and involved parties.

A.5.4 UNFORESEEN SITUATIONS OR CIRCUMSTANCES

a) The provisions (in part or in whole) of the Grid Code may be suspended is case of grid conditions putting at risk safety of persons, security of assets or pursuant to any directions given by the Authority.

b) Kahramaa shall investigate with the Grid User the possible solutions to recover the compliance and agree on recovery conditions (actions, responsibilities, time schedule.).

c) The affected Grid User shall, however, exercise due diligence and all necessary efforts to remove such disability and fulfil its obligations under the Grid Code.

d) Unforeseen situations with non-urgent or non-immediate consequences leading to Grid Code conflicts or to inadequate consequences shall be analysed and tackled by the GCRP (see A.6) to reach a consensus on action to be taken.

A.5.5 CONFIDENTIALITY

Any confidential information received, exchanged or transmitted pursuant to this Grid Code shall be subject to the following conditions of professional secrecy:

a) the obligation of professional secrecy shall apply to any persons, regulatory authorities or entities subject to the provisions of this Grid Code;

b) confidential information received by the persons, authorities or entities in the course of their duties may not be divulged to any other person or Authority, without prejudice to cases covered by national law; and

c) without prejudice to cases covered by national law, authorities, entities or persons who receive confidential information pursuant to this Grid Code may use it only for the purpose of carrying out their duties under this Grid Code.

A.6 GRID CODE REVIEW PANEL

a) A Grid Code Review Panel (GCRP) is set up by Kahramaa to review the Grid Code and to propose updates in association with representatives of ETN stakeholders.

b) The GCRP is chaired by the Director of Electricity Network Affairs or his representative and the members are:

   1. Authorized representatives of registered Grid Users; and
   2. Authorized representative from public, academic organizations and industry associations involved in electricity usage.

c) The GCRP:

   1. is responsible of the Grid Code reviews;
   2. collects Directives, Grid Code issues and proposals for changes submitted by Grid Users;
   3. debate on requests for change proposed by Kahramaa or by Grid Users;
   4. manages the process validating the Grid Code changes;
   5. notes and evaluate all Derogations granted to Grid Users; and
   6. makes recommendations to the Authority for solving issues for Grid Code application.

d) Kahramaa provides administrative and logistics support for the GCRP. A dedicated website for information and for consultation is publicly accessible. Agendas of the GCRP, minutes of meetings and documents related to Grid Code reviews and changes are public.

A.7 INTERPRETATION OF THE GRID CODE

a) Unless the context otherwise requires, all references to Kahramaa are:

   1. in its role as Transmission Operator: owner and operator of the ETN; and
   2. in its role as System Operator: overall coordinator of the EPS, including, its role of central scheduling and dispatch of generation.

b) Precedence: In the event of any conflict between the provisions of the Grid Code and any contract or agreement between Kahramaa and a Grid User, the provisions of the Grid Code shall govern, unless the Grid Code expressly provides otherwise.

c) The preface, table of contents, index and titles have been added for the information and convenience of the readers of the Grid Code. These, therefore, shall not be considered in interpreting the provisions of the Grid Code.

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

A.8 DEFINITIONS AND GLOSSARY

The following table contains words listed alphabetically with their associated definition to facilitate the understanding of the content of the Grid Code. Some words having a particular meaning in the domain of the electrical power systems are included with a short explanation.

Term	Definition
Active Energy	The electrical energy produced, flowing or supplied by an electric circuit during a time interval, being the integral with respect to time of the instantaneous power, measured in units of watt-hours or standard multiples thereof.
Active Power	The real component of the apparent power at fundamental frequency, expressed in watts or multiples thereof such as kilowatts (kW) or megawatts (MW).
Acceptance Certificate	A document provided by the Generating Facility Owner, Demand Facility Owner, to Kahramaa stating the current status of compliance with the relevant specifications and requirements.
Adequacy	A measure of the ability of the EPS to meet the electric power and energy requirements of its consumers within acceptable technical limits, taking into account scheduled and unscheduled outages of system components.
Alert State	Alert State means the system state in which the system is within Operational Security Limits, but a contingency from the contingency list, has been detected and in case of its occurrence the available remedial actions are not sufficient to keep the Normal State.
Ancillary Services	Services necessary for the operation of an electric power system provided by the system operator and/or by Grid Users including Automatic Generation Control, Reactive Power, operating reserves, frequency control, voltage control, back-up capacity, Black Start, etc.
Apparatus (es)	Plant or equipment connected to, or forming part of, the EPS and which is required for the generation, transmission, distribution, control or measurement of electricity supplied to or through the system.
Apparent Power	The product of voltage and current at fundamental frequency, and the square root of three in the case of three-phase systems, usually expressed in kilovolt-amperes (kVA) or megavolt-amperes (MVA).
Approved	As per Kahramaa Safety Rules.
Authority	As used in this Grid Code refers to nominated individuals or bodies that have been designated by the Ministry of Energy for the implementation, for the enforcement and for the control of the Grid Code.

Term	Definition
Authorized Person	A competent person who is above 21 years of age and appointed in writing by the Director of Electricity Networks Affairs to carry out specific operations and work on the EPS in accordance with his Certificate Of Authorization.
Automatic Generation Control (AGC)	AGC is being a computerized technique based at the NCC which automatically enables frequency regulation and the optimization of overall generation costs by sending the signal to adjust the set-point adjustment of a Generating Unit's Governor via the SCADA system.
Automatic Voltage Regulator (AVR)	Part of the Excitation System of the generator regulating the voltage at the generator terminals by controlling the current through the generator rotor winding.
Availability	The state of a system or a component or an Apparatus to be able to perform as required under defined conditions.
Availability Declaration	A statement of expected Availability, made by a generator in respect of one of its Generating Units.
Battery Management System	The Battery Management System (BMS) is an electronic component that manages a rechargeable battery (cell or battery pack). The purpose of the BMS is to maintain the safety and reliability of the battery, state monitoring and evaluation, charge control, and cell balancing.
Black-Start Capability	The capability of recovery of a Generating Unit from a total shutdown through a dedicated auxiliary power source without any electrical energy supply from external to the Generating Facility.
Blackout State	The ETN is considered in Blackout State if: a) A total Blackout occurs, and all Demand Facilities are not anymore powered by the ETN; and/or b) Following an under-frequency emergency or a partial Blackout and during restoration phase, the EPS is operated outside of frequency and voltage standards.
Bottom-Up Re-Energization Strategy	A strategy where part of the system can be re-energised without the assistance from other TSOs.
Bulk Consumer	An individual or legal entity, existing and future, requesting a power above 5 MW. A Bulk Consumer can be an industrial consumer (with specific needs for grid connection and for performances) or a non-industrial consumer.
Business Day	Any day, which is not a Friday or Saturday, during which the banks are open for normal business in Qatar and which is not declared holiday by Authority.

Term	Definition
Calendar Week	A period of seven consecutive days commencing on a Sunday.
Calendar Year	The period starting at 00:00 hours on 1 January in a year and finishing at 24:00 hours on the 31 December in the same year.
Capacity	Achievable power output of a Generating Unit at Connection Point, within its operating parameters, given in MW, at 48°C ambient temperature.
Certificate of Operation	The certificate issued by Kahramaa to the contractor after signing the Notification of Safety Precautions Certificate (NOSP in which Kahramaa will accept the operation of the works or milestone under the contractor's supervision for thirty (30) days reliability and performance).
Certificate of Readiness	The certificate issued by Kahramaa to the contractor, in which Kahramaa certify that the works or the milestone(s) are ready for connection to the ETN but Kahramaa cannot provide access to network due to reasons referred solely to Kahramaa.
Completion	The state of the works or a milestone (as applicable) being completed except for defects not known, passed all test on completion and transfer of operational responsibility from Contractor to Kahramaa.
Connection Equipment	Means the electrical infrastructure connecting a Generating or a Demand Facility to the ETN.
Connection Permit	Means a permit required by the Bulk Consumer from Kahramaa to enable connection of supply of product to the purchaser.
Connection Point	The interface point at which a Generator’s Power Plant or a User’s System is connected to Kahramaa’s System. Without any special situation, the Connection Point represents the property limits.
Contingency Analysis	An analysis using computer-based simulation of contingencies from the contingency list.
Contingency Event	Outage occurrence caused by one or more system component (Generating Units and/or transmission elements).
Control Telephony	Telephone system, installed primarily for system control purposes and linking the users and Kahramaa.
Credible Contingency Event	means one or more Contingency Events, the occurrence of which System Operation considers to be reasonably possible in the surrounding circumstances.

Term	Definition
Declaration	Means, in respect of each Availability period during the following day, the net power production capacity (expressed in MW) of the Generating Units or power plant at reference ambient conditions declared by the company to be available for dispatch by Kahramaa at the power Connection Points, pursuant to scheduling and dispatch procedure.
Defense Plan	The technical and organizational measures to be undertaken to prevent the propagation or deterioration of disturbances in the ETN in order to avoid an area state disturbance or Blackout State.
Defense service provider	A legal entity with a legal or contractual obligation to provide a service contributing to one or several measures of the Defense Plan.
Delivery Point	The interface point at which electrical energy is delivered by Kahramaa to a Demand Facility or Generating Unit, or by a Demand Facility or Generating Unit to Kahramaa. The quantity of electrical energy so delivered is determined at a metering point which is close to but not necessarily at the Delivery Point; the configuration of equipment at the Delivery Point is determined by a PWPA or BSA (if any).
Demand	The magnitude of an electricity supply, expressed in watts or volt-amperes or multiples thereof such as kilovolt-ampere (kVA) or megavolt-ampere (MVA).
Demand Facility or Unit	A physical location importing power from the grid and operated by a consumer connected to the ETN. The Demand Facility can have one or several Demand Units, which can be operated independently (e.g. mills, furnaces, etc.)
Demand Facility Owner	An individual or legal entity owning a Demand Facility.
Demand Forecast	A statement of the Forecast Demand and Demand pattern.
Derogation	An exemption from or relaxation of a Grid Code requirement.
De-Synchronize	The act of electrical disconnection of a Generating Unit from the ETN.
Directive	An instruction issued by Kahramaa, in terms of provisions of the Grid Code, compelling Grid Users to take such action as Kahramaa may reasonably request or require, which Directive shall be treated as if it were a change in a regulation, law or decree of Qatar, thereby granting any relief that may be available in terms of any PWPA that is in effect between Kahramaa and the Generating Facility Owner.

Term	Definition
Distribution Network	Qatar electrical infrastructure (lines, cables, substations, etc.) at 11 kV and below, operated by Kahramaa.
Droop	The ratio of a Steady State change of frequency to the resulting Steady State change in active power output, expressed in percentage terms. The change in frequency is expressed as a ratio to nominal frequency and the change in active power expressed as a ratio to maximum capacity or actual active power at the moment the relevant threshold is reached.
Earth Fault Factor	At a given location of a three-phase system, and for a given system configuration, ratio of the highest root-mean-square value of line-to-earth power frequency voltage on a healthy line conductor during an earth fault affecting one or more line conductors at any point on the system, to the root-mean-square value of line-to-earth power frequency voltage which would be obtained at the given location in the absence of any such earth fault.
Earthing	The provision of an electrical connection between one or more conductors and earth, using an approved ground device.
Earthing Device	A device, which provides a connection between a conductors and ground being of adequate strength & capacity and approved category.
Economic Dispatch	The allocation of the total EPS energy needs among available sources for optimum system economy, Security and Reliability with due consideration of generating costs, power purchase costs, transmission losses, load flows and other operational considerations as reasonably determined solely by Kahramaa.
Electric Power System (EPS)	The combination of power apparatus, systems and components, including the ETN and the connected Generating and Demand Facilities, operated by Kahramaa.
Electricity Transmission Network (ETN)	Qatar electrical infrastructure (lines, cables, substations, etc.) from 33 kV up to 400 kV operated by Kahramaa.
Embedded Power Plant	A power plant, which may provide electricity to the EPS, but which is connected to a Bulk Consumer's electrical network.
Emergency State	The system state in which one or more Operational Security Limits are violated.

Term	Definition
Equipment Certificate	A document issued by an authorized certifier for equipment used by a Generating Unit, Demand Facility, Distribution System, Demand Facility. The Equipment Certificate defines the scope of its validity in Qatar. For the purpose of replacing specific parts of the compliance process, the Equipment Certificate may include models that have been verified against actual test results.
Erection Completion Certificate	The certificate prepared and issued by the Contractor upon substantial completion of erection and installation of works and passing successfully all test after installation.
Excitation Control System	A feedback control system used for voltage, reactive power or Power Factor that includes the generator and its excitation system.
Fast Fault Current	A current injected by a Power Park Module during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance.
Fault-Ride-Through	The capability of electrical devices to be able to remain connected to the ETN and operated through transient periods of low voltage at the Connection Point caused by the clearance of grid electrical faults.
Field Current	The current flowing through the field coil of the rotor of an alternator.
Final Completion Certificate	The certificate to be issued by Kahramaa to the Contractor to confirm the completion of the Contractor's obligations under the Contract for the Works and for the Warranty Period.
Forced Outage	Except as otherwise agreed in any relevant and then current PWPA, a total interruption of the generating capability of a Generating Unit that is not the result of any of, or a combination of any of, an instruction or Directive issued by Kahramaa, a maintenance outage, or circumstances occurring over which the Generating Facility Owner manifestly has control.
Forecast Demand	The level of Demand for power (generated or sent-out, as the case may be) that it is expected to be met.
Frequency Control	A feedback control system to adjust active power output of Generating Units in response to a measured deviation of system frequency from a Set Point, in order to contribute to maintain stable system frequency.

Term	Definition
Frequency Response Dead Band	An interval used intentionally to make the Frequency Control unresponsive.
Frequency Response Insensitivity	The inherent feature of the control system specified as the minimum magnitude of change in the frequency or input signal that results in a change of output power or output signal.
Frequency Sensitive Mode (FSM)	The operating mode of a Generating Unit in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency.
Generating Facility (ies)	A facility that converts primary energy into electrical energy and which consists of one or more Generating Units connected to the ETN at one or more Connection Points.
Generating Facility Owner	An individual or legal entity owning a Generating Facility.
Generation Program	The Generation Schedule to be issued pursuant to scheduling and dispatch procedure at yearly, monthly, weekly and daily time periods.
Generating Unit	Either a synchronous generating set or a Power Park Module.
Governor	The equipment which controls the energy input to the turbine, usually automatically, and the rotating speed of the turbine if the unit is operating isolated from the EPS.
Grid Impact Study	Or Grid Study: A study elaborating the technical feasibility and the impacts of the integration of a Generating Facility in the ETN.
Grid User	Operator of a Generating Facility or a Demand Facility connected to the ETN.
High Priority Significant Grid User	The Significant Grid User for which special conditions apply for disconnection and for Re-Energization.
House-Load Operation	The operation which ensures that Generating unit is able to continue to operate supplying its in-house loads after being disconnected from the ETN.
Implementing Party	Kahramaa or Grid User receiving a request from the Requesting Party and implementing the activities described in the related safety document.
Incident	An unplanned occurrence on, or related to, the system which has caused, or could have caused, a breach of the Security Limits or which has caused injury to any individual.
Inertia	Characteristic of a Generating Unit defined as its kinetic energy divided by machine's rated capacity.

Term	Definition
Instruction	Any command, within its authority, given by Kahramaa to a Generating Facility Owner, Demand Facility Owner, or other Transmission System Operators in order to perform an action.
Island Operation	Island Operation is an operation mode of part of a network that is isolated after being disconnected from the interconnected system, having at least one Generating Unit supplying power to this part of network and controlling the frequency and voltage.
Limited Frequency Sensitive Mode Over Frequency (LFSM-O)	A Generating Unit operating mode which will result in active power output reduction in response to a change in system frequency above a certain value.
Limited Frequency Sensitive Mode Under Frequency (LFSM-U)	A Generating Unit operating mode which will result in active power output increase in response to a change in system frequency below a certain value.
Loading Rate and De-Loading Rate	Loading Rate: The rate at which a synchronized Generating Unit can increase output under operator control and in normal operating conditions. De-Loading Rate: The rate at which a synchronized Generating Unit can reduce output under operator control and in normal operating conditions.
Loss Of Load Expectation (LOLE)	Loss Of Load Expectation represents the number of hours per annum in which, over the long-term, it is statistically expected that supply will not meet Demand.
Maintenance Schedule	The schedule showing the expected Generating Facility, external inter-connector and transmission system apparatuses outages covering a yearly, monthly, weekly and a single 24-hour time period.
Maximum Capacity (Pmax)	The maximum continuous active power which a Generating Unit can produce, less any demand associated solely with facilitating the operation of that Generating Unit and not fed into the network as specified in the Connection Agreement or as agreed between Kahramaa and the Generating Facility Owner.
Minimum Regulating Level	The minimum active power, as specified in the Connection Agreement or as agreed between Kahramaa and the Generating Facility Owner, down to which the power-generating module can control active power.
Minimum Stable Operating Level	The minimum active power, as specified in the Connection Agreement or as agreed between the relevant system operator and the Generating Facility Owner, at which the Generating Unit can be operated stably for an unlimited time.

Term	Definition
National Control Center (NCC)	Main Kahramaa's facility used to operate and control/maintain the EPS.
Netted Demand	The netted value of active power seen from a given point of the system, computed as (load - generation), generally expressed in kilowatts (kW) or megawatts (MW), at a given instant or averaged over any designated interval of time.
Non-Credible Contingency Event	A Contingency Event other than a Credible Contingency Event. Without limitation, examples of Non-Credible Contingency Events are likely to include: 1. Electrical faults on the EPS not properly eliminated by protection systems and damaging grid structures as transformers, cables, breakers, etc., or 2. Simultaneous disruptive events such as multiple quasi simultaneous Generating Unit disconnections or failures or quasi simultaneous failure of double circuit transmission cable or line (such as may be caused by GIS destruction or tower collapse).
Normal (Operating) State	Normal (Operating) State means a situation in which the EPS is within Operational Security Limits in the N-situation and after the occurrence of any contingency from the contingency list, taking into account the effect of the available remedial actions.
Notification Of Safety Precautions Certificate (NOSP)	Notification of Safety Precaution (NOSP) is a document issued to the Demand Facility Owner or Generating Facility Owner to inform all concerned that from a specific date and time the new transmission equipment which is ready to be connected to the ETN after successful completion of pre-commissioning tests will come under the operational jurisdiction of Director, Electricity Network Affairs. After issuance of NOSP, any work on the equipment shall only be carried out with appropriate Safety Documents issued as per Kahramaa Safety Rules and Regulations (Source: Kahramaa Safety Rules Documents, page 19).
Operation	Scheduled or planned action relating to control of any part of the EPS.
Operational Effect	An effect on the operation of any part of the EPS which may require Kahramaa or any other Grid User to operate in a non-standard way in order to minimize the chance of the operating standards being breached.
Operational Security Limits	See Security Limits.
Over-Excitation Limiter	A control device within the AVR which prevents the rotor of an alternator from overloading by limiting the excitation current.

Term	Definition
Performance Standards	Technical capabilities of Generating and Demand Facilities able to support system Security and connected to the ETN or able to connect within a defined time period.
Planning Data	Information and data in respect of an Embedded Power Plant or Generating Unit, which is provided to Kahramaa for long term system planning purposes under planning procedure.
Planning Outage	The outage of the Generating Unit or Demand Facility according to the schedule which has been provisionally proposed by the Generating Facility Owner or Demand Facility Owner and finally arranged by Kahramaa.
Power and Water Purchase Agreement (PWPA)	A contract between Kahramaa and the Generating Facility Owner, which includes the relevant site and specific technical requirements for the Generating Facility, amount of power and water to be purchased, validity of contract and other necessary relevant details.
Power Factor	The ratio of the absolute value of active power to apparent power.
Power Park Module (PPM)	A unit or ensemble of units generating electricity, which is either non-synchronously connected to the network or connected through power electronics, and that also has a single Connection Point to the ETN.
Power Park Unit	A generating unit within a Power Park Module.
P-Q Capability Diagram	A diagram describing the reactive power capability of a Generating Unit in the context of varying active power at the Connection Point.
Power Storage Unit	Set of battery energy storage systems considered as a Generating Unit or a Demand Unit.
Power System Stabilizer (PSS)	An additional functionality of the Automatic Voltage Regulator (AVR) of a Synchronous Generating Unit whose purpose is to damp power oscillations.
Protected Event	A Non-Credible Contingency Event that has declared to be a Protected Event.
Reactive Power	The imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar (kVAr) or megavar (MVAr).
Re-Energization	Reconnecting generation and load to energize the parts of the EPS that have been disconnected.
Reference Voltage	Voltage value choose to connect a Generating Unit according to its rated capacity and to its location.

Term	Definition
Reliability	A measure of the ability of the EPS to deliver electricity to all points of consumption and receive electricity from all points of supply within accepted standards and in the amount desired.
Requesting Party	Either Kahramaa or Grid User requesting to the other party to work on the electrical transmission network or on the interface between the electricity transmission network and the Generating Unit or the Demand Facility.
Restoration Plan	All technical and organizational measures necessary for the restoration of the EPS back to Normal State
Restoration Service Provider	A legal entity with a legal or contractual obligation to provide a service contributing to one or several measures of the Restoration Plan.
Restoration State	Means the system state in which the objective of all activities in the EPS is to re- establish the system operation and maintain Operational Security after the Blackout State or the Emergency State.
Re-Synchronization	Action synchronizing and connecting again two synchronized islanded power systems at the resynchronization point.
Risk	Combination of the frequency of occurrence of harm or contingency and the severity of that harm or contingency. The system operational risk is defined as the product of probability and severity of the system failure states in terms of expected load interruption cost taking into account the randomness of contingencies as well as the uncertainty of operating conditions caused by load and forecasting errors.
Scheduling and Dispatch Procedures	A series of procedures covering the Scheduling and Dispatch of Generating Units, including: 1. daily submission of information on capacity available and operating characteristics of their Units by Generators; 2. preparation of the Daily Generation Program; and 3. dispatch of Generating Units.
Secured Fault	A fault which is successfully cleared according to the EPS operator's planning criteria.
Security	The ability of the EPS to tolerate a credible event without loss of load, over-stress of system components, or deviation from specified voltage and frequency tolerances

Term	Definition
Security Limits	Within the Operation Code, Security Limits are the acceptable operating boundaries for the EPS: thermal limits, voltage limits, short-circuit current limits, frequency and dynamic stability limits.
Set Point	The target value for any parameter typically used in control schemes.
Significant Grid User	A Significant Grid User (SGU) is a Grid User (Demand or Generation) important for system operation matters (for instance: power capacity, grid stability, Ancillary Services, grid location, load shedding capability, etc.). A SGU can be either a Significant Generating Facilities (SgF) or a Significant Demand Facilities (SdF).
Significant Incident	An incident which in Kahramaa's reasonable opinion has caused, or could have caused, a system emergency or serious injury to an individual.
Slope	The ratio of the change in voltage, based on reference pu voltage, to a change in reactive power in-feed from zero to maximum reactive power, based on maximum reactive power.
Stator	The portion of a synchronous generator which includes the stationary magnetic parts with their associated windings.
Steady-State Stability	The ability of a network or a synchronous Generating Unit to revert and maintain stable operation following a minor disturbance.
Substation	Technical infrastructure performing functions of electrical nodes (topology, monitoring, protections) of electricity networks and connecting Generation or Demand Facilities or interconnecting transmission assets. A substation connecting a Generating Facility is sometimes named a power substation or a Connection Equipment. A substation connecting a Demand Facility is sometimes named a Connection Equipment or a primary substation.
Synchronous Area	Area covered by synchronously interconnected power systems of GCCIA.
Synchronous Generating Unit	An indivisible set of installations which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism.
System Control Engineer	As per Safety Rules.
System Demand	The actual or forecast power consumption on the EPS for a defined time period.

Term	Definition
System Strength	Relates to the ability of the EPS to withstand changes in generation output and load levels while maintaining stable voltage levels. When System Strength is high, voltage changes less for a change in load or generation than it would if System Strength is low. System Strength is generally measured by the three-phase fault level, expressed in megavolt-amperes (MVA). In a system with low System Strength generators may be unable to remain connected during disturbances on the EPS: control of system voltage becomes more difficult, protection systems which control the safe operation of the network may not operate correctly. This impacts on system Security and increases the risk of system instability and supply interruptions to consumers. System Strength is provided locally by sources such as traditional synchronous generators, transmission network lines and transformers, voltage control equipment and synchronous condensers.
Taking Over Certificate	The certificate to be issued by Kahramaa to the contractor to confirm the satisfactory completion of the works or milestone (if any) and all the tests on completion, including successful reliability and performance tests.
Technical Envelope	The technical boundary limits of the EPS for achieving and maintaining the secure operating state of the power system for a given Demand and power system scenario. The Technical Envelope is the basis of determining events considered to be credible contingency events at that time.
Transmission System Operator (TSO)	Kahramaa entity operating independently from the other Grid Users and responsible for the transmission of electric power on the ETN. As TSO, Kahramaa provides grid access to the Grid Users according to non-discriminatory and transparent rules. In order to ensure the security of supply, the TSO guarantee the safe operation and maintenance of the EPS.
U-Q/Pmax-Profile	A profile representing the reactive power capability of a Generating Unit in the context of varying voltage at the Connection Point.
Under-Excitation Limiter	A control device within the AVR, the purpose of which is to prevent the alternator from losing synchronism due to lack of excitation.
Voltage Levels	According to Safety Rules, subsection A.8 Definitions and Glossary.

A.9 ACRONYMS

AC	Alternative Current
AGC	Automatic Generation Control
ATA	Asset Transfer Agreement
AVR	Automatic Voltage Regulator
BSA	Bulk Supply Agreement
CCGT	Combined Cycle Gas Turbine
CSA	Consultancy Services Agreement
DC	Direct Current
DCC	Distribution Control Center
DSO	Distribution System Operator
ED	Electricity Distribution
ENA	Electricity Network Affairs
ENP	Electricity Network Planning
EPS	Electric Power System
ERC	Emergency and Restoration Code
ETN	Electric Transmission Network
ETS	Emergency Tripping Scheme
FAT	Factory Acceptance Test
FSM	Frequency Sensitive Mode
GC	Grid Code
GCCIA	Gulf Cooperation Council Interconnection Authority
GCRP	Grid Code Review Panel
GDP	Gross Domestic Product
GIS	Grid Impact Study
GP	General Provision

HV	High Voltage
HVDC	High Voltage Direct Current
ICC	Interconnection Control Centre
IPP	Independent Power Producer
ITC	Interconnector Transmission Code (GCCIA)
Kahramaa	Qatar General Electricity & Water Corporation.
LFSM	Limited Frequency Sensitive Mode
LOLE	Loss Of Load Expectation
LON	Limited Operational Notification
LV	Low Voltage
MFS	Minimum Function Specifications
MoU	Memorandum of Understanding
MV	Medium Voltage
NCC	National Control Centre
O&M	Operation & Maintenance
OMA	Operation & Maintenance Agreement
OC	Operation Code
PC	Planning Code
PPA	Power Purchase Agreement
PPM	Power Park Modules (non-synchronously connected Generating Units)
PSS	Power System Stabilizer
PWPA	Power & Water Purchase Agreement
RGCC	Requirements for Generators and for Consumers Code
RMS	Root Mean Square
RPM	Revolutions Per Minute
SAT	Site Acceptance Test

SCADA	Supervisory Control And Data Acquisition
SDP	Scheduling and Dispatch Procedures
SFT	Sanction For Test
SGU	Significant Grid User
SgF	Significant Generating Facility
SdF	Significant Demand Facility
SOM	System Operation Memorandum
SR	Safety Rules
TSO	Transmission System Operator
Tx	Transformer
UTC	Coordinated Universal Time

B. PLANNING CODE (PC)

B.1 PURPOSE

The Planning Code:

a) Specifies the requirements for the supply of information by Grid Users of the ETN. This information is required to enable Kahramaa, whilst planning the ETN, to take due account of Grid User's needs.

b) Introduces the technical and design criteria, and the procedures to be followed by Kahramaa in planning the ETN.

c) Includes Kahramaa's guideline to study and elaborate power demand, generation capacity planning and transmission planning.

B.1.1 SCOPE

The Planning Code:

a) introduces the functions of the EPS planning: Demand Forecast, generation planning, system Adequacy and planning of the development of the ETN;

b) lists the information and data requested by Kahramaa from the Grid Users to perform EPS planning functions. In particular, it describes:

1. the responsibility of the stakeholders involved in the EPS;
2. the processes performed to elaborate the EPS planning;
3. the studies and updates of ETN development plans;
4. the technical criteria used for elaborating the ETN development plan; and
5. the detailed data which are necessary for the EPS planning.

B.1.2 PLANNING OBJECTIVES

In order to meet the needs of the EPS Grid Users, the planning processes aim at the best quality of service as defined in OC, at the lowest cost and in compliance with the rules for safeguarding the EPS and for minimizing the impacts on the environment.

The main planning documents elaborated and updated each year by Kahramaa purposes are covering:

a) Ten Year Electricity and Water Demand Forecasting;

b) Five Year System Studies Report & Development Plan;

c) Yearly Demand Forecast Plan; and

d) Yearly Summer Operation Outlook.

B.2 RESPONSIBILITIES

B.2.1 STAKEHOLDERS

The procedures, rules, requirements and criteria presented in this section apply to all Grid Users which are:

a) Kahramaa;

b) Water and Power Producers; and

c) Bulk Consumers (industrial and non-industrial).

B.2.2 KAHRAMAA RESPONSIBILITIES

Kahramaa is responsible for:

a) the studies for national consumption and the elaboration of the Demand Forecast;

b) the collection and the aggregation of all data needed for Demand, transmission and generation planning purposes;

c) the elaboration of the Ten Years Electricity Yearly Demand Forecast Output;

d) the elaboration of the Five Years System Study & Development Plan;

e) the elaboration of the Yearly Demand-Supply Report;

f) the elaboration the Summer Operation Outlook;

g) the definition of the methodology and assumptions to perform system Adequacy and load balancing studies;

h) the studies at national level for the development of the ETN; and

i) the identification of potential issues on power quality, on system Adequacy or on power shortage.

On Grid User request, Kahramaa can provide non-commercial sensitive data on ETN Planning.

B.2.3 GRID USERS RESPONSIBILITIES

Grid Users are responsible:

a) for providing Kahramaa with all information and data concerning the Generating Units and the Demand Facilities. Information are requested from the beginning of the project development phase and all along the lifetime of the facilities;

b) for informing and providing Kahramaa with data and information for new grid connection projects as well as for changes in characteristics of existing facilities. The Grid User shall inform Kahramaa without delay of any actual or anticipated changes to any of the information; and

c) for facilitating Kahramaa to perform any measurements if required to update the equipment parameters (verification and validation) during the operation of the facility.

The list of the data requested, and associated conditions are listed in Schedules (B.5).

B.3 DESCRIPTION OF THE ELECTRICAL POWER SYSTEM PLANNING

B.3.1 STUDIES AND METHODOLOGIES

The inputs of the EPS planning are provided by a general analysis on long term Demand Forecast, generation planning and according to scheduled ETN infrastructure developments.

Inputs are:

- The Ten Years Electricity Yearly Demand Forecast Output;
- The Five Years System Study & Development Plan;
- The Three-Year Operating Program; and
- Data and statistics coming from economy policy and EPS.

The outcomes of the EPS planning are delivered by a chain of studies integrating, at each step, inputs from Kahramaa and from Grid Users and methodologies and criteria chosen by Kahramaa. This chain is represented in Figure B.3-1.

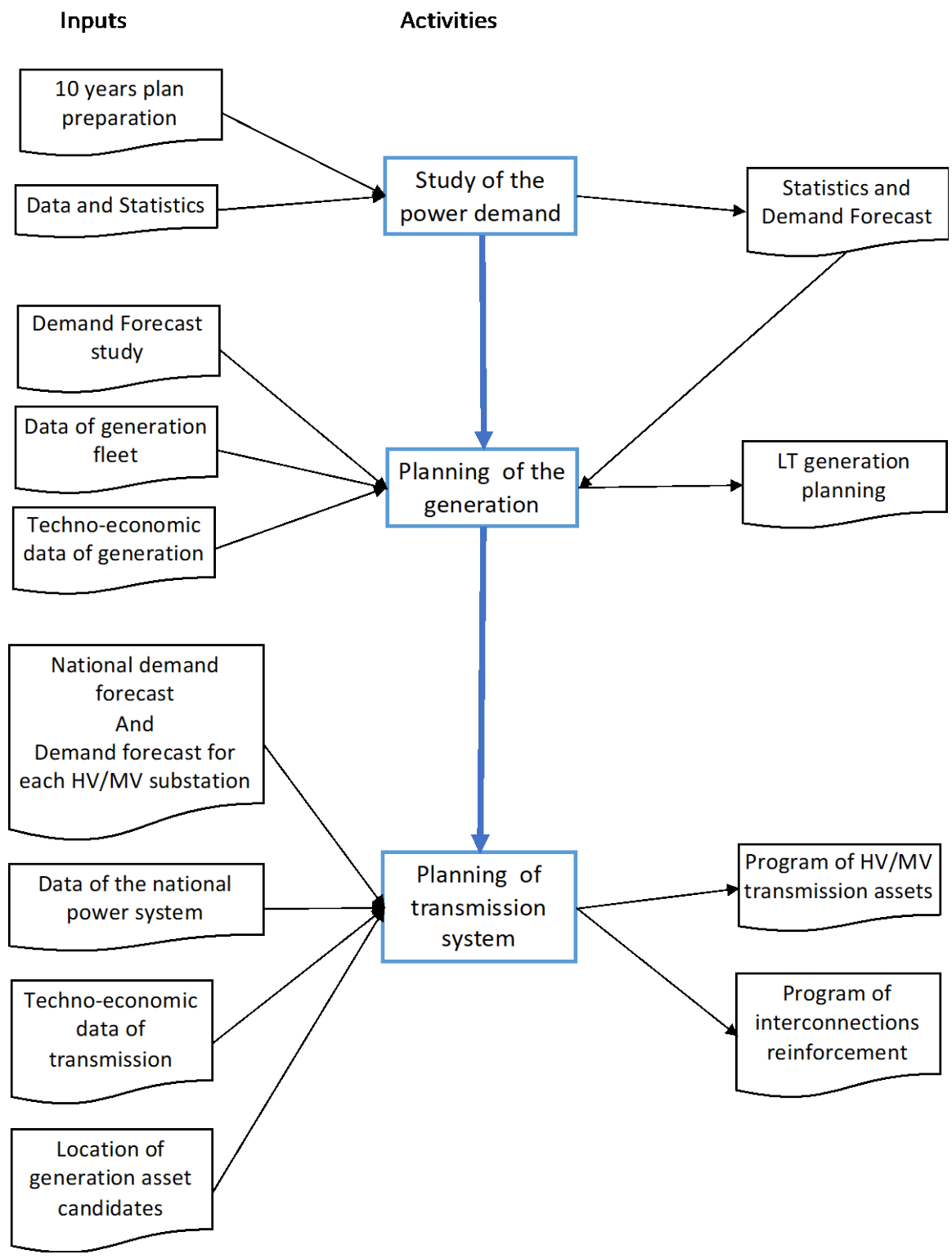

Figure B.3-1: Inputs and activities for Demand Forecast, planning of generation assets and development of ETN

B.3.2 METHODOLOGY FOR DEMAND PLANNING

a) The methodology for Demand Forecast is based on correlation between historical consumption of energy and water volumes of various sectors and uses econometric forecast data such population, GDP to future consumption. A combination of top-down (econometric) and bottom-up (for industrial Demand) approach is used. The forecasting model shall distinguish between industrial and domestic Demand Forecast. The per capita consumption of households are key inputs to the electricity forecasting models. Bulk Consumers' data representing the industrial load is another key part of the input due to its significant effect on the variations of overall Demand Forecast.

b) End user survey method is used for industrial Demand Forecast while econometric approach is to be adopted as the standard methodology for Demand Forecasting for domestic (residential and commercial).

c) Forecasted energy volumes are then converted to capacity (MW) in the final output using suitable factors.

B.3.2.1 FORECASTING PERIODS AND SCENARIOS

a) Electricity Demand Forecasts are developed and updated annually with a 10 years' horizon. Three future consumption scenarios are analysed:

1. Low case: it is unlikely that the realized future values will be below the low forecast;
2. Base case: this is the most probable forecast, but it is very unlikely that the realized future values will be exactly equal to the base forecast. The base case scenario shall be taken as the basis for preparation of electricity and water production capacity projections; and
3. High case consumption scenarios: it is unlikely that the realized future values will be above the high forecast.

b) Demand Forecast results for each year of the 10 years' horizon include the annual forecasts for total electricity consumption in GWh/y or MWh/y, electricity peak demand in MW, for low, base and high consumption scenarios.

B.3.2.2 FORECASTING INPUTS AND RESULTS

a) The forecasted input data set is adjusted, making it appropriate in Demand Forecasting model through application of transformations resulting from statistical tests. Effects of input data that is required by Demand Forecasting model on results of Demand Forecasting are supported by means of scientific and logical approaches;

b) Official data published or provided by relevant authorities, institutions and internal department are used in fundamental data set for Demand Forecasting. These sources currently include the following:

1. historical electricity consumption data and peak load and Bulk Consumer data,
2. application and survey for Bulk Consumer; and
3. demographic and economic data.

c) land planning and development information:

1. industrial project information; and
2. major domestic projects information.

d) Electricity forecasting has high level of uncertainties due to the variability of input data and assumptions like population growth and consumption rates and losses, etc., affecting forecast outcomes. To quantify the risk of Demand Forecast uncertainty the following is applied:

1. Sensitivity cases are developed for base case scenario to quantify the impact and risk of uncertainty of key input data and assumption;
2. Considering that planning and building new production capacity takes at least 4 years to start generation, therefore assessment of future over/under supply shall be conducted for each sensitivity case; and
3. Based on risk assessment, Kahramaa picks the best scenario that ensures cost effective Reliability of supply to Bulk Consumers. Kahramaa rolls forecast plans every year for next 10 years for electricity peak Demand. Results for the next year are communicated at the end of each year.

B.3.3 METHODOLOGY FOR GENERATION PLANNING

B.3.3.1 GENERATION CAPACITY

a) The generation capacity studies consider the base case forecast of the Demand Forecast scenario for production capacity expansion plans;

b) In addition, plans consider expected and prospective production resource as follows:

1. Expected resources:
   i. existing facilities;
   ii. committed facilities;
   iii. retired facilities (reduction of resources); and
   iv. committed agreement extension.
2. Prospective resources are:
   i. facilities with agreement term expired and acceptable transfer conditions or facilities in good condition which have not completed lifetime;
   ii. any firm renewable capacities;
   iii. facilities with extension of any expired agreement if:
      – extension will relieve network congestion or improve any network reliability criteria violation;
      – extension helps to postponed investment in major transmission projects; and/or
      – they do not impact Operational marginal cost.
   iv. extension postponed investment in next facility by at least one year.

B.3.3.2 SYSTEM ADEQUACY

a) Kahramaa ensure system Adequacy in determining the needed production capacity that must be installed to meet future Demand.

b) The strategy for maintaining reliable generation supply is to maintain adequate level of Reserve Margin to make sure that Kahramaa always have more supply available than may be required. As there are uncertainties affecting accuracy of electricity Demand Forecast, and of building new generating capacity, additional capacity over and above the expected peak Demand is secured so that sufficient resources are available at all times to meet load.

c) By end of each year, Kahramaa performs and documents a demand supply balance for the next 10 years to demonstrate planed resource adequacy. For each year, Demand supply shall show details of expected and prospective resource along with Demand Forecast, reserve margins and expected surplus and deficit.

B.3.3.3 CRITERIA FOR LOSS OF LOAD EXPECTATION AND FOR RESERVE MARGIN

The Ten Years' Expansion Plan ensure system Reliability and Adequacy that satisfy the following targets:

a) 5 hours of LOLE per year while interconnected to the GCCIA network. 6 % target reserves margin;

b) 10 hours LOLE per year while not interconnected to the GCCIA network. Not less than 10 % target reserves margin; and

c) Target reserves margin are reviewed every two years if necessary, to secure LOLE targets.

B.3.4 METHODOLOGY FOR TRANSMISSION PLANNING

B.3.4.1 POWER STUDIES

Every year, Kahramaa elaborates the System Studies Report & Development Plan including the current state of the EPS, all the committed developments up to the commissioning projects and the proposed transmission/sub-transmission expansion of the ETN. This report is developed according to the following methodology:

a) Power studies to analyse the behaviour of the EPS at different grid configurations and according to different demand levels and shapes. Power studies are simulation-based studies integrating grid model, generation and demand models, generating and Demand Units characteristics and grid control characteristics;

b) The quality of the simulations (the results are credible because in some cases, they are close to measures got from similar experienced grid situations) relies for a significant part on the conformity of the data provided by Grid Users with the data that has been implemented or observed in their facilities;

c) Results of power studies allow Kahramaa to get an approached representation of the status of the EPS at national and at local levels according to certain EPS conditions.

Analyses can be made on load flows, voltage and short-circuits levels, active and reactive power exchanges, frequency and angle stability;

d) The comparison of the outcomes of the power studies with the planning criteria adopted for the design and for the operation of the EPS allows to identify if a particular grid configuration or topology or load-demand situation, for instance, can be accepted for ETN operation; and

e) Upgradation of obsolete technologies shall be considered by Kahramaa for planning of ETN expansion to achieve technological advancement.

The following drawings are illustrating the main activities and products elaborated when performing power studies.

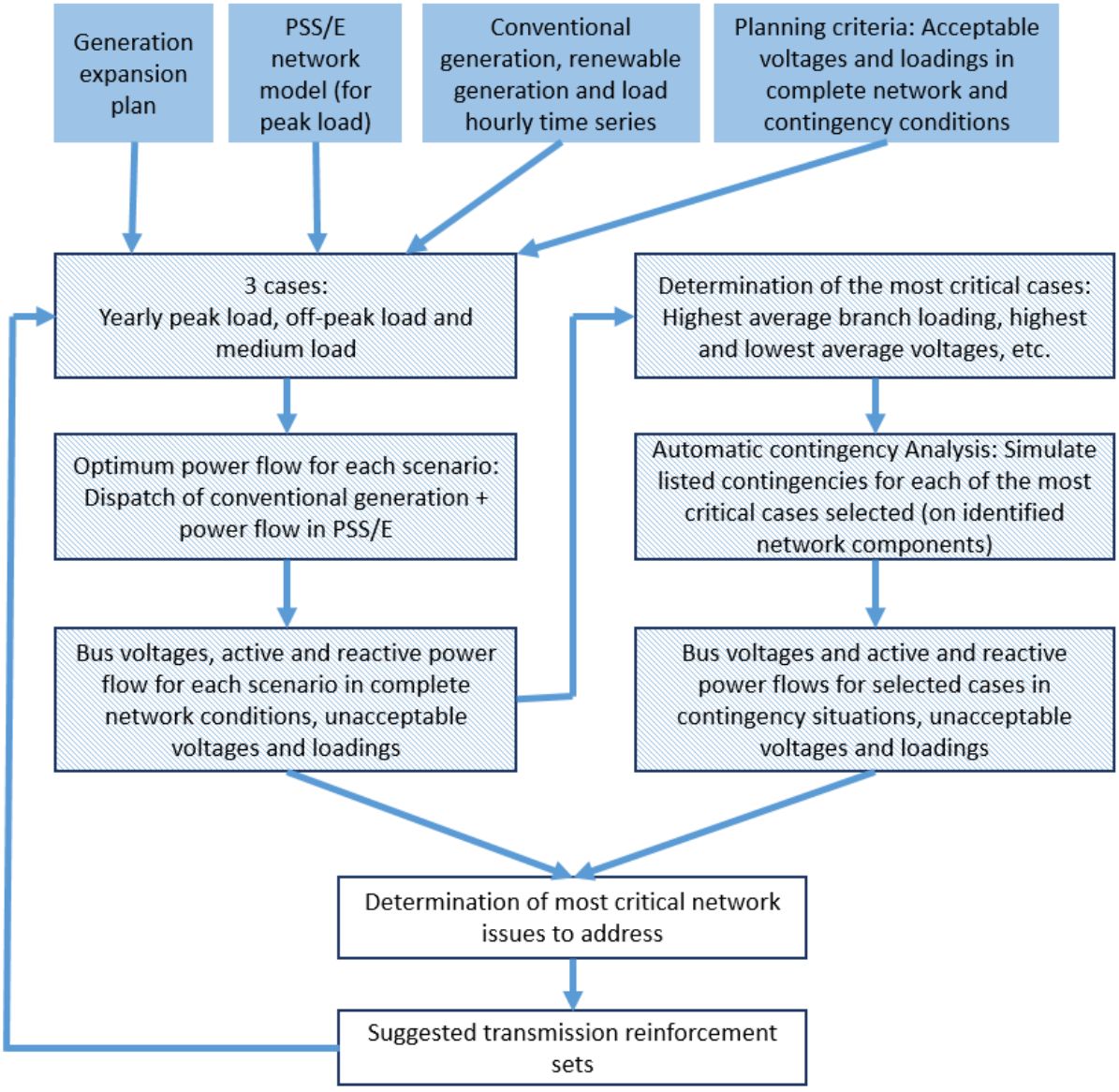

Figure B.3-2: Static study methodology

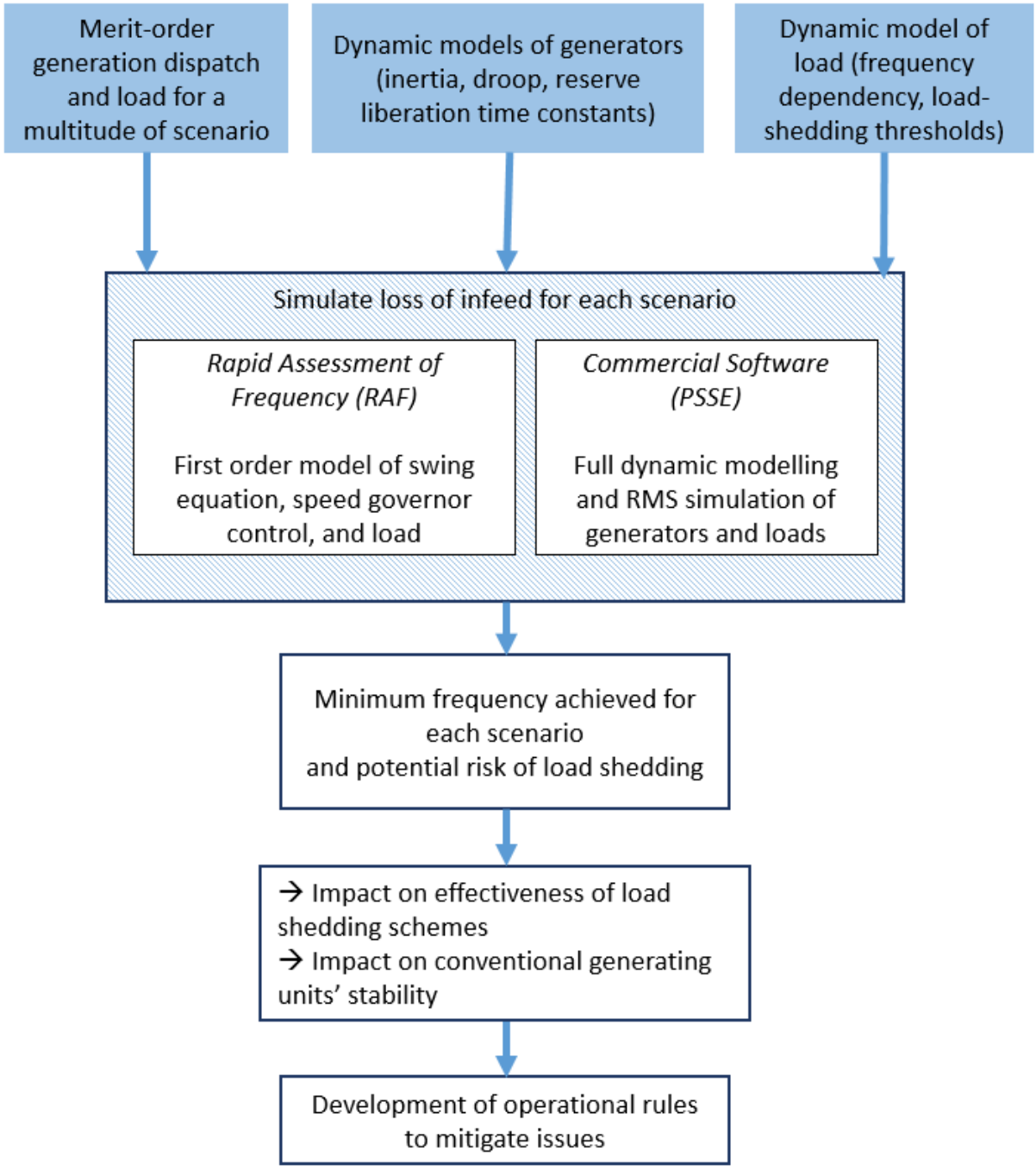

Figure B.3-3: Dynamic study methodology

B.3.4.2 CRITERIA FOR THE DEVELOPMENT OF THE ETN

a) System Security shall be guaranteed considering credible criteria for the selection of contingencies. In case of listed contingency, the EPS must remain in Normal State or in Alert State that does not cause any violations of the operating limits or any load disruption.

b) The listed contingencies and the planning criteria for the EPS are summarized in Table B.3-1.

c) Kahramaa has the responsibility to define the values associated to the planning criteria. These criteria may not be the same as the ones used for operational planning (see Operation Code in section E) because the optimization objectives at grid planning stage may differ from the optimisation criteria for operation.

Listed contingencies		Planning criteria
Faults on individual grid components	Busbars (as necessary), OHL, cables, 400 kV towers, transformers, feeders	Frequency & Voltage according to RGCC. Transmission loads and short circuits according to technical characteristics of systems and components (conductors, breakers, etc.)
Loss of generation	Largest Generating Unit	
Load shedding	Maximum demand disconnected simultaneously	

Table B.3-1: Listed contingencies and planning criteria

Note: The operational contingencies are detailed in Operation Code (section E).

B.4 DATA AND INFORMATION REQUESTED FROM GRID USERS

B.4.1 GENERATING FACILITIES AND UNITS

B.4.1.1 PRELIMINARY DATA

Generating Facility Owners shall provide to Kahramaa, in writing, the data and information listed in B.5.1.1 in respect of any proposed Generating Facility:

a) at the time it has been agreed, in principle, with Kahramaa (acting in its role of electricity purchaser) that the proposed Generating Facility will be constructed and operated against a PWPA entered into between the Generating Facility Owner and Kahramaa, but before such agreement is signed; or

b) for a Generating Facility which will not operate under a PWPA with Kahramaa:

   1. at the time an application is made to Kahramaa to allow the proposed Generating Facility to be connected to the ETN but where no such agreement has been reached; or

   2. at the time an application is made to a Grid User to allow the proposed Generating Facility to be connected to the Grid User's network (where the Generating Facility concerned will be referred to as an Embedded Power Plant) but where no such agreement has been reached.

B.4.1.2 COMMITTED DATA

Generating Facilities Owner shall provide to Kahramaa, in writing, the committed data and information listed in B.5.1.2 and in the contracting agreements as per Connection Code in respect of any proposed Generating Unit:

a) at the time a PWPA (in respect of the proposed Generating Facility) has been concluded with Kahramaa (acting in its role of electricity purchaser) but before such Generating Facility has been declared as ready to commence commissioning; or

b) for a proposed Generating Facility which will not operate under a PWPA with Kahramaa:

   1. at the time an agreement has been reached with Kahramaa to allow the proposed Generating Facility to be connected to the EPS but before such Generating Facility has been declared as ready to commence commissioning; or

   2. at the time an agreement has been reached with a Grid User to allow the proposed Generating Facility to be connected to the Grid User's system (where the concerned Generating Facility will be referred to as an Embedded Power Plant) but before such Generating Facility has been declared as ready to commence commissioning.

B.4.1.3 CONSISTENCY OF DATA AND INFORMATION PROVIDED

The preliminary and committed data and information shall be consistent with the connected data and information. Any discrepancy or difference shall be documented, justified and agreed by Kahramaa.

B.4.2 BULK CONSUMERS

Bulk Consumers filing applications to connect a Demand Facility are requested to provide data and information from the early stage of their project up to the full energization of their facility according to the templates in B.5.2 and to the contracting agreements as per Connection Code.

B.5 PLANNING CODE SCHEDULES

IMPORTANT: Data listed in these schedules are not exhaustive. Depending on technical characteristics of Generating Units or Demand Facilities (e.g. case of a technology that may have an impact on power system security) or on particular arrangements for grid connection and operation (e.g. special protection schemes, etc.), Kahramaa may require complementary technical data.

B.5.1 SCHEDULE PC-SPD

The Schedule PC-SPD (Planning Code - Standard Preliminary Data) lists the Planning Data for Generating Facilities that shall be submitted according to the requirements of the Planning Code (section B) and the Connection Code (section C).

a) The list of concerned data shall be defined according to the technologies and the characteristics of the Generating or Demand Facility/Unit and agreed by Kahramaa.

b) This Schedule shall be filled at planning stage and completed and updated all along project phases (Grid Study, Generating Facility specifications/FAT/SAT, energization, commissioning, operation).

B.5.1.1 PRELIMINARY DATA

a) Name, address and contact details of the person making this submission.

b) Name of the Generating Facility to which these data refer.

c) Location of the Generating Facility to which these data refer.

d) Category of Generating Facility and technology proposed, including:

   1. if thermal, then open cycle gas turbine, combined cycle gas turbine, steam turbine, reciprocating engine, emission control technology, source of cooling water, cooling water requirements as m3/hour at full load;
   2. Power Park Modules technology (PV inverters, wind turbines types, etc.); and
   3. Power Storage Unit.

e) Identification of each Generating Unit to which these data refer.

f) For each Generating Unit identified under d):

   1. Rated MVA and MW;
   2. Nominal voltage rating;
   3. Maximum continuous rating;
   4. Emergency rating;
   5. Auxiliary power requirements;
   6. Short circuit ratio;
   7. Inertia constant (MW seconds /MVA);
   8. Generating Unit step-up transformer MVA rating, reactance and tap details;

9. Expected date for start of commissioning;
10. Expected fuels to be used;
11. Model of machine and parameters;
12. Parameters of Governor/ turbine;
13. Parameters of Excitation Control System;
14. Parameters of Generating Units;
15. Incremental heat rate and correction to adjust overall efficiency from time to time;
16. Black-Start Capability details, if any;
17. Min. notice required for synchronizing a Generating Unit from de-synchronization;
18. Min. time between synchronizing different Generating Units in a generating station;
19. The minimum block load requirements on synchronizing;
20. Time required for synchronizing a Generating Unit for the following condition: hot, warm and cold; and
21. Maximum Generating Unit loading rate for the following conditions: hot, warm, and cold.

g) For auxiliary demand:

1. Normal station service load by each generating units in MW;
2. Auxiliary or start-up power requirements;
3. Sensitivity to automatic or unplanned interruptions;
4. Non-generators related on-site loads; and
5. Location of auxiliary load to be supplied.

h) For Power Storage Unit:

1. Rated output power at nominal voltage;
2. Energy;
3. Type;
4. Allowable charging capacity;
5. Discharging capacity;
6. Round-trip AC energy efficiency (including auxiliaries) at nominal system voltage;
7. Cycle life; and
8. Any technical situation leading to limit previous above performances.

B.5.1.2 COMMITTED DATA

a) Update of data provided in B.5.1.1.

b) For Synchronous Generating Unit:

1. Generating Unit parameters:

i. De-rated capacity on monthly basis;

ii. Rated MW per pole for transfer in each direction

iii. Additional capacity (if possible);

iv. Minimum stable loading;

v. Speed;

vi. Rated terminal volts (kV);

vii. Maximum terminal voltage Set Point (kV);

viii. Terminal voltage Set Point step resolution – if not continuous (kV);

ix. Rated MVA;

x. Rated MW;

xi. Minimum Generation MW;

xii. Short circuit ratio;

xiii. Direct axis synchronous reactance;

xiv. Direct axis transient reactance;

xv. Direct axis sub-transient reactance;

xvi. Direct axis short-circuit transient time constant;

xvii. Direct axis short-circuit sub-transient time constant;

xviii. Quadrature axis synchronous reactance;

xix. Quadrature axis sub-transient reactance;

xx. Quadrature axis short-circuit sub-transient time constant;

xxi. Stator time constant;

xxii. Stator leakage reactance;

xxiii. Armature winding direct-current resistance;

xxiv. Turbo-generator Inertia constant (s);

xxv. Rated Field Current (A) at rated MW, and MVAr output at rated terminal voltage;

xxvi. Field Current (A) open circuit saturation curve for Generating Unit terminal voltages ranging from 50 % to 120 % of rated value in 10 % steps as derived from appropriate Manufacturers Test Certificates;

xxvii. Grounding arrangement; and

xxviii. Basic lightning insulation level.

2. For frequency changes:

i. Response values are required at four MW loading points for each Generating Unit (minimum operating level, 50 %, 80 %, 95 %);

ii. Primary and secondary response to frequency fall (-0.5 Hz); and

iii. High frequency response to frequency rise (+0.5 Hz).

3. For Generating Unit step up transformer:

i. Rated MVA;

ii. Voltage ratio;

iii. Cooling stages and MVA rating at each stage;

iv. Positive sequence reactance (at max, min, & nominal tap);

v. Positive sequence resistance (at max, min, & nominal tap);

vi. Zero phase sequence reactance;

vii. Tap changer range, step size and type: on load or off circuit;

viii. Basic lightning impulse insulation level;

ix. Power frequency withstand voltage;

x. Chopped impulse withstand voltage; and

xi. Switching impulse voltage.

4. Excitation Control System parameters:

i. Excitation System type, model and make;

ii. Nominal response, DC gain of excitation loop;

iii. Rated field voltage, maximum and minimum;

iv. No-Load field voltage;

v. Excitation System On-Load positive ceiling voltage;

vi. Excitation System No-Load positive ceiling voltage;

vii. Excitation System No-Load negative ceiling voltage;

viii. Stator current limiter (applicable only to synchronous Generating Units);

ix. Details of excitation System (including PSS if fitted) described in block diagram form showing transfer functions of individual elements, inputs, gains, lead/lag time and IEEE model in PSS/E format;

x. Details of Over-Excitation Limiter described in block diagram form showing transfer functions of individual elements;

xi. Details of Under-Excitation Limiter described in block diagram form showing transfer functions of individual elements;

xii. The block diagrams should have been verified as far as reasonably practicable by simulation studies as representing the expected behaviour of the system;

xiii. IEEE models in PSS/E format; and

xiv. Positive, negative and zero sequence saturated impedance values.

5. Governor parameters:

i. All generators: Governor and associated prime mover parameters;

ii. Governor model in IEEE PSSE format.

iii. Governor and associated prime mover parameters and models - steam units:

- HP valve time constant (s);
- HP valve opening limits (%);
- HP valve opening rate limits (%/s);
- HP valve closing rate limits (%/s);
- HP turbine time constant (s);
- IP valve time constant (s);
- IP valve opening limits (%);
- IP valve opening rate limits (%/s);
- IP valve closing rate limits (%/s);
- IP turbine time constant (s);
- LP valve time constant (s);
- LP valve opening limits (%);
- LP valve opening rate limits (%/s);
- LP valve closing rate limits (%/s);
- LP Turbine time constant (s);
- Reheater time constant (s);
- Boiler time constant (s);
- HP power fraction (%); and
- IP power fraction (%).

iv. Gas turbines:

- Inlet guide vane time Constant (s);
- Inlet guide vane opening limits (%);
- Inlet guide vane opening rate limits (%/s);
- Inlet guide vane closing rate limits (%/s);
- Fuel valve constant (in seconds);
- Fuel valve opening limits (%);
- Fuel valve opening rate limits (%/s);
- Fuel valve closing rate limits (%/s); and
- Waste heat recovery boiler time constant (s).

6. Generating Facility flexibility Performance:
    i. Run-up rate to capacity;
    ii. Run-down rate from capacity,
    iii. Synchronising generation;
    iv. Block load; and
    v. Load rejection capability while still synchronised and able to supply load.
7. Generating Unit mechanical parameters:
    i. Number of turbine generator masses;
    ii. Diagram showing the Inertia and parameters for each turbine generator mass (kgm^2) and stiffness constants and parameters between each turbine generator mass for the complete drive train (Nm/rad);
    iii. Number of poles;
    iv. Relative power applied to different parts of the turbine (%);
    v. Torsional mode frequencies (Hz); and
    vi. Modal damping decrement factors for the different mechanical modes.
8. Alternative fuel information:

    The following data items must be supplied with respect to each synchronous Generating Unit whose main fuel is gas. For each alternative fuel type (if facility installed):

    i. Alternative fuel type e.g. oil distillate, alternative gas supply;
    ii. For the changeover from main to alternative fuel:
        - Time to carry out off-line and on-line fuel changeover (min);
        - Maximum output following off-line and on-line changeover (MW);
        - Maximum output during on-line fuel changeover (MW);
        - Maximum operating time at full load assuming typical and maximum possible stock levels (hours);
        - Maximum rate of replacement of depleted stocks (MWh electrical/day) on the basis of good industry practice; and
        - Number of successful changeovers carried out in the last decade (choice of 0, 1-5, 6-10, 11-20, >20).
    iii. For the changeover back to main fuel:
        - Time to carry out off-line and on-line fuel changeover (min); and
        - Maximum output during on-line fuel changeover (MW).

c) For Power Park Module, non-synchronous Generating Unit and associated control system data:

1. Power Park Module model:

i. A mathematical model of each type of Power Park Module capable of representing its transient and dynamic behaviour under both small and large disturbance conditions;

ii. The model shall include non-linear effects and represent all equipment relevant to the dynamic performance of the Power Park Module as agreed with Kahramaa;

iii. The model shall be suitable for the study of balanced, root mean square, positive phase sequence time-domain behaviour, excluding the effects of electromagnetic transients, harmonic and sub-harmonic frequencies;

iv. The model shall accurately represent the overall performance of the Power Park Module over its entire operating range including that which is inherent to the Power Park Module and that which is achieved by use of supplementary control systems providing either continuous or stepwise control; and

v. Model resolution should be sufficient to accurately represent Power Park Module behaviour both in response to operation of ETN protection and in the context of longer-term simulations.

2. Wind Power Park Modules:

i. Rated MVA;

ii. Rated MW;

iii. Rated terminal voltage;

iv. Average site air density (kg/m^3), maximum site air density (kg/m^3) and minimum site air density (kg/m^3) for the year;

v. Year for which the air density is submitted;

vi. Number of pole pairs;

vii. Blade swept area (m^2);

viii. Gear box ratio;

ix. Mechanical drive train;

x. For each Power Park Module, details of the parameters of the drive train represented as an equivalent two mass model should be provided. This model should accurately represent the behaviour of the complete drive train for the purposes of EPS analysis studies and should include the following data items:

- Equivalent Inertia constant (s) of the first mass (e.g. wind turbine rotor and blades) at minimum, synchronous and rated speeds;
- Equivalent Inertia constant (s) of the second mass (e.g. generator rotor) at minimum, synchronous and rated speeds; and
- Equivalent shaft stiffness between the two masses (Nm/electrical radian).

xi. Additionally, for Power Park Units that are induction generators (e.g. squirrel cage, doubly-fed) driven by wind turbines:

- Stator resistance;
- Stator reactance;
- Magnetizing reactance;
- Rotor resistance (at starting);
- Rotor resistance (at rated running);
- Rotor reactance (at starting); and
- Rotor reactance (at rated running).

xii. Additionally, for doubly-fed induction generators only:

- The generator rotor speed range (minimum and maximum speeds in RPM);
- The optimum generator rotor speed versus wind speed submitted in tabular format; and
- Power converter rating (MVA).

3. Torque / speed and blade angle control systems and parameters;
4. Voltage/Reactive Power/Power Factor control system parameters;
5. Frequency Control System parameters;
6. Protection: Details of settings for the following protection relays (to include): under frequency, over frequency, under voltage, over voltage, rotor over current, stator over current, high wind speed shut down level;
7. Complete Power Park Module model, parameters and controls;
8. Harmonic and flicker parameters:

   When connecting a Power Park Module, it is necessary for the owner to evaluate the production of flicker and harmonics on the ETN and Grid User' systems. At Kahramaa's reasonable request, the owner is required to submit the following data (as defined in IEC 61400-21 (2001)) for each Power Park Module:

   i. Flicker coefficient for continuous operation;

   ii. Flicker step factor;

   iii. Number of switching operations in a 10 min window;

   iv. Number of switching operations in a 2 hours window;

   v. Voltage change factor; and

   vi. Current injection at each harmonic for each Power Park Module and for each Power Park Module.

d) For PV Power Park Modules:

1. DC converter parameters:

   i. DC converter type (i.e. current or voltage source);

   ii. Number of poles and pole arrangement;

iii. Rated DC voltage/pole (kV).

iv. Rated MVA;

v. Nominal primary voltage (kV);

vi. Nominal secondary (converter-side) voltage(s) (kV);

vii. Winding and earthing arrangement;

viii. Positive phase sequence reactance at minimum, maximum and nominal tap;

ix. Positive phase sequence resistance at minimum, maximum and nominal tap;

x. Zero phase sequence reactance;

xi. Tap-changer range in %; and

xii. Number of tap-changer steps.

2. DC network parameters:

i. Rated DC voltage per pole;

ii. Rated DC current per pole;

iii. Single line diagram of the complete DC network;

iv. Details of the complete DC network, including resistance, inductance and capacitance of all DC cables and/or DC lines; and

v. Details of any DC reactors (including DC reactor resistance), DC capacitors and/or DC-side filters that form part of the DC network.

3. AC filter reactive compensation equipment parameters:

Note: The data provided pursuant to this paragraph must not include any contribution from reactive compensation plant.

i. Total number of AC filter banks;

ii. Type of equipment (e.g. fixed or variable);

iii. Single line diagram of filter arrangement and connections;

iv. Reactive power rating for each AC filter bank, capacitor bank or operating range of each item of reactive compensation equipment, at rated voltage; and

v. Performance chart showing reactive power capability of the DC converter, as a function of MW transfer, with all filters and reactive compensation plant, belonging to the DC converter Station or HVDC system working correctly.

4. Generating Facility flexibility performance:

i. Nominal and maximum (emergency) loading rate with the DC converter in rectifier mode;

ii. Nominal and maximum (emergency) loading rate with the DC converter in inverter mode;

iii. Maximum recovery time, to 90 % of pre-fault loading, following an AC system fault or severe voltage depression; and

iv. Maximum recovery time, to 90 % of pre-fault loading, following a transient DC network fault.

e) For Power Storage Unit: Minimum Functions of Battery Management Systems:

1. Metering and monitoring;
2. Safety protections;
3. Data communication and performance; and
4. Battery Management Systems data communication.

f) For User System Data:

1. Diagrams, drawings at Delivery points, indicating quantities, ratings and operating parameters of the following:

   i. Equipment and apparatuses;

   ii. Electrical circuits as lines, cables with rated operating voltage, positive sequence resistance and reactance, zero sequence resistance and reactance, positive sequence shunt susceptance, zero sequence susceptance;

   iii. Grounding arrangement;

   iv. Protections schemes and description, parameters, settings, and maintenance plans;

   v. Interrupting devices;

   vi. Phase configuration;

   vii. Operating voltages;

   viii. Any data or information necessary to undertake protection coordination study; and

   ix. Numbering and nomenclature.

2. for transformers:

   i. Rated MVA;

   ii. Voltage ratio;

   iii. Cooling stages and MVA rating at each stage;

   iv. Positive sequence reactance (at max, min, & nominal tap);

   v. Positive sequence resistance (at max, min, & nominal tap);

   vi. Zero phase sequence reactance;

   vii. Tap changer range, step size and type: on load or off circuit;

   viii. Basic lightning impulse insulation level;

   ix. Power frequency withstand voltage

   x. Chopped impulse withstand voltage; and

xi. Switching impulse voltage.

3. for switchgears, breakers, load break switches, disconnect switches:
   i. Rated voltage;
   ii. Rated current;
   iii. Rated symmetrical RMS short-circuit current;
   iv. Rated unsymmetrical RMS short-circuit current;
   v. Rated interrupting current and time;
   vi. Symmetrical short-circuit current withstand time;
   vii. Power frequency withstand voltage;
   viii. Chopped impulse withstand voltage; and
   ix. Switching withstand voltage.

B.5.2 SCHEDULE PC-BC

The schedule PC-BC (Planning Code – Data from Bulk Consumer) lists the data for Bulk Consumers that shall be submitted according to the requirements of the Planning Code and the Connection Code sections:

a) User's facility Demand (Active Power) and active energy data for each year;

b) Single line diagram during power consumption;

c) Post fault system layout;

d) Control of Demand:
   1. Magnitude of Demand which is tripped MW;
   2. System frequency at which tripping is initiated Hz;
   3. Time duration of system frequency below trip setting for tripping to be initiated (s); and
   4. Time delay from trip initiation to tripping (s).

e) General Demand data:
   1. Details of any individual loads which have characteristics significantly different from the typical range of domestic, commercial or industrial loads supplied;
   2. Load Model to be used in PSS/E for all components;
   3. The sensitivity of the Demand (active and reactive embedded) to variations in voltage and frequency on the ETN;
   4. Details of any traction/air conditioning loads, e.g. connection phase pairs and continuous load variation with time;
   5. The average and maximum phase unbalance, in magnitude and phase angle, which the Grid User would expect its demand to impose on the ETN;
   6. The maximum harmonics content which the Grid User would expect its demand to impose on the ETN; and

7. Details of all loads which may cause Demand fluctuations greater than those permitted.

C. CONNECTION CODE (CC)

C.1 CONTENT

The Connection Code (CC) section describes the processes and the steps for the connection of a Generating Facility/Unit or a Demand Facility, from the application for the connection until the first grid operation of the Facility.

The Connection Code section sets out the technical requirements related to the grid Security and Reliability to be met by Generating and Demand Facilities in order to connect these facilities to the Electrical Transmission Network (ETN).

These requirements are considered as minimal because carrying out the reasonable contribution of the Grid Users to grid Reliability and to Operational Security, according to the criteria chosen for system development and for system operation.

The objective of this Connection Code section is to:

a) inform Grid Users about the connection processes and their associated obligations;

b) ensure that the technical and operational conditions which must be met by a Demand or by a Generating Facility are clearly stated and verifiable; and

c) to ensure that Demand Facilities and Generating Units connected to the ETN are meeting the technical and operational requirements laid down in the Grid Code.

Concerning the Grid Code compliance, information and data required from Grid Users during the connection processes are embedded in the Planning Code, in the Connection Agreements (PWPA for Generating Facility, BSA for Demand Facility, etc.) and in their referenced or associated documents.

C.2 CONNECTION PROCESS FOR A GENERATING FACILITY

A project for the implementation of a new Generating Unit or Facility combines four successive phases:

a) a development phase during which the Generating Facility developer or owner takes actions for the feasibility of his project (technical, environmental, regulatory, economic, financial, social, energy, etc.) up to signing the PWPA;

b) a study phase to analyze the impacts of the Generating Facility on the grid and to elaborate the detailed specifications necessary for the grid connection and for the construction;

c) a construction phase covering the purchase, the construction and the acceptance of the systems, components and apparatuses of the Connection Equipment station and of the Generating Units, blocks and Facility; and

d) a commissioning phase to proceed to the energization and to the full testing of the connection equipment station and of the Generating Units, blocks and Facility.

C.2.1 RESPONSIBILITIES OF GENERATING FACILITY OWNER

After receiving the Letter of Award, the responsibilities of the Generating Facility Owner are:

a) During the development phase, to provide all data and information requested in the Planning Code (section B) for the future connection of the Generating Facility to the ETN;

d) to enter into a PWPA for designing, building, commissioning and operating the Facility;

e) to provide all data and information requested during all phases of the Connection Code (section C);

f) to fulfil all applicable technical requirements defined in the RGCC (section D); and

g) to coordinate on all technical, administrative and regulatory topics with Kahramaa along all the project phases.

C.2.2 RESPONSIBILITY OF KAHRAMAA

Kahramaa's obligations as TSO shall as minimum cover the following up to achieving the technical and administrative clauses:

a) to include in the Connection Agreements the lists of all data required by the Grid Users for the project milestones indicated in C.2.3;

b) to include in the Connection Agreements the list of all technical requirements in RGCC that are applicable to the Units and the Facility according to their category;

c) to review, to analyze and to negotiate the terms of the technical documentation elaborated by the Generating Facility Owner to obtain the compliance with the requirements set forth in the Grid Code;

d) to facilitate technical coordination between Generating Facility and Kahramaa teams;

e) to facilitate securing agreements and approvals to the extent agreed under the terms of the PWPA; and

f) to determine if the Generating Facility has to be considered as Significant Generating Facility (SgFs) for system operation as defined in GP (subsection A.2.2).

C.2.3 DESCRIPTION OF THE PROCESS TO CONNECT A GENERATING FACILITY

The process to connect a Generating Facility to the ETN is described in Kahramaa' "General Terms and Conditions EPC/PC Contracts" document.

Considering the Grid Code compliance, the main phases and milestones are introduced by Figure C.2-1.

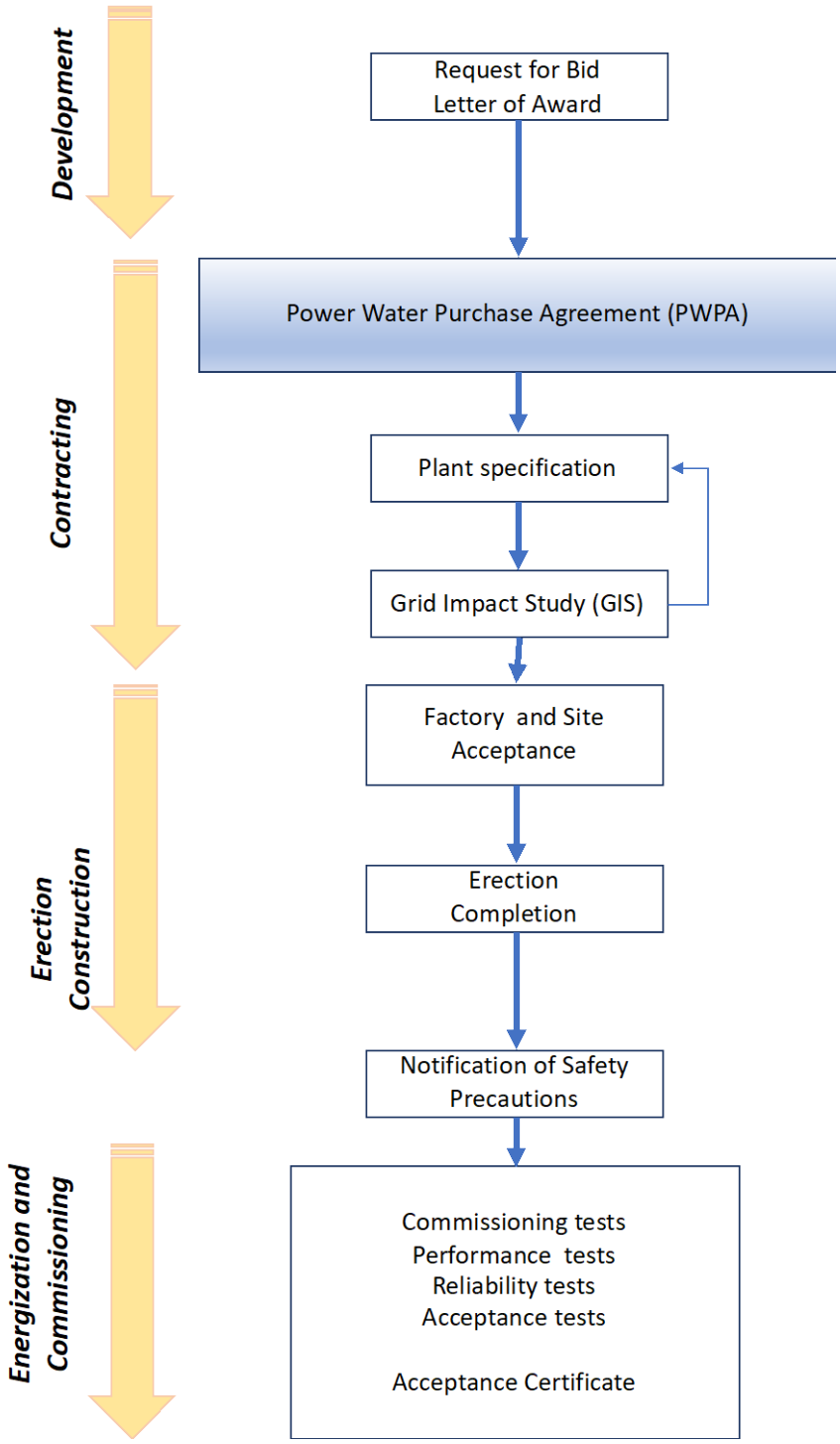

Figure C.2-1: General process for grid connection for a Generating Facility

The main milestones are:

a) Issuance of Letter of Award by Kahramaa;

b) Signing of the PWPA;

c) Grid Impact Study validation;

d) Erection Completion Certificate;

e) Notification of Safety Precautions for Connection Equipment;

f) Certificate of Operation;

g) Taking Over Certificate; and

h) Final Completion Certificate.

The activities covering this general process and the corresponding responsibilities for the Generating Facility Owner and for Kahramaa are depending upon the necessity or not to erect a specific Connection Equipment connecting the Generating Facility to the ETN and are illustrated in Figure C.2-3.

C.2.3.1 COORDINATED ACTIVITIES

a) For the project developer or the Generating Facility Owner, the main stages are:

   i. the initiation of the generating project;

   ii. the elaboration and the acceptance of the PWPA which integrates all technical, legal and commercial clauses. Amongst technical clauses, some are directly linked with grid Security and Reliability and are specified in the RGCC (section D);

   iii. the performance of the Grid Impact Study and if necessary, the adaptation of the Generating Facility specifications to fulfil the outcomes of the Grid Impact Study;

   iv. the initiation of the construction of the Facility;

   v. the performance of the factory and site acceptance tests and the submission of associated Certificate of Readiness;

   vi. the submission of notification of safety precautions to energize the systems and apparatuses of Connection Equipment station;

   vii. the submission of the clearance for energization and the performance of all tests requested in the PWPA for the Generating Facility; and

   viii. the submission of the Final Acceptance Certificates.

b) For Kahramaa, after signing the PWPA the corresponding stages are:

   i. the acceptance of the Grid Impact Study;

   ii. if necessary, the acceptance of the proposed revised Generating Facility specifications;

   iii. the issuance of necessary purchase orders;

   iv. the verification of items of compliance as: FAT, SAT and Certificate of Readiness supporting the delivery, the installation and the construction of the systems, components and apparatuses;

   v. the acceptance of notification of safety precautions to allow energization of the systems and apparatuses of Connection Equipment;

   vi. the acceptance of the clearance for energization and the monitoring of all tests requested in the PWPA for the Generating Facility; and

   vii. the validation of the final Acceptance Certificates.

C.2.3.2 PLANNING FOR NEW GENERATING FACILITY

a) Initiating new Facility project and/or negotiating extension of existing agreement shall start at least 4 years before April of target first capacity year and shall respect the prevailing electricity and water market structure and financing capability.

b) Design, timing and technology of new Facility shall be made to meet at least target reserve margin (see Operation Code in section E), with consideration maximum utilization of economy of scale related to site and infrastructure required for electricity, water and gas networks, as well as sustainability measures. The expected high reserve margin (above target level) in the 3 years just after facility commissioning date shall be part of this evaluation.

C.2.3.3 GRID IMPACT STUDY

a) The Grid Impact Study elaborates the technical feasibility of the integration of the Generating Facility in the ETN. The goal of the Grid Impact Study is to propose a connection solution and to identify the technical conditions to secure the compatibility between the specifications formulated by the Generating Facility Owner and the requirements set forth in the Grid Code.

b) The Grid Impact Study is performed by the project developer.

c) The Grid Impact Study shall be accepted by Kahramaa.

C.2.3.3.1 GENERAL CONTEXT OF THE STUDY

The study will consider:

a) the geographical map of the study area including the location of the installation to be connected, the existing grid structures on which the proposed connection is based, the Delivery Point and the works for which the connection induces constraints;

b) the identification of the category of Generating Units, their capacity, the desired connection date, the desired level of Reference Voltage, the nearest existing power station;

c) actual data of Generating Units and Connection Equipment provided by the Facility Owner; and

d) the technical consistency of the connection scheme proposed for main power evacuation, as well as the consistency of reinforcements of the existing network and/or the limitations of use of the connection if necessary.

C.2.3.3.2 STUDIES FOR MAIN CONNECTION SCHEME

a) Kahramaa shall provide all grid data necessary to perform the Grid Impact Study.

b) Kahramaa shall agree on the list of the power studies to be performed (load flow, short-circuit, dynamic stability, contingency, transients, insulation coordination, etc.) as well as on the criteria for the acceptance of the results of the studies.

c) Study reports shall present the main results of the power studies in the estimated year of commissioning. These results only concern situations for which constraints (frequency, transit, short-circuit current, voltage, etc.) shall be highlighted.

d) The results will take the form of a table mentioning by type of constraint (seasonal if applicable) for all the situations of constraints.

e) For each situation, the study will deliver:

   i. Constraints: the relative excess of the strongest constraint; the network situation resulting in the longest period of limitation of use of the installation with the duration of risk; and the mode of treatment of these constraints (preventive or curative); and

   ii. Failure rates (in terms of number of failures per year) of structures whose losses lead to limitations: The average duration of the Incidents and the power at which it is appropriate; and the time of the Incident limiting the Facility.

f) Finally, the study provides an evaluation per season of the risk of constraints limiting the load factor of the Facility.

C.2.3.4 STUDIES FOR AUXILIARY OR BACK-UP DEMAND CONNECTION

The Grid Impact Study analyses:

a) the requirements of the Grid User on the nature of the guarantee requested (minimum power, LOLE criteria, minimum short circuit power, etc.) at the Delivery Point;

b) the technical implementation by technical specifications of these requirements; and

c) the proposed solution associated with the verification of compliance with the specifications.

C.2.3.5 OTHER CONNECTION SOLUTIONS STUDIED

All other solutions envisaged to meet the connection request are mentioned, with the main reason that leads them to be discarded.

C.2.3.6 GRID IMPACT STUDY CONCLUSION

The study provides with elements justifying, if proposed:

a) the need for a new or for upgrading a Connection Equipment station;

b) any reinforcement of the existing ETN; and

c) to limit the capacity of the use of the Generating Facility.

The conclusion of the Grid Impact Study summarizes the technical feasibility and consistency of the proposed connection, as well as the main constraints and their origins.

C.2.4 INTEGRATION OF THE GRID CODE REQUIREMENTS IN THE PWPA

a) The PWPA and associated schedules shall refer to all applicable Grid Code requirements necessary for grid Security and Reliability. These requirements are selected by Kahramaa depending on the category and the significance of the Generating Facility/block/unit as defined in the General Provisions section and in the RGCC.

b) The references to Kahramaa's technical documents (Safety rules, SOM, protections, metering, communication, etc.) and to International Standards endorsed by Kahramaa (IEC, IEEE, etc.) shall be described according to the following scheme.

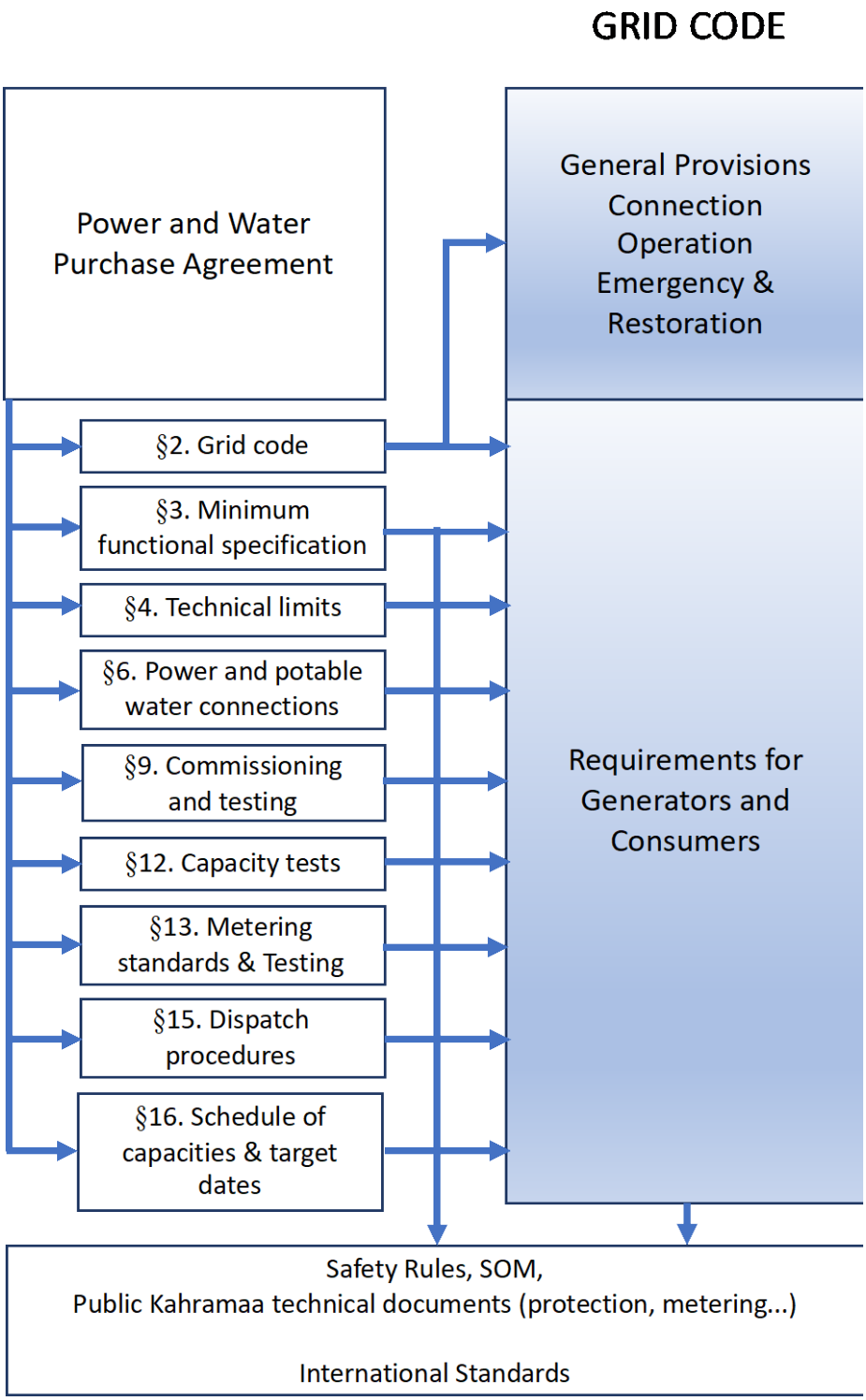

Figure C.2-2: Requirement links between PWPA and Grid Code, Kahramaa technical documents and international standards.

C.2.5 CONDITIONS FOR GRID CONNECTION AND GRID OPERATION

The conditions for grid connection and operation include all applicable regulatory and technical RGCC requirements:

a) The regulatory requirements are covering data provision and compliance process; and

b) The technical requirements are covering active and reactive power; frequency and voltage control, stability, neutral point, short-circuit, protections, metering, control, information exchange; simulation; testing and for power quality.

C.2.6 REFERENCE VOLTAGE AND POWER LEVELS

For the connection of a new Generating Unit, the Reference Voltage range is determined as a function of the maximum active power delivered by the Generating Unit, according to the following table:

Reference Voltage range Uref (kV)	Maximum power capacity Pmax (MW)
11	25
22	40
33	50
66	120
132	250
≥ 220	>250

Table C.2-1: Reference Voltage for Generating Unit connection

C.2.6.1 DATA PROVISION

a) During the connection process, the Generating Facility Owner shall deliver data requested in contractual documents, particularly:
    1. before connection (preliminary data as indicated in PC); and
    2. before commissioning (committed data as indicated in PC).

b) Before commissioning, data set shall at minimum cover:
    1. preliminary and committed data as requested in PC section;
    2. generation planning data;
    3. data and voice communication systems with NCC interface;
    4. protections and metering systems; and
    5. equivalent or user defined models to be used in PSS/E for all components.

c) Data shall be provided at least fourteen (14) Business Days before each milestone indicated in C.2.3. At each milestone, data shall have either a temporarily or final status.

d) Before commissioning and connection to the ETN, protection system checklists and settings shall be agreed by Kahramaa.

e) The level of detail of the data requested (detailed parameters or settings, uncertainty, etc.) shall allow Kahramaa to fulfil all missions and obligations requested in the Grid Code.

C.2.6.2 COMPLIANCE PROCESSES

a) The compliance of the Generating Facility is achieved by performing compliance processes supported by compliance statements as per RGCC.

b) Statements of compliance are documents elaborated by the Generating Facility Owner evidencing how the technical choices in terms of functionality, capacity, performance and in design, specifications, simulations and test during construction, commissioning and testing of the Generating Facility are supporting the compliance with the applicable requirements set forth in the Grid Code.

c) The statements of compliance are incrementally updated along the different connection projects milestones as indicated in C.2.3.

C.2.6.3 COMPLIANCE WITH TECHNICAL REQUIREMENTS

a) The Generating Facility Owner shall demonstrate that the Generating Unit or the Facility complies with the requirements set out in RGCC:

   i. for active and reactive power, frequency and voltage control; for stability; for grid operation; for simulation; for testing and for power quality;

   ii. for compliance with conditions required for energization, for testing and for commissioning; and

   iii. for first grid operation.

b) The Facility Owner shall consider and integrate applicable requirements of RGCC in the technical documentation of the Generating Facility.

c) The technical documentation of the Generating Facility shall be reviewed and accepted by Kahramaa.

C.2.7 COMMISSIONING AND TESTING

a) All activities when preparing and performing the energization of Generating Units/systems/apparatus/components shall be performed according to Kahramaa Safety rules, regulations & necessary safety precautions, PWPA requirements and SOM documents.

b) In the case where Kahramaa has reported that the Delivery Point or any associated apparatus is not ready for the energizing of the Delivery Point to go ahead, the Generating Facility Owner shall make such changes to the apparatuses and/or Delivery Point as are required, and shall inform Kahramaa when a further inspection can take place.

c) Kahramaa has the responsibility to attend the energization and the commissioning, and to monitor electrical parameters at the grid/plant interface.

d) In case of unexpected behaviour or issue that may endanger the Security of personnel or the ETN, Kahramaa has the right to hold activities, pending for investigations under the responsibility of the Generating Facility Owner.

e) During the commissioning and the testing of the Facility, the Facility Owner shall:

i. ensure that each Generating Unit complies with the requirements applicable under this regulation throughout the lifetime of the Facility;

ii. notify Kahramaa of any modification of the technical capabilities of a Generating Unit which may affect its compliance with the requirements applicable under this regulation, before initiating that modification;

iii. notify Kahramaa of any operational Incidents or failures of a Generating Unit that affect its compliance with the requirements of the Grid Code, without undue delay, after the occurrence of those Incidents; and

iv. notify Kahramaa of the planned test schedules and procedures to be followed for verifying the compliance of the Generating Unit with the applicable requirements, in due time and prior to their launch. Kahramaa shall approve in advance the planned test schedules and procedures. Such approval by Kahramaa shall be provided in a timely manner and shall not be unreasonably withheld.

f) Kahramaa shall participate during testing and shall record the performance of the Generating Units.

g) The Generating Facility Owner shall be informed of the outcome of the compliance checks including simulation checks.

h) Kahramaa have the right to request the Generating Facility Owner to carry out compliance tests and simulations according to a repeat plan or general scheme or after any failure, modification or replacement of any equipment that may have an impact on the Generating Unit's compliance with the requirements of the Grid Code.

C.2.8 ACCEPTANCE OF TAKING OVER CERTIFICATE AND FIRST OPERATION

C.2.8.1 ACCEPTANCE

a) When applying for the Taking Over Certificate, the Generating Facility Owner shall provide a full update of all the technical documentation, simulation results, as-build data and testing results.

b) Kahramaa shall validate the Taking Over Certificate for the Generating Facility once all non-compliances with the PWPA and the Grid Code have been addressed and fixed by the Generating Facility Owner.

C.2.8.2 LIMITED ACCEPTANCE

a) Kahramaa may accept limited Taking Over Certificates according two types of situations:

i. Concerning Generating Facilities with multiple Generating Units, Taking Over Certificates are delivered and limited to the Generating Units which have been successfully individually commissioned and tested; and

ii. In case of Grid Code deviation justified by the Facility Owner, Kahramaa may grant, after analysing of the impact on system Security and Reliability, a time limited Taking Over Certificates during which the Generating Facility Owner is committed to fix the deviation.

b) The restrictions imposed in the limited Taking Over Certificates can be applied on Generating Units, on operating performances, on operation time duration or on operating conditions.

c) All data that have been provided and accepted by Kahramaa in limited Taking Over Certificate are considered temporary until the issuance of the final Taking Over Certificate.

C.2.8.3 WARRANTY PERIOD

During the warranty period, the Generating Facility shall comply with the requirements of the Operating Code.

C.2.9 REQUIREMENTS APPLICABLE IN CASE OF CHANGE

a) During the construction, the commissioning and the testing of the Generating Facility, Kahramaa shall be informed and shall agree on any change proposed or performed by the Generating Facility Owner in components, system, data, value, parameters in reference to RGCC, and to PWPA schedules.

b) In case of planned change (due to replacement, modification or modernization) of any technical characteristics previously communicated to Kahramaa (protection and control schemes or settings, capability of apparatus, power performances, etc.) the Generating Facility Owner shall notify to Kahramaa:

i. The reasons for change and the impacts on the statement of compliance, before initiating that replacement, modification or modernization; and

ii. The planned test schedules and procedures to be followed after change or repair for verifying the compliance with the concerned requirements of the Grid Code, in due time and prior to their launch. Kahramaa shall approve in advance the planned test schedules and procedures. Such approval shall be provided in a timely manner and shall not be unreasonably withheld.

c) Any operational Incidents or failures that affect the compliance with the requirements shall be communicated to Kahramaa without undue delay.

C.2.10 COORDINATION OF ACTIVITIES AND REQUESTED DATA

The following chart is illustrating the coordination of activities and the phases where data are requested from Facility Owners for the connection of a Generating Facility and for the Connection Equipment.

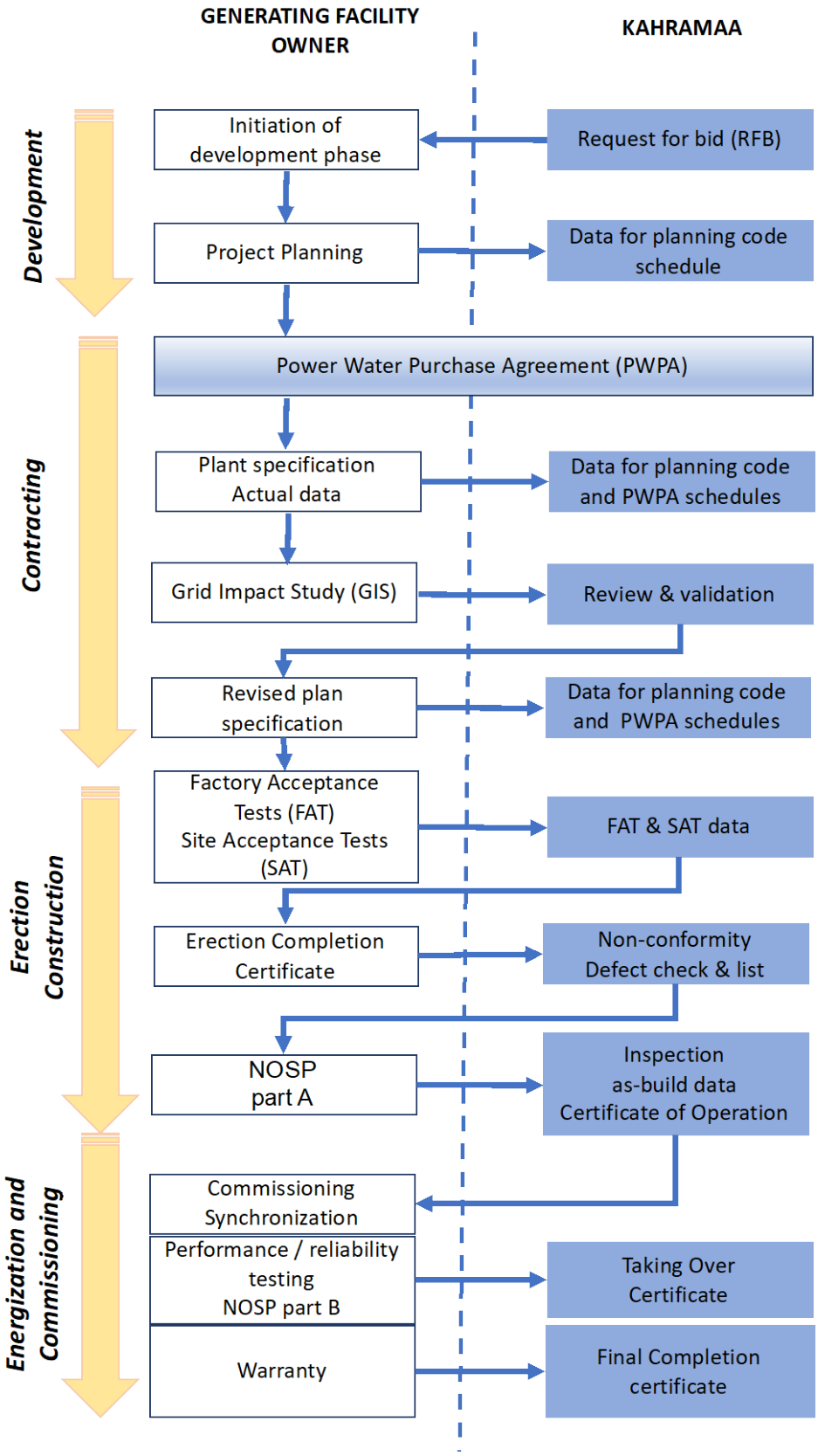

Figure C.2-3: Generating Facility: Coordination of activities and requested data

C.3 CONNECTION PROCESS FOR A DEMAND FACILITY

This procedure is applicable to all Bulk Consumers' requests for electricity supply above 5 MW from submitting the application to energization of including signing off related agreements.

The connection processes are distinct according to the industrial or non-industrial nature of the Demand and considering the need to erect a new Connection Equipment (or primary Substation).

C.3.1 RESPONSIBILITIES OF DEMAND FACILITY OWNER

The responsibilities of the Demand Facility owner are:

a) to file an application on Kahramaa's website for the connection of the facility for the use of power according the technical nature of his facility (industrial or not industrial), providing all data and information requested in the application form and in PC section;

b) if a new Connection Equipment is needed to power the Delivery Point, the Demand Facility owner shall agree a MoU for defining the construction project of the Connection Equipment and for sharing the cost of construction.

   A Consultancy Service Agreement (CSA) may be agreed with Kahramaa to provide services for tendering, design, engineering, construction, and commissioning necessary to complete the erection of the primary Substation;

c) to enter into a Bulk Supply Agreement (BSA) to regulate the terms and conditions for the supply and the use of electricity;

d) to enter into an Operation and Maintenance Agreement (OMA) to regulate the responsibilities, the terms and conditions for the maintenance and the operation of the primary Substation;

e) to enter into an Asset Transfer Agreement (ATA) for to set up the conditions for transferring the property of the primary Substation to Kahramaa;

f) to provide all data and information requested by Kahramaa during all phases and milestones of the connection project as indicated in PC (section B), C.3.3 and C.3.4.2;

g) to fulfil all applicable technical requirements defined in the RGCC (section D); and

h) to coordinate on all technical, administrative and regulatory topics with Kahramaa along all the project phases.

C.3.2 RESPONSIBILITIES OF KAHRAMAA

Kahramaa's obligations as energy supplier and as TSO shall as minimum cover the following up to achieving the technical and administrative clauses:

a) to review and to analyze the application submitted by the Demand Facility owner and to propose a connection solution;

b) to include in the application and in the Connection Agreements (MoU, CSA, BSA, OMA, ATA) the lists of all data required from the Grid Users;

c) to include in the Connection Agreements the list of all RGCC requirements that are applicable to the Facility;

d) to determine if the Demand Facility shall be considered as Significant Demand Facility (SdFs) for system operation as defined in General Provisions (section A);

e) to review the technical documentation elaborated by the Demand Facility owner to obtain the compliance with the requirements set forth in the Grid Code;

f) to facilitate technical coordination between Demand Facility and Kahramaa teams; and

g) to facilitate securing authorizations and approvals to the extent agreed under the terms of the applicable Agreements (MoU, CSA, BSA, OMA, ATA; etc.).

C.3.3 DESCRIPTION OF THE PROCESS TO CONNECT A DEMAND FACILITY

The general process to connect a Demand Facility to the ETN is introduced by Figure C.3-1.

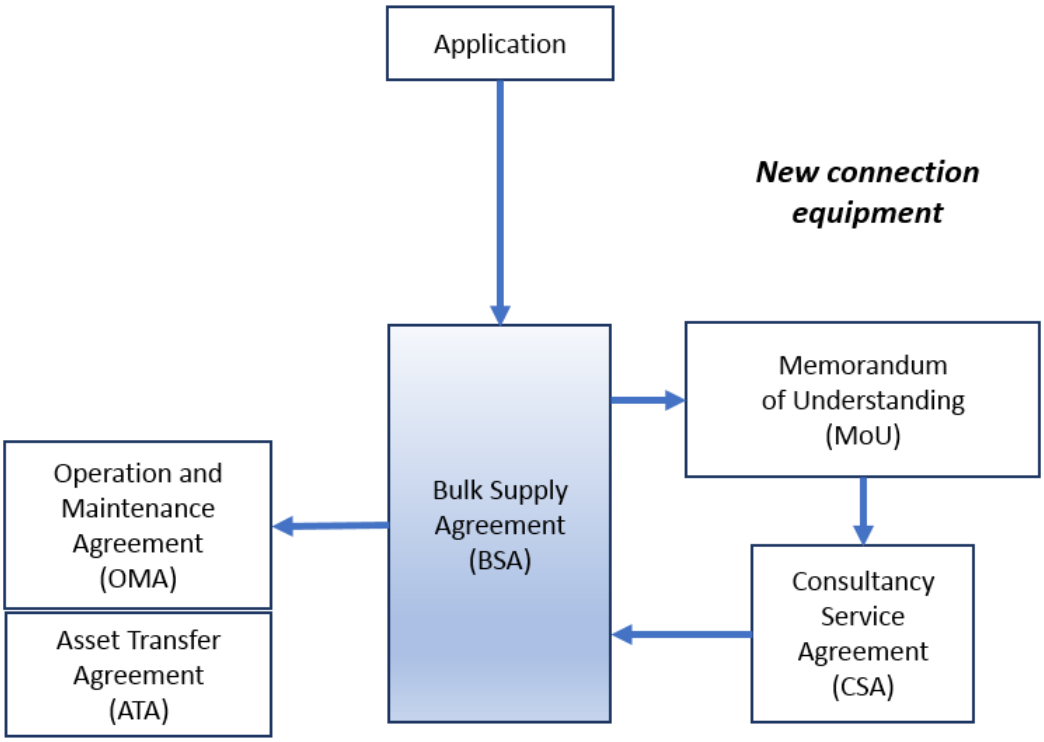

Figure C.3-1: General process for grid connection of a Demand Facility

The main milestones are:

a) Application for supply of power for Bulk Consumers;

b) Signature of the MoU;

c) Signature of the Bulk Supply Agreement;

d) Commissioning of the Connection Equipment (primary substation);

e) Test and connection to the Facility;

f) Delivery by Kahramaa of the Connection Permit; and

g) First supply date.

C.3.4 CONDITIONS FOR GRID CONNECTION AND GRID OPERATION

The conditions for grid connection and operation related to grid Security and Reliability include all applicable regulatory and technical RGCC requirements:

a) The regulatory requirements are covering data provision and compliance process; and

b) The technical RGCC requirements are covering frequency and voltage ranges, active and reactive power; neutral point, short-circuit, protections, metering, control, information exchange; simulation; testing and power quality.

C.3.4.1 REFERENCE VOLTAGE RANGES AND POWER LEVELS

The reference connection voltage is determined as a function of the maximum apparent power consumed by the Demand Facility, according to the following table:

Maximum Demand S (MVA)	Connection voltage level U (kV)
$S \leq 120$	$U \geq 66$
$120 \leq S \leq 250$	$U \geq 132$
$S > 250$	$U \geq 220$

Table C.3-1: Reference Voltage for Demand Facility connection

C.3.4.2 DATA PROVISION

a) During the connection process, the Demand Facility owner shall deliver data requested in contractual documents, particularly:
   1. before connection (preliminary data as per Planning Code); and
   2. before commissioning (committed data as per Planning Code).

b) Before commissioning and connection to the ETN, data set shall at minimum cover:
   1. preliminary and committed data as requested in PC section;
   2. demand planning data;
   3. data and voice communication systems with Kahramaa interface;
   4. protections and metering systems; and
   5. equivalent or user defined models to be used in PSS/E for all components.

c) Before commissioning and connection to the ETN, protection system checklists and settings shall be agreed by Kahramaa.

d) The level of detail of the data requested (detailed parameters or settings, uncertainty, etc.) shall allow Kahramaa to fulfil all missions and obligations requested in the Grid Code.

e) Datasets requested in project documents associated to the milestones as per C.3.3 shall be delivered and updated at least fourteen (14) Business Days before each milestone. Particularly, before first operation, datasets are updated by collecting as-build data and agreed testing results.

f) The level of detail of the data requested shall allow Kahramaa to fulfil all missions and obligations requested in the Grid Code.

C.3.4.3 COMPLIANCE PROCESSES

a) The compliance of the Demand Facility is achieved by performing compliance processes supported by compliance statements as per RGCC.

b) Statements of compliance are documents elaborated by the Demand Facility owner evidencing how the technical choices in terms of functionality, capacity and performance and in design, specifications, simulations and test during construction, commissioning and testing of the Demand Facility are supporting the compliance with the requirements set forth in the Grid Code.

c) The statements of compliance are incrementally updated along the different connection projects milestones as indicated in C.3.3.

C.3.4.4 COMPLIANCE WITH TECHNICAL REQUIREMENTS

a) The Facility owner shall demonstrate that the Demand Facility complies with the requirements set out in RGCC:

1. for energization and for testing;
2. for grid operation with conditions on frequency and voltage, active and reactive power; neutral point, metering, control, information exchange;
3. for stability with conditions on short-circuit, protections, simulation, power quality; and
4. for observability with conditions on metering, control and information exchange.

b) The Facility Owner shall consider and integrate the requirements of RGCC in the technical documentation of the Demand Facility.

c) The technical documentation of the Demand Facility shall be reviewed and accepted by Kahramaa.

C.3.5 COMMISSIONING AND TESTING

a) The energization of the Facility is performed under Kahramaa‘s rules in compliance with Safety rule, regulations & necessary safety precautions and SOM documents, covering all necessary activities on systems, components and apparatuses.

b) Kahramaa has the responsibility to attend the energization and during, to monitor electrical parameters at the grid-facility interface.

c) In case of unexpected behaviour or issue that may endanger the security of personnel or the ETN, Kahramaa has the right to hold activities, pending for investigations under the responsibility of the Demand Facility owner.

d) Testing procedures are elaborated by the Demand Facility owner according to RGCC requirements. Kahramaa shall approve in advance the planned test schedules and procedures. Such approval by Kahramaa shall be provided in a timely manner and shall not be unreasonably withheld.

e) During the energization and the testing of the Facility, the Facility Owner shall:

   i. notify to Kahramaa any planned modification of the technical capabilities of the Facility which may affect its compliance with the applicable requirements and before initiating that modification;

   ii. notify Kahramaa of any operational Incidents or failures of a Demand Facility that affect its compliance with the requirements of the Grid Code, without undue delay, after the occurrence of those Incidents; and

   iii. notify Kahramaa of the planned test schedules and procedures to be followed for verifying the compliance of the Facility with the requirements of RGCC, in due time and prior to their launch. Kahramaa shall participate during testing and shall record the performance of the Demand Facilities.

f) The Facility Owner shall be informed of the outcome of the compliance checks performed by Kahramaa including simulation checks.

g) Kahramaa have the right to request the Demand Facility Owner to carry out compliance tests and simulations according to a repeat plan or general scheme or after any failure, modification or replacement of any equipment that may have an impact on the Demand Facility's compliance with the requirements of the Grid Code.

C.4 OPERATION AND MAINTENANCE SAFETY CONDITIONS

All Grid Users responsible for the operation and maintenance of the electrical systems and apparatuses of their facility are also responsible for the safety of equipment, persons, and facilities at their respective sides connected to the ETN. On safety issues, Grid Users shall follow the procedures as laid down in Operating Code, SOM and the Safety Rules & Regulations.

D. REQUIREMENTS FOR GENERATORS AND CONSUMERS CODE (RGCC)

D.1 APPLICABLE REQUIREMENTS

a) The requirements in Table D.1-1 are applicable for Generating Units and Demand Facilities according to their categories and capacities as defined in GP section.

b) According to the General Provisions section:

1. Generating Units connected at or above 11 kV with a capacity between 2 and 10 MW are considered category D;
2. Synchronous Generating Units connected at or above 11 kV and with a capacity above 10 MW are considered category S; and Non-Synchronous Generating Units connected at or above 11 kV and with a capacity above 10 MW are considered category P.

c) When a requirement is applicable for several Generating Unit categories, the parameters may be different, reflecting the discrepancy between Generating Unit technologies.

Chapter	Requirements	Generating Unit categories			Demand Facility
		S	P	D	
REQUIREMENTS FOR GENERATORS					
D.2.1.1	Frequency ranges	Y	Y	Y	N
D.2.1.2	Active power control	Y	Y	Y	N
D.2.1.3	Synchronization	Y	Y	Y	N
D.2.1.4.1	Frequency Sensitive Mode	Y	N	N	N
D.2.1.4.2	LFSM-O	Y	N	N	N
D.2.1.4.3	LFSM-U	Y	N	N	N
D.2.1.4.4	Secondary control	Y	N	N	N
D.2.2.1	Voltage ranges	Y	Y	Y	N
D.2.2.2	Voltage control	Y	N	N	N

Chapter	Requirements	Generating Unit categories			Demand Facility
		S	P	D	
D.2.2.3	Reactive power capability	Y	N	N	N
D.2.2.4	Excitation System and PSS	Y	N	N	N
D.2.3	Fault Ride Through capability	Y	N	N	N
D.2.4.1	Grid connection	Y	Y	Y	N
D.2.4.2	Electrical protections	Y	Y	Y	N
D.2.4.3	Metering	Y	Y	Y	N
D.2.4.3.1	Neutral Point	Y	Y	Y	N
D.2.4.5	Recordings	Y	Y	Y	N
D.2.4.6	Communication and information exchange in operation	Y	Y	N	N
D.2.5	Simulation	Y	Y	Y	N
D.2.6	Power quality	Y	Y	Y	N
D.2.7.1	Power restoration	OR	N	N	N
D.2.7.2	Island Operation	Y	N	N	N
D.2.7.3	Quick Re-Synchronization	OR	N	N	N
D.2.8	Testing category S	Y	Y for D.2.8.3	N	N
D.2.9	Compliance	Y	Y	Y	N
D.3.3	Power as function of frequency	N	Y	Y	N
D.3.4	Voltage stability	N	Y	Y	N
D.3.5	Reactive power capability	N	Y	N	N
D.3.6.1	Fault Ride Through capability	N	Y	N	N
D.3.6.2	Fast Fault Current contribution	N	Y	N	N
D.3.7	Testing category P	N	Y	OR	N
REQUIREMENTS FOR DEMAND FACILITIES					
D.4.1	Frequency and voltage ranges	N	N	N	Y
D.4.2	Power consumption	N	N	N	Y
D.4.3	Reactive power capability	N	N	N	Y
D.4.4	Short-circuit	N	N	N	Y
D.4.5	Neutral point	N	N	N	Y

Chapter	Requirements	Generating Unit categories			Demand Facility
		S	P	D	
D.4.6	Protections	N	N	N	Y
D.4.6.2	Recordings	N	N	N	Y
D.4.7	Metering	N	N	N	Y
D.4.8	Control	N	N	N	OR
D.4.9	Information exchange	N	N	N	Y
D.4.10	Disconnection and reconnection	N	N	N	Y
D.4.11	Power quality	N	N	N	Y
D.4.12	Simulation	N	N	N	OR
D.4.13	Testing	N	N	N	Y
D.4.14	Compliance	N	N	N	Y

Table D.1-1: Requirements applicable for Generating Units and Demand Facilities

Y= Yes, N = No; OR = on Kahramaa request

D.2 REQUIREMENTS FOR SYNCHRONOUS GENERATORS CATEGORY S

D.2.1 REQUIREMENTS FOR ACTIVE POWER CONTROL AND SYNCHRONIZATION

D.2.1.1 FREQUENCY RANGES

a) The Generating Units must remain connected to the ETN in the frequency ranges and time periods specified in Table D.2-1:

Frequency range	Time period for operation
47.5 Hz – 49.5 Hz	Minimum 30 min
49.5 Hz – 50.5 Hz	Unlimited
50.5 Hz – 51.5 Hz	Minimum 30 min

Table D.2-1: Frequency ranges and time period

b) After 30 min of over frequency the Generating Facility operator has to consult the NCC to continue operation.

D.2.1.2 ACTIVE POWER CONTROL

a) The Generating Facility shall generate power only after being authorized by the NCC.

b) In Steady State operation, the power generated by the Generating Unit shall not deviated more than ±1% of the power set-point requested by Kahramaa.

c) Automatic reconnection systems are not allowed unless conditions are specified in coordination with Kahramaa.

D.2.1.3 SYNCHRONIZATION

a) When starting a Generating Unit, synchronisation shall be performed only after authorisation by the NCC. The Generating Unit shall be equipped with the necessary synchronisation facilities. The synchronisation of the Generating Unit shall be possible at any frequency within the frequency ranges set out in D.2.1.1.

b) Upon start-up, the increase surge in active power should be limited to a maximum of 10 % of the Generating Units' rated power on a per minute time stamp.

c) The settings of synchronization devices shall authorize the synchronisation of the Generating Unit if:

1. the frequency deviated not more 0.1 Hz;
2. the voltage at the generator terminals is in the range [0.95 ; 1.05] of Un (network voltage); and
3. the deviations of the phases are not greater than 30°.

D.2.1.4 REQUIREMENTS FOR CONTRIBUTION TO FREQUENCY CONTROL

D.2.1.4.1 FREQUENCY SENSITIVE MODE (FSM)

a) The Generating Units shall be able to continuously control active power within the frequency range of 49.5 Hz to 50.5 Hz. The Generating Units shall be able to provide active power frequency response (Frequency Sensitive Mode FSM) in accordance with the following parameters (Figure D.2-1):

1. Active power range related to capacity defined by Kahramaa;
2. Frequency response insensitivity less than 10 mHz;
3. Frequency Response Dead Band (500 mHz);
4. Droop 4 %;
5. Delay less than 2 s, time to full activation t_2 less than 30 s; and
6. The frequency measuring error should not exceed ± 10 mHz.

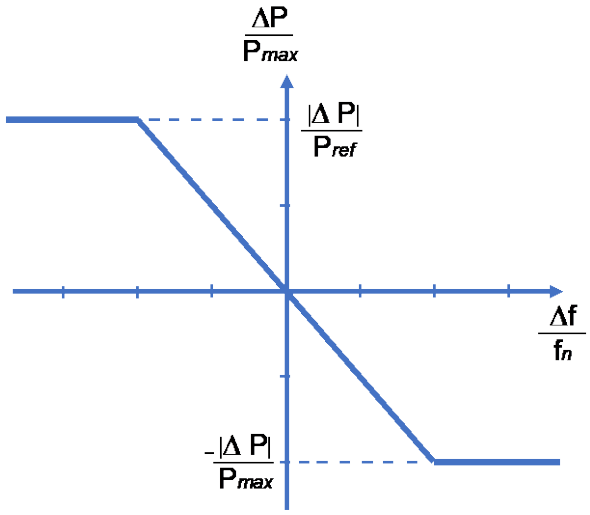

Figure D.2-1: Active power frequency response capability

- Pmax is the rated active power to which ΔP is related.
- ΔP is the change in active power output from the Generating Unit.
- f_n is the nominal frequency (50 Hz) in the network.
- Δf is the frequency deviation in the network.

b) To monitor the operation of active power frequency response, the communication interface shall be equipped to transfer in real time and in a secured manner from the Generating Units to the NCC, at least the following signals:

1. status signal of FSM (on/off);
2. status signal of secondary control (on/off);
3. scheduled active power output;

4. actual value of the active power output;
5. actual parameter settings for active power frequency response;
6. Droop and dead band; and
7. percentage of rated power for secondary control participation.

c) In specifying those parameters, Kahramaa shall take account of the following facts:

1. in case of over-frequency, the active power frequency response is limited by the Minimum Regulating Level;
2. in case of under-frequency, the active power frequency response is limited by the active power capacity; and
3. the actual delivery of active power frequency response depends on the operating and ambient conditions, in particular limitations on operation at low frequencies considering admissible active power reduction with available primary energy sources.

D.2.1.4.2 LIMITED FREQUENCY SENSITIVE MODE IN OVER FREQUENCY (LFSM-O)

a) With regard to the limited Frequency Sensitive Mode in Over-Frequency, the following shall apply:

1. the Generating Units shall be capable of activating the provision of active power frequency response according to Figure D.2-2 at a frequency threshold between 50.2 Hz and 50.5 Hz inclusive and Droop settings between 2 % and 12 % specified by Kahramaa;
2. the Generating Units shall be capable of activating a power frequency response with an initial delay that is as short as possible. If that delay is greater than two seconds, the Generating Facility Owner shall justify the delay, providing technical evidence to Kahramaa;
3. Kahramaa may require that upon reaching Minimum Regulating Level, the Generating Unit be capable of either:
   i. continuing operation at this level; or
   ii. further decreasing active power output.

b) the Generating Unit shall be capable of operating stably during LFSM-O operation and when LFSM-O is active, the LFSM-O set-point will prevail over any other active power set-points;

c) In case of deviation of the network frequency above 51.5 Hz, the Generating Unit shall disconnect from the ETN;

d) The settings of the disconnection protection (threshold, time delay of the tripping) shall be agreed with Kahramaa; and

e) In case of frequency increases, where Δf is higher than + 500 mHz compared to the nominal value (50 Hz), the generator module must decrease the active power according to the Droop s_2.

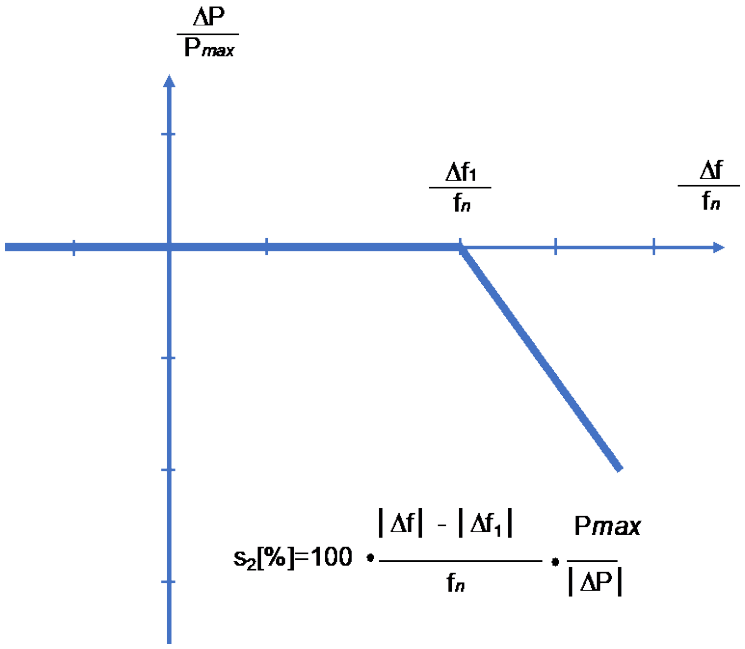

Figure D.2-2: Active capacity response capability in LFSM-O

where:

- ΔP is the variation of the active power produced by the Generating Unit;
- Pmax is the rated active power against which ΔP is set - namely the maximum power of the generator module;
- Δf is the frequency deviation of the ETN;
- f_n is the nominal frequency (50 Hz) of the ETN.

D.2.1.4.3 LIMITED FREQUENCY SENSITIVE MODE IN UNDER FREQUENCY (LFSM-U)

Considering the possibility of the Generating Unit, the variation in active power relatively to the active power produced is given by the primary source as a result of the frequency decrease, within the limits shown in Figure D.2-3 and Figure D.2-4 as follows:

a) For power Generating Units operated at Pmax, if required by the technical capability of the Generating Unit, when the frequency is below 49 Hz, as shown in Figure D.2-3, it is authorized to decrease the active power produced (the allowable power, given by the primary source) in a percentage equal to 2% of the maximum active power produced at 50 Hz for each 1 Hz frequency drop. Any maxima power reduction curve produced by the frequency, which is above the dotted line, is allowed;

b) For power Generating Units operated at Pmax, if required by the technical capability of the Generating Unit, a maximum reduction in active power produced at a frequency lowering of 49.5 Hz is allowed, as shown in Figure D.2-3, with a percentage equal to

10 % of the maximum active power produced at 50 Hz for each frequency decrease by 1 Hz if the frequency is less than 49.5 Hz for a duration longer than 30s. Any maximum frequency-dependent power reduction curve, which is above the continuous line, is allowed;

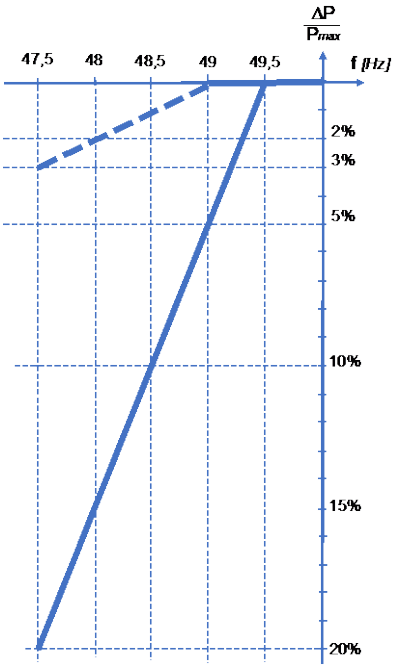

Figure D.2-3: Acceptable limits of power reduction and rate reduction at Pmax

c) the Generating Units operating at a power level below Pmax shall be capable of activating the provision of active power frequency response at a frequency threshold and with a Droop specified by Kahramaa as followed and shown in Figure D.2-4.

   1. the frequency threshold specified by the Kahramaa shall be between 49.8 Hz and 49.5 Hz inclusive;
   2. the Droop settings specified by Kahramaa shall be in the range 2-12 %;
   3. the actual delivery of active power frequency response shall follow the ramps in Figure D.2-4 when the frequency is oscillating between 49.5 Hz and 49.8 Hz depending on the capability of the Generating Unit;
   4. the actual delivery of active power frequency response in LFSM-U mode shall take into account:
      i. ambient conditions when the response is to be triggered; and
      ii. the operating conditions of the Generating Unit, in particular limitations on operation near maximum capacity at low frequencies.

d) the activation of active power frequency response by the Generating Unit shall not be unduly delayed. In the event of any delay greater than 2 seconds, the Generating Facility Owner shall justify it to Kahramaa;

e) in LFSM-U mode the Generating Unit shall be capable of providing a power increase up to its Maximum capacity; and

f) stable operation during LFSM-U operation shall be ensured.

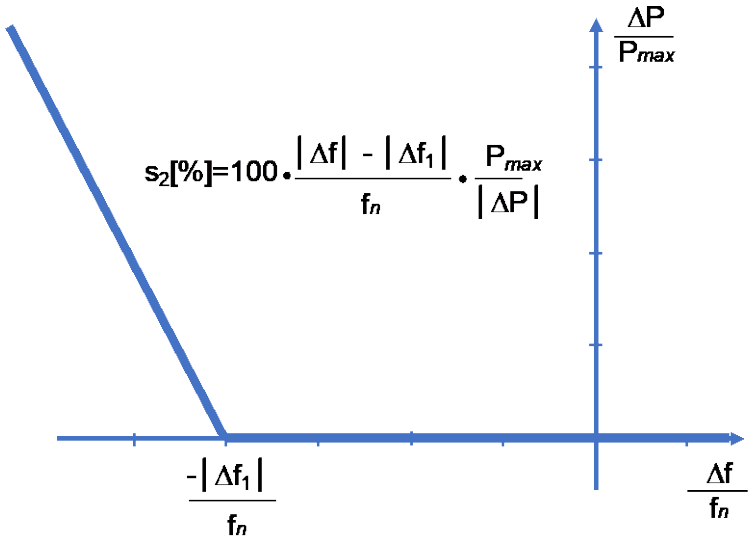

Figure D.2-4: Active power frequency response capability of Generating Units in LFSM-U

D.2.1.4.4 REQUIREMENTS FOR SECONDARY FREQUENCY CONTROL

a) Kahramaa shall define, for each Generating Unit contributing to secondary reserve, the percentage of rated power for participation to secondary control. The capacity of spinning reserve on each synchronised Generating Unit operated simultaneously in FSM and in secondary control mode shall be at a minimum percentage of the maximum capacity instructed by Kahramaa.

b) The technical requirements applicable to Generating Units contributing to system secondary control are the following:

1. Generating Units shall activate secondary control in accordance with the set-point received from the NCC;
2. Generating Units shall have an automatic secondary control activation delay not exceeding 30 s;
3. Generating Units providing secondary reserve shall be capable of activating complete automatic or manual reserve capacity within the full activation time of 30 min; and
4. Generating Units providing secondary reserve shall declare Availability and ramping rates.

D.2.2 REQUIREMENTS FOR VOLTAGE STABILITY

D.2.2.1 VOLTAGE RANGES

a) A Generating Unit shall be capable of remaining connected to the ETN and operating within the network voltage ranges, expressed by the voltage at the Delivery Point related to the reference 1 pu, and for the time periods specified in table below.

Voltage Level (1 pu)	Voltage range	Time period for operation
11 kV – 66 kV	0.85 pu - 0.90 pu	Maximum 30 min
	0.9 pu – 1.1 pu	Unlimited
	1.1 pu - 1.15 pu	Maximum 30 min
132 kV	0.85 pu-0.925 pu	Maximum 60 min
	0.925 pu – 1.075 pu	Unlimited
	1.075 pu - 1.15 pu	Maximum 20 min
220 kV	0.85 pu - 0.90 pu	Maximum 60 min
	0.90 pu – 1.1 pu	Unlimited
	1.1 pu - 1.15pu	Maximum 20 min
400 kV	0.85 pu - 0.95 pu	Maximum 60 min
	0.95 pu – 1.05 pu	Unlimited
	1.05 pu - 1.1 pu	Maximum 20 min

Table D.2-2: Voltage ranges and time period for Generating Unit operation

b) Figure D.2-5 defines the profiles of the periods of time for limited and unlimited operation according to Table D.2-2 during which Generating Units shall be capable of remaining connected to the ETN in the event of simultaneous over voltage and under-frequency or simultaneous under-voltage and over-frequency. The voltage values for points A and B shall be agreed between the Generating Facility Owner and Kahramaa.

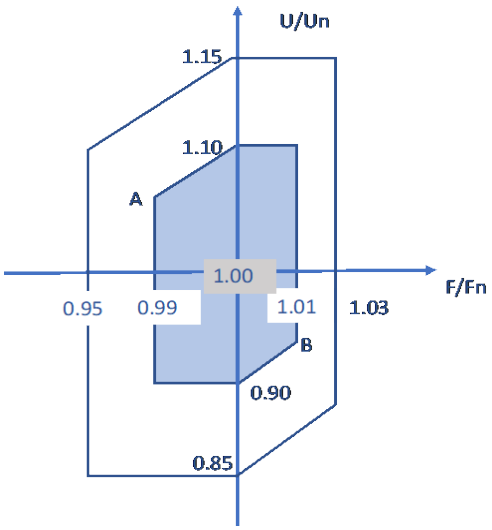

Figure D.2-5: Simultaneous UF profile

D.2.2.2 VOLTAGE CONTROL

a) The Generating Unit must be able to disconnect automatically when the voltage at the Delivery Point, if any, exceeds the level limits specified in Table D.2-2. The conditions and settings for automatic disconnection of Generating Units are determined by Kahramaa and agreed by the Generating Facility Owner.

b) The parameters and settings of the components of the voltage control system shall be agreed between the Generating Facility Owner and Kahramaa and shall cover the specifications and performances of an Automatic Voltage Regulator with regard to Steady State voltage, transient voltage and the specifications of the Excitation Control System.

D.2.2.3 REACTIVE POWER CAPABILITY

a) Kahramaa shall specify the reactive power capability at Maximum capacity in the context of varying voltage. For that purpose, Kahramaa specify a U-Q/Pmax-Profile within the boundaries of which the Synchronous Generating Unit shall be capable of providing reactive power at its maximum capacity. The specified U-Q/Pmax profile may take any shape, having regard to the potential cost of delivering the capability to provide reactive power production at high voltage and reactive power consumption at low voltage;

b) Kahramaa may specify supplementary reactive power to be provided if the Delivery Point of a Generating Unit is neither located at the high-voltage terminals of the step-up transformer to the voltage Level of the Delivery Point nor at the alternator terminals, if no step-up transformer exists. This supplementary reactive power shall compensate the reactive power demand of the line or cable between the high-voltage terminals of the step-up transformer or the alternator terminals and the Delivery Point. This supplementary reactive power shall be provided by the owner of that line or cable;

c) The U-Q/Pmax diagram is established by Kahramaa in accordance with the following principles:

1. the U-Q/Pmax contour does not exceed the inner contour of the U-Q/Pmax diagram, in Figure D.2-6;
2. the U-Q/Pmax diagram contour (Q/Pmax interval and voltage range) falls within the maximum values set out in Table D.2-3: and the positioning of the U-Q/Pmax diagram is within the fixed outer contour; and
3. the U-Q/Pmax diagram established for the Generating Unit may be of any shape, taking into account the possibility of achieving reactive power supply capacity at voltage gains and power consumption reactive to voltage drops.

d) The reactive power supply capability requirement applies at the Delivery Point, as the case may be. For other contour shapes than rectangular shapes, the voltage range represents the highest and lowest limit values. Therefore, the entire reactive power range is not expected to be available in the constant voltage range.

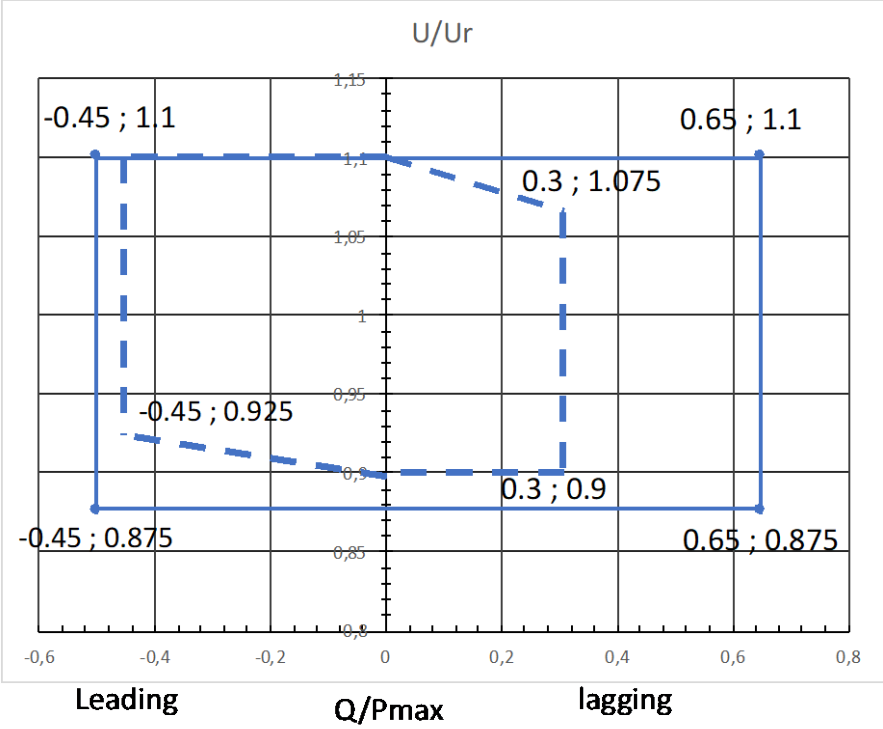

Figure D.2-6: U-Q/Pmax diagram

This figure is typical of the U-Q/Pmax diagram at the Delivery Point, as the case may be, expressed as the ratio between the real value and the reference value in relative units and the ratio between the reactive power (Q) and the maximum capacity (Pmax). The position, the size and the shape of the doted frame are indicative, depending on the system conditions at the Delivery Point, other shapes of the U-Q/Pmax diagram can be requested according to the maximum range in Table D.2-3: .

Maximum value of Q/Pmax	Maximum range of permanent Voltage Level, expressed in relative units
0.75	0.2

Table D.2-3: Maximum Q/Pmax value and U/Un

D.2.2.4 EXCITATION SYSTEM AND POWER SYSTEM STABILIZER

a) With regard to Steady State voltage and transient voltage control, the specifications and performances of the Excitation Control System shall include:

1. a bandwidth limitation of the output signal to ensure that the highest frequency of response cannot excite torsional oscillations on other Generating Units connected to the ETN;
2. an Under-Excitation Limiter to prevent the AVR from reducing the alternator excitation to a level which would endanger synchronous stability;
3. an Over-Excitation Limiter to ensure that the alternator excitation is not limited to less than the maximum value that can be achieved whilst ensuring that the synchronous power-generating module is operating within its design limits;
4. a Stator current limiter; and
5. a Power System Stabilizer (PSS) function to attenuate power oscillations.

b) The Excitation Control System shall provide constant alternator terminal voltage at a selectable set-point without instability over the entire operating range of the Figure D.2-6.

c) Power System Stabilizer settings shall be studied to define:

1. Gain and phase Bode diagrams for the open loop frequency domain response of the Generating Unit excitation with and without the PSS, with the synchronous generator operating at maximum leading conditions with the fault level at the ETN voltage of the Delivery Point at minimum. These studies should be in a format that illustrates the phase contribution of the PSS and the gain and phase margin of the Excitation System.
2. On load time series simulations of the response of the Excitation System with and without the PSS to 2 % and 10 % steps in the AVR voltage reference point with the synchronous generator operating at maximum leading conditions and the fault level at the ETN voltage of the Delivery Point at minimum.
3. Time series simulation of a 100ms solid three phase fault on the ETN voltage of the Generating Unit transformer, with and without PSS, initially operating at rated capacity, 1 pu volts and at maximum leading condition.

d) In the event of power oscillations, Generating Units shall remain at Steady State Stability when operating at any operating point of the P-Q-Capability Diagram.

e) Kahramaa and each Generating Facility Owner shall enter into an agreement regarding technical capabilities of the Generating Unit to aid angular stability under fault conditions.

D.2.3 REQUIREMENT FOR FAULT RIDE THROUGH

a) The Generating Unit shall be capable of remaining connected to the ETN and continuing to operate stably when the actual course of the phase-to-phase voltages on the network at the Delivery Point is low during a symmetrical fault, given the pre-fault and post-fault conditions, unless the protection scheme for internal electrical faults requires the disconnection of the Generating Unit from the ETN.

b) The protection schemes and settings for internal electrical faults must not jeopardize Fault-Ride-Through performance.

c) The details of that capability shall be subject to coordination and agreements on protection schemes and settings.

d) With regard to Fault-Ride-Through capability of the Generating Unit:

1. Figure D.2-7 specifies a voltage-against-time-profile at the Delivery Point for fault conditions, for which the Generating Unit is capable of staying connected to the ETN and continuing to operate stably after the EPS has been disturbed by faults on the ETN;
2. the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltage on the network voltage Level at the Delivery Point during a symmetrical fault, as a function of time before, during and after the fault; and
3. the lower limit referred to U_{clear} is specified by Kahramaa using the parameters within the ranges set out in Table D.2-4: .

e) Kahramaa will specify the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

1. calculation of the pre-fault minimum short-circuit capacity at the Delivery Point,
2. pre-fault active and reactive power operating point of the Generating Unit at the Delivery Point and voltage at the Delivery Point, and
3. calculation of the post-fault minimum short-circuit capacity at the Delivery Point.

f) At the request of the Generating Unit, Kahramaa shall provide the pre-fault and post-fault conditions to be considered for Fault-Ride-Through capability as an input of the calculations at the Delivery Point regarding:

1. pre-fault minimum short-circuit capacity at Delivery Point expressed in MVA;
2. pre-fault operating point of the Generating Unit expressed in active power output and reactive power output and voltage at the Delivery Point, and
3. post-fault minimum short-circuit capacity at Delivery Point expressed in MVA. Alternatively, Kahramaa may provide generic values derived from typical cases.

g) Under-voltage protection (either Fault-Ride-Through capability or minimum voltage specified at the Delivery Point voltage) shall be set according to the widest possible technical capability of the Generating Unit, unless Kahramaa requires narrower settings in accordance with electrical protection schemes and settings. The settings shall be justified by the Generating Unit according to this principle; and

h) Fault-Ride-Through capabilities in case of asymmetrical faults can be specified by Kahramaa.

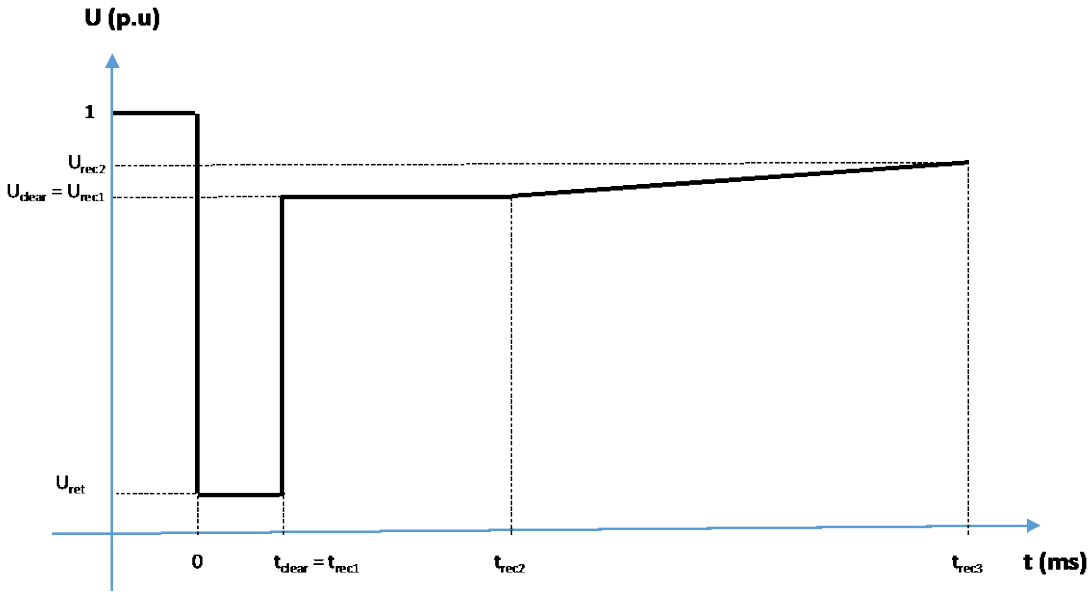

Figure D.2-7: Diagram for Fault-Ride-Through capability for Generating Unit

This figure represents the lower limit of a voltage-against-time profile of the voltage at the Delivery Point, expressed as the ratio of its actual value and its reference 1 pu value before, during and after a fault.

- U_{ret} is the retained voltage at the Delivery Point during a fault;
- t_{clear} is the instant when the fault has been cleared; and
- U_{clear} the corresponding voltage.

U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of voltage recovery after fault clearance.

Parameters referring to passing over the defect are provided in next tables.

Voltage parameters (pu.)		Time parameters (ms)	
U_{ret}	$0.05 \leq U \leq 0.3$	T_{clear}	$140 \leq t \leq 250$
U_{clear}	$0.7 \leq U \leq 0.9$	T_{rec1}	T_{clear}
U_{rec1}	U_{clear}	T_{rec2}	T_{rec1} - 700
U_{rec2}	$0.85 \leq U \leq 0.9$ and $\geq U_{clear}$	T_{rec3}	T_{rec2} - 1500

Table D.2-4: Parameters for Fault-Ride-Through capability for category S

D.2.4 REQUIREMENTS FOR GENERAL GRID OPERATION

D.2.4.1 GRID CONNECTION

a) Each connection between a Generating Facility and the ETN must be controlled by a circuit breaker capable of interrupting the maximum short-circuit current at the point of connection. On request, Kahramaa shall supply the Generating Facility Owner and other Grid Users with the values of short-circuit current and the rating of Kahramaa circuit breakers at existing and committed Delivery Points for future years.

b) All circuit breakers, switch disconnectors, disconnectors, grounding devices, power transformers, voltage transformers, reactors, current transformers, surge arresters, bushings, neutral equipment, capacitors, line traps, coupling devices, external heavy polluted condition insulation and insulation co-ordination at the Delivery Point shall comply with the ANSI/IEEE standards or codes agreed by Kahramaa except for certain devices where other standards are preferred and explicitly specified. All electrical equipment and materials shall comply with IEC Standards and prevailing Kahramaa Transmission Specifications.

c) Generating Facility and apparatuses shall be designed, manufactured and tested in premises certified in accordance with the quality assurance requirements of ISO 9000 (latest version) or equivalent as reasonably approved by Kahramaa. Equipment shall be tested according to IEC Standard or other prevailing Kahramaa Specifications.

d) The Generating Facility shall be designed such that the failure of any single auxiliary plant equipment within a unit will not result in the loss of production from that or any other unit.

D.2.4.2 ELECTRICAL PROTECTIONS

This chapter covers electrical protections for the Connection Equipment and for the Generating Unit.

The definition and application of function numbers and acronyms for devices and functions used for electrical protections in connection equipment and generating facilities shall be compliant with the latest IEEE C 37.2 standards.

D.2.4.2.1 RESPONSIBILITY AND COORDINATION

a) Kahramaa provides guideline and specifications for the protection schemes and settings for the Connection Equipment as per ET-P26/G1 (Guidelines for Protection Requirements) and ET-P20/S1_(Transmission Protection Standards for TA and ET Projects).

b) The protection and settings of all other equipment and circuits in the Generating Facility are under the responsibility of Generating Facility Owners.

c) It is the responsibility of the Generating Facility Owner to meet the requirement of Kahramaa and submit all the necessary documents to Kahramaa for acceptance before the milestone “Erection Completion Certificate” as per Connection Code.

d) The protection document required by Kahramaa at each stage of project shall be submitted to Kahramaa for review/approval/record.

e) Generating facility Owner shall provide required new protections or modifications of existing protection of the Kahramaa interfacing bays.

f) The maintenance of all protection equipment at the premises of the Generating Facility including those of Connection Equipment is at the responsibility of Generation Facility Owners in coordination with Kahramaa, as applicable.

g) Kahramaa and the Generation Facility Owner shall agree on any changes to the protection schemes relevant for the Generation Facility, and on the arrangements for the protection schemes of the Generation Facility.

h) The protection schemes and settings proposed for the Generating Facility Owner shall be coordinated with the protection schemes and settings specified by Kahramaa to protect the Connection Equipment or the ETN according to the connection scheme.

i) Electrical protection of the Generating Unit shall take precedence over operational controls, taking into account the system Security and the health and safety of staff and of the public, as well as mitigating any damage to the Generating Unit.

D.2.4.2.2 FUNCTIONS AND PERFORMANCES OF ELECTRICAL PROTECTIONS

a) The protections and schemes proposed by the Generating Facility Owner shall protect the possible but not limitative electrical events and apparatuses as listed below:

b) For electrical events:

1. external and internal short-circuit;
2. asymmetric load (negative phase sequence);
3. Stator and rotor overload;
4. over/under-excitation;
5. over/under-frequency at the Delivery Point;
6. over/under-voltage at the Delivery Point;
7. inrush current;
8. asynchronous operation (pole slip);
9. inadmissible shaft torsions (for example, sub-synchronous resonance);
10. over-fluxing (U/f);
11. inverse power;
12. rate of change of frequency;
13. cable and line thermal overload;
14. neutral voltage displacement; etc.

c) For Apparatuses:

1. Feeder;
2. Generating Unit line;
3. unit transformer;
4. switchgear malfunction;

5. DC supplies and control units;
6. breaker failure, etc.

D.2.4.3 REQUIREMENTS FOR METERING

D.2.4.3.1 SUPPLY OF EQUIPMENT OF THE METERING DEVICE (S)

a) Meters, measuring reducers (current and voltage transformers) accompanied by the metering panel, and accessories associated with this panel are provided by the Generating Facility Owner.

b) The specifications of the metering equipment provided shall be agreed by Kahramaa.

D.2.4.3.2 INSTALLATION OF METERING DEVICE (S)

a) The metering equipment is installed in the premises of Generating Facility and access to Kahramaa manpower shall be provided at all times for checking.

b) Prior to any order/purchase, a material submittal is requested for Kahramaa. After installation, an inspection request shall be submitted. Communication aspects shall be confirmed with Kahramaa.

c) The Generating Facility Owner shall send to Kahramaa the Verification and/or Test Certificates guaranteeing compliance with the rules and standards in force for the equipment it supplies, before being put into service.

d) The equipment provided by the Generating Facility Owner is installed at his own expense. The equipment is sealed for by Kahramaa in the presence of the Generating Facility Owner.

e) The requests of Kahramaa for meter maintenance, configuration and replacement are under the responsibility and cost of the Generating Facility Owner.

D.2.4.4 REQUIREMENTS FOR NEUTRAL POINT

a) In order to preserve the safety of people and asset, any Generating Facility, at its interface with the ETN, includes a device at ETN voltage side for fixing the potential of the neutral with respect to the earth. The zero-sequence impedance to be complied with at the Delivery Point or, the value of the zero-sequence current at this point is prescribed by Kahramaa at the end of the Grid Impact Study.

b) The Generating Facility shall be equipped, at its interface with the ETN, with a protection system which eliminates any insulation fault within the installation likely to create an overcurrent or degradation of the quality of electricity on the ETN.

c) This protection system shall also be able to eliminate any short-circuit current input from the terminal of the Generating Units when an insulation fault occurs on the connection link and on the busbar of the ETN as well as any short-circuit current input from the installation due to insulation faults located on other connected links.

d) The functional characteristics of this protection system and its performance comply with the requirements defined by Kahramaa. These requirements concern, in particular, the performance of the protection system, its coordinated setting with the

protection system of the ETN and the archiving of information concerning the operation of the protections.

e) At nominal voltages of 33 kV and above, the higher voltage windings of a transformer of a Generating Unit must be star connected with the star point suitable for connection to earth.

f) The Earth Fault Factor shall not be below than prevailing international standard/practice and agreed by Kahramaa.

g) The standby earth fault protection setting at the transformer neutrals shall be set up for back up clearance of an earth fault close to the Delivery Point.

D.2.4.5 REQUIREMENTS FOR RECORDINGS

a) Generating Facilities shall be equipped with fault recording and monitoring of dynamic system behaviour. This Generating Unit shall record at least the following parameters at Delivery Point:

1. Voltage;
2. Current;
3. Power Factor;
4. Active power;
5. Reactive power;
6. Frequency;
7. Harmonics; and
8. Status of connection equipment.

b) On Kahramaa request, specific signals elaborated by the Generating Units shall be collected by the fault recording system.

c) The settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the Generating Unit owner and Kahramaa.

d) The dynamic system behaviour monitoring shall include an oscillation trigger specified by Kahramaa, with the purpose of detecting poorly damped power oscillations.

e) The facilities for recording and monitoring shall include arrangements between the Generating Unit owner and Kahramaa to access the information. The communication protocols for recorded data shall be agreed between the Generating Unit owner and Kahramaa. The recordings shall be preserved by Generating Facility and produced when asked by Kahramaa.

f) The fault recording and monitoring system shall be synchronized using a time protocol agreed by Kahramaa.

D.2.4.6 REQUIREMENTS FOR COMMUNICATION AND INFORMATION EXCHANGE

a) The guideline and requirements for communication systems between the NCC and operation centre of the Generating Facility are defined by Kahramaa.

b) The requirements for signal exchanges between the NCC and the Generating Facility Operation Centre are defined by Kahramaa.

c) In operation, Generating Facilities shall be capable of exchanging information with Kahramaa in real time or periodically with time stamping. Information shall at least include:

1. Net and gross active and reactive power;
2. Status of synchronizing device;
3. Generator voltage (kV);
4. Generator speed (Hz);
5. Tap changer position on Generator transformers;
6. Gas Supply pressure;
7. Open / Close status of generator circuit breaker;
8. Local / remote switch status for generator regulation;
9. Local / remote switch status for transformer tap changer;
10. Open / Close status of main gas valve;
11. Raise / Lower control impulses for generator active power;
12. Raise / Lower control impulses for generator reactive power;
13. Raise / Lower control of tap changer for generator transformer;
14. Generator active and reactive power Set Point;
15. voltage Set Point of Automatic Voltage Regulator or generator transformer;
16. Gas turbine: 24 alarm points;
17. Generator: 48 alarm points;
18. Transformer: 48 alarm points;
19. Temperature in RTU room;
20. Low voltage AC Switchgear 24 alarm points;
21. Telemetry equipment (including power supply) 24 alarm points;
22. Status for participating to Frequency Control; etc.

d) Kahramaa may require exchanging other information related to grid/plant interface and to Generating Facility status (protection status, auxiliaries of connection equipment, etc.), or to security (fire alarm, detection of person, etc.).

D.2.5 REQUIREMENTS FOR SIMULATIONS

D.2.5.1 SIMULATIONS PERFORMANCE

a) Simulations are used by facility owners to check the compliance of their facility against some requirements of the Grid Code as per D.2.9. The tools used for simulation and the types of simulation has to be agreed between Kahramaa and facility owners and shall at least include transient stability, small signal stability, voltage control, load transfer stability and Fault-Ride-Through.

b) Simulation models and data are communicated to Kahramaa:

1. During the connection process (see the Connection Code);
2. After any change of Generating Facility apparatuses concerned by simulation; or
3. In case of any change of simulation tools.

c) The Generating Facility Owner shall ensure that the models provided have been verified against the results of compliance tests referred in D.2.8, and shall notify the results of the verification to Kahramaa.

D.2.5.2 REQUESTED DATA

a) At the request of Kahramaa, the Generating Facility Owner shall provide simulation models which properly reflect the behaviour of the Generating Unit in both Steady State and dynamic simulations (50 Hz component) and in electromagnetic transient simulations. This request shall include:

1. the format in which models are to be provided;
2. the provision of documentation on a model's structure and block diagrams; and
3. an estimate of the minimum and maximum short-circuit capacity at the Delivery Point, expressed in MVA, as an equivalent of the network.

b) The models provided by the Generating Unit owner shall contain the following sub-models, depending on the existence of the individual components:

1. alternator and prime mover;
2. speed and power control;
3. voltage control, including, if applicable, Power System Stabilizer function and Excitation Control System;
4. Generating Unit protection models;
5. Power Park Module models;
6. converter models; and
7. reactive capacity.

c) The Generating Unit owner shall provide recordings of the Generating Unit's performance to Kahramaa if requested. Kahramaa may make such a request, in order to compare the response of the models with those recordings.

D.2.6 REQUIREMENTS FOR POWER QUALITY

Considered disturbances on voltage and current are flicker, unbalance and harmonics.

a) Disturbances emitted by the Generating Facility, measured at the Delivery Point, must not exceed the permissible limit values.

b) Kahramaa shall provide reference value of minimal short-circuit current for calculation of flicker level.

c) The Generating Facility Owner shall limit the value indicated in Table D.2-5: to the values τ_g indicated in the formula below:

$$\tau_g = \sqrt{\sum_{n=2}^{40} {I_{hn}}^2} \cdot \frac{\sqrt{3}U_c}{S} \qquad \text{where} \qquad I_{hn} = k_n \cdot \frac{S}{\sqrt{3}U_c}$$

- τ_g is the Total Harmonic Distortion;
- U_c is the value of the Delivery Point voltage;
- S is equal to the apparent power corresponding to the power as long as S remains less than 5 % of S_{cc}, otherwise S is taken equal to 5 % of S_{cc} (power take being generally considered to be equal to the highest);
- S_{cc} is the minimum value of the short-circuit power supplied by the ETN at the Delivery Point;
- k_n is a limiting coefficient defined according to the rank n of the harmonic (Table D.2-5: gives the value of k_n according to the rank n of the harmonic).

d) These values are multiplied by 0.6 for installations connected at 400 kV.

e) The measurement is carried out in accordance with IEC 61000-4-30 with a measurement time interval of 10 min.

f) The Generating Facility Owner shall limit to the values indicated in the formula below for imbalance and flicker.

<table>
<tr><th>Voltage Level</th><th>Flicker</th><th>Imbalance IEC 61000-3-13</th><th>Total Harmonic Distortion τ_g</th><th>Harmonics</th></tr>
<tr><td>11kV -33 kV
Minimum Scc = 40 MVA</td><td>Pst=0.35
IEC 61000-4-15
Plt = 0.65
IEC 61000-3-3</td><td>Lim = 1%</td><td>3%</td><td><table><tr><td>Odd</td><td>Kn%</td><td>Even</td><td>Kn%</td></tr><tr><td>3</td><td>4</td><td>2</td><td>2</td></tr><tr><td>5-7</td><td>5</td><td>4</td><td>1</td></tr><tr><td>9</td><td>2</td><td>>4</td><td>0.5</td></tr><tr><td>11-13</td><td>3</td><td></td><td></td></tr><tr><td>>13</td><td>2</td><td></td><td></td></tr></table></td></tr>
<tr><td>66 kV-132 kV- 220 kV
Minimum Scc = 400 MVA</td><td>Pst= 1 according to IEC 61000-4-15
Plt = 0.65
IEC 61000-3-3</td><td>Lim = 1%</td><td>3%</td><td><table><tr><td>Odd</td><td>Kn%</td><td>Even</td><td>Kn%</td></tr><tr><td>3</td><td>6.5</td><td>2</td><td>3</td></tr><tr><td>5-7</td><td>8</td><td>4</td><td>1.5</td></tr><tr><td>9</td><td>3</td><td>>4</td><td>1</td></tr><tr><td>11-13</td><td>5</td><td></td><td></td></tr><tr><td>>13</td><td>3</td><td></td><td></td></tr></table></td></tr>
<tr><td>400 kV
Minimum Scc = 4000 MVA</td><td>Pst= 0.6 according to IEC 61000-4-15
Plt = 0.65
IEC 61000-3-3</td><td>Lim = 0.6%</td><td>3%</td><td><table><tr><td>Odd</td><td>Kn%</td><td>Even</td><td>Kn%</td></tr><tr><td>3</td><td>3.9</td><td>2</td><td>1.8</td></tr><tr><td>5-7</td><td>4.8</td><td>4</td><td>0.9</td></tr><tr><td>9</td><td>1.8</td><td>>4</td><td>0.6</td></tr><tr><td>11-13</td><td>3</td><td></td><td></td></tr><tr><td>>13</td><td>1.8</td><td></td><td></td></tr></table></td></tr>
</table>

Table D.2-5: Criteria for power quality

Note for Flicker: The requirements are based on a minimum reference short-circuit power at the Delivery Point. If the short-circuit power actually made available by Kahramaa is lower, the limits of voltage disturbances produced by the generator are multiplied by the ratio between the reference short-circuit power and the short-circuit power actually supplied.

D.2.7 REQUIREMENTS FOR POWER, ISLAND OPERATION AND QUICK RE-SYNCHRONIZATION

D.2.7.1 REQUIREMENTS FOR POWER RESTORATION

a) Black-Start Capability is not mandatory without prejudice to Kahramaa to introduce obligatory rules in order to ensure EPS Security.

b) A Generating Unit with Black-Start Capability shall be capable of starting from shutdown without any external electrical energy supply within a time frame specified by Kahramaa.

c) A Generating Unit with Black-Start Capability shall be able to synchronize within the frequency limits laid down in requirement D.2.1.3 and, where applicable, voltage limits specified in D.2.2.1.

d) A Generating Unit with Black-Start Capability shall be capable of automatically damping voltage dips caused by connection of Demand.

e) A Generating Unit with Black-Start Capability shall be capable of regulating load connections in block load.

f) A Generating Unit with Black-Start Capability shall be capable of operating in LFSM-O and LFSM-U, as specified in points D.2.1.4.2 and D.2.1.4.3.

g) A Generating Unit with Black-Start Capability shall control frequency in case of over-frequency and under-frequency within the whole active power output range between Minimum Regulating Level and Maximum capacity as well as at House-Load level.

h) A Generating Unit with Black-Start Capability shall be capable of parallel operation of a few Generating Units within one Island.

D.2.7.2 REQUIREMENTS FOR ISLAND OPERATION

a) Generating Units shall be capable of taking part in Island Operation if required by Kahramaa.

b) The frequency limits for Island Operation shall be those established in accordance with D.2.1.1.

c) The voltage limits for Island Operation shall be those established in accordance with Table D.2-2 where applicable.

d) Generating Units shall be able to operate in FSM during Island Operation, as specified D.2.1.4.1.

e) In the event of a power surplus, Generating Units shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-Capability Diagram. In that regard, the Generating Unit shall be capable of reducing active power output as much as inherently technically feasible, but to at least 55 % of its maximum capacity.

f) The method for detecting a change from interconnected power system operation to Island Operation shall be agreed between the Generating Facility Owner and Kahramaa. The agreed method of detection must not rely solely on the system operator's switchgear position signals.

g) Generating Units shall be able to operate in LFSM-O and LFSM-U during Island Operation, as specified in D.2.1.4.2.

D.2.7.3 REQUIREMENTS FOR QUICK RE-SYNCHRONIZATION:

a) In case of disconnection of the Generating Unit from the ETN, the Generating Unit shall be capable of quick re-synchronisation in line with the protection strategy agreed between the system operator in coordination with Generating Unit.

b) After its disconnection from any external power supply, a Generating Unit with a minimum re-synchronisation time greater than 15 min must be designed to trip to House-Load from any operating point in its P-Q-Capability Diagram. In this case, the identification of House-Load Operation must not be based solely on the switchgear position signals.

c) A Generating Unit shall be capable of continuing operation following tripping to House-Load, irrespective of any auxiliary connection to the external network. The minimum operation time shall be specified by Kahramaa, taking into consideration the characteristics of the technology.

D.2.8 REQUIREMENTS FOR TESTING FOR CATEGORY S GENERATING UNITS

D.2.8.1 FRAMEWORKS FOR TESTING PROCEDURES

a) All the tests shall be coordinated with Kahramaa to ensure the system stability.

b) The recordings will be achieved without other filtering than anti-aliasing frequency filtering. Kahramaa may authorize a more convenient filter in case of difficulties. The recordings will be sent to Kahramaa in csv format to be analysed.

c) A document will be sent to Kahramaa, including operating points, curves representing all the recorded signals with accurate zoom, analyses, calculations, comparisons to the acceptance criteria, and comments.

d) The detailed trial tests procedures must be sent to Kahramaa at least 1 month before the tests.

e) During testing, if there is any fault or a trip, the Generating Facility Owner shall provide the incident report and obtain Kahramaa approval before re-start of the test/activity.

NB: the frequency test shall be performed using the full frequency signal and not using a signal added to the frequency.

D.2.8.2 TEST: INFORMATION EXCHANGE

The information exchanges will be tested and conform to the data required by Kahramaa.

D.2.8.3 TEST: SYNCHRONIZATION

This test aims to verify the conditions of synchronization, and the rates of active power that will be possible in operation.

a) Input values: Ramp rates (up, down) (MW/min)

b) Measurements:

1. Active power at the Delivery Point:
   - For category S, active power at the generator terminals (if the Generating Facility is composed by several units, each elementary power unit must be measured);
   - For category P, active power at invertor terminals;
2. Active power Set Point;
3. Voltage (at the Delivery Point); and
4. Minimum sampling frequency of the recording: 50 Hz

c) Tests:

1. Test 1: connection of the main transformer;
2. Test 2: synchronization of the Generating Facility;
3. Test 3: ramp up from P_{min} to P_{max};
4. Test 4: Generating Facility at P_{max} during 15 minutes;
5. Test 5: ramp down unit from P_{max} to $P_{min;}$
6. Test 6: Generating Facility at P_{min} during 15 min; and
7. Any other tests as mentioned in the PWPA.

d) Acceptance:

1. No trip;
2. Test 1, 2: maximum voltage deviation: 5 % of the voltage, measured at the Delivery Point; and
3. Test 3, 5: the ramp fits the declared ramps for power up and down.

D.2.8.4 TEST: QUALITY OF ELECTRICITY

This test aims to verify the disturbances due to the Generating Facility, according to the tolerances of the Grid Code:

a) Flicker/unbalance/harmonics;

b) Measurements are performed for 1 week at least; and

c) Compliance: Conformity to the requirements for power quality of the Grid Code.

D.2.8.5 TEST: PRIMARY FREQUENCY CONTROL - FSM

This test aims to evaluate the dynamic and volume of primary reserves, in Frequency Sensitive Mode.

a) Input values:

1. P_{max} (MW) (full load);
2. P_{min} (MW) (minimum load);
3. P_{ref} (MW) (active power used in the speed Governor to define the Droop in %, this value is closed to the registered capability of the Generating Facility);

4. f_{ref} (Hz) (Frequency used in the Governor to define the speed Droop in %);
5. K (MW/Hz) (power frequency characteristic); and
6. Maximum primary reserve of the Generating Facility (MW).

The time responses (primary response, secondary response, delay, rise, time and settling time) are defined as follows:

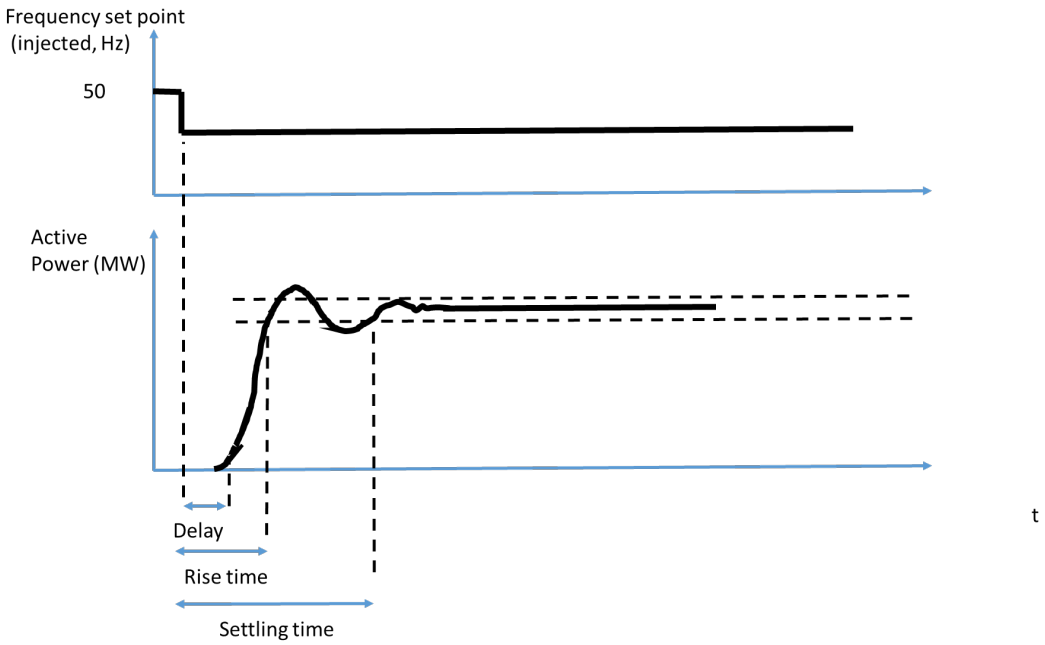

Figure D.2-8: Primary and secondary responses

Primary response: The automatic increase in active power output or, as the case may be, the decrease in active power demand in response to a system frequency fall. This increase in active power output or, as the case may be, the decrease in active power demand will be released increasingly with time over the period 0 to 10 s from the time of the start of the frequency fall and sustainable for at least a further 20 s.

Secondary response: The automatic increase in active power output or, as the case may be, the decrease in active power demand in response to a system frequency fall. This increase in active power output or, as the case may be, the decrease in active power demand will be fully available by t_2 seconds (e.g. 30 s) from the time of the start of the frequency fall and be sustainable for at least a further 30 min.

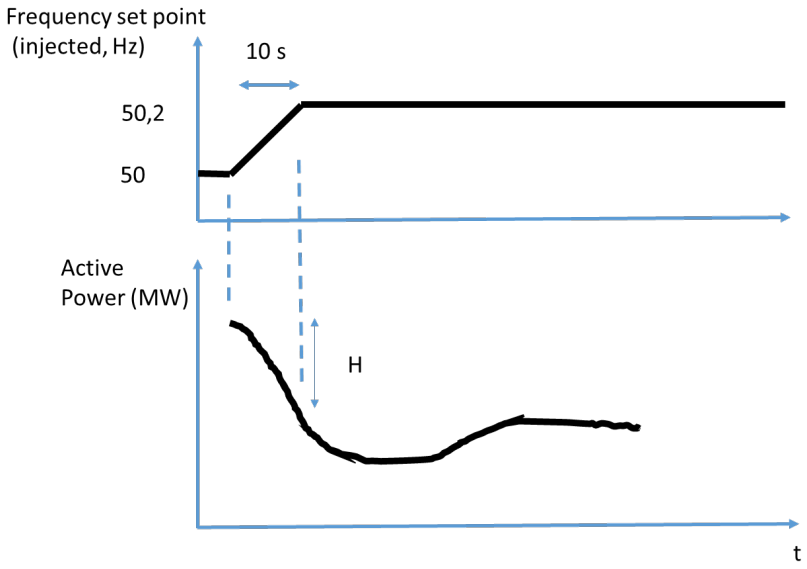

Figure D.2-9: High frequency response

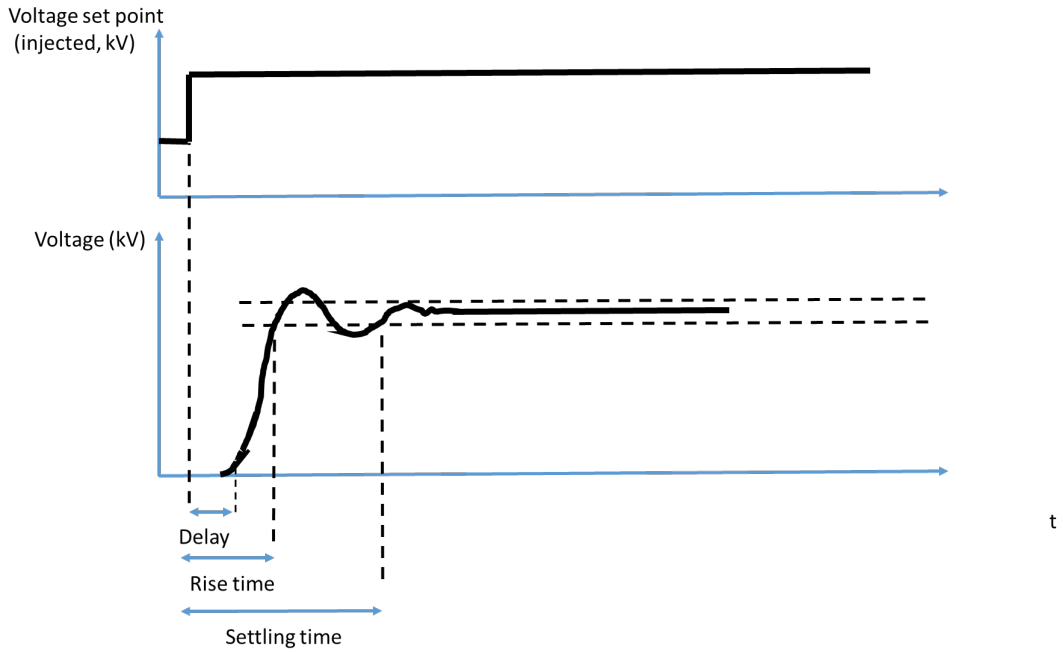

Figure D.2-10: Response times and delays

b) Measurements:

1. Active Power at the Delivery Point;
2. Active Power at the generator terminals (if the Generating Facility is composed by several units, each elementary power unit must be measured);
3. Set Point of the Governor including frequency external injection;
4. Position of the main actuator; and

5. Minimum sampling frequency of the recording: 50 Hz

c) Preliminary Test 1: the Generating Facility must be at full load (Pmax) to measure the effective maximum load during at least 15 min. Pmax (defined as an average value) measured is used to calculate the initial Set Point for the next tests.

d) Test 2: Generating Facility initial conditions: 75 % Pmax. Injection of a – 15 mHz step.

Compliance: The Active Power should increase at least of 0.0025 Pmax within 30 s minimum.

e) Test 3: at 95 % Pmax. Injection of the following profile:

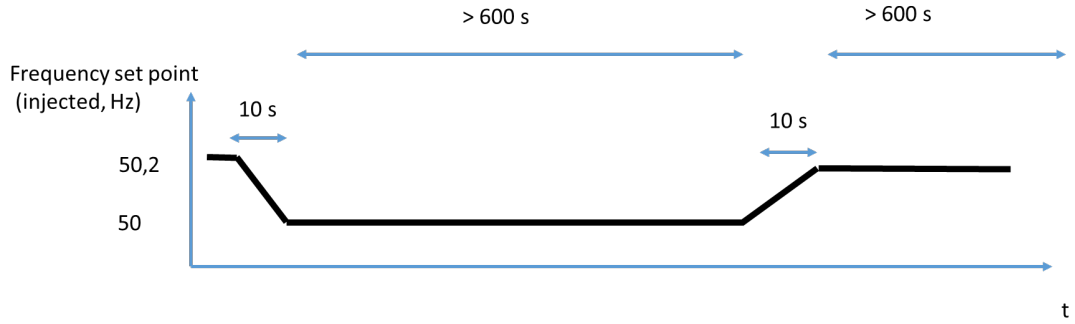

Figure D.2-11: Injected frequency profiles for 95 % Pmax

Compliance:

- Primary Response, Secondary Response > 1 % P_{ref} for a 4 to 5 % Droop (see Kahramaa for other values),

- For other Generating Facilities than CCGT: in addition, the active power should increase more than 90% of min (primary reserve, K*Δf) 20 s after the end of the ramp, if t2=30 s (see Kahramaa for other values).

f) Test 4: At 80 % P_{max}. Injection of the following profile:

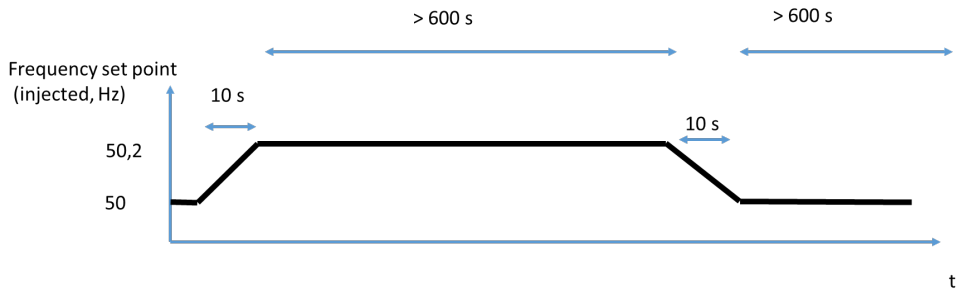

Figure D.2-12: Raised injected frequency profiles for 80% Pmax

Compliance: the active power should decrease less than 90 % of min (primary reserve, K*Δf) 20 s after the end of the ramp if t2=30 s (see Kahramaa for other values),

g) Test 5: at 80 % P_{max}. Injection of the following profile

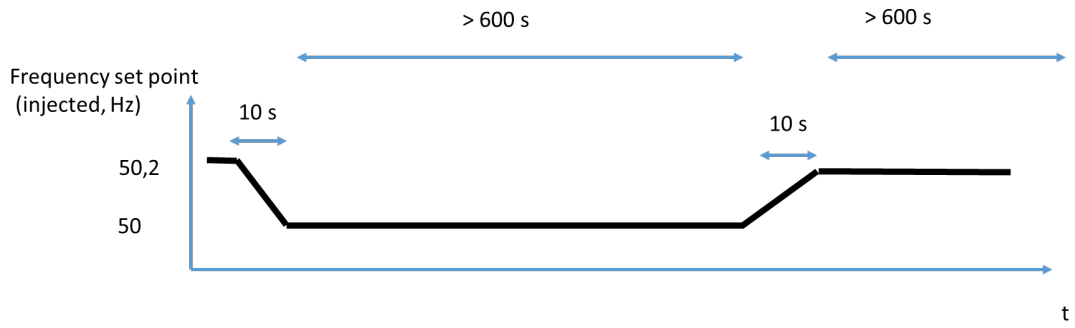

Figure D.2-13: Decreased injected frequency profiles for 80 % Pmax

Compliance: primary, secondary response > 3 % P_{ref} for a 4 to 5 % Droop (see Kahramaa for other values),

h) For other Generating Facilities than CCGT: Test 6: At the power corresponding to Pmax-K*500 mHz, injection of a -500 mHz step during 600 s.

The active power increase should reach:

- 50 % of min (maximum primary reserve, K*Δf) at least 15 s after the end of the step;

- 95 % of min (maximum primary reserve, K*Δf) at least 30 s after the end of the step.

i) Compliance for all tests:

1. Stability;
2. Infinite time response prove the accurate value of the speed Droop;
3. Time increasing response over the period 0 to 10 s;
4. Delay < 2 s (corresponding to a minimum answer of 0.0025 Pmax); and
5. Frequency disturbances should not cause tripping of the unit.

D.2.8.6 TEST: SECONDARY FREQUENCY CONTROL

This test aims to evaluate the dynamics and volume of secondary reserves.

a) Input values:

1. Pmax (full load) (MW);
2. Pmin (minimum load) (MW); and
3. ramp rate (MW/min).

b) Measurements: For these tests the Frequency Sensitive Mode is inactive or insensitive.

1. active power at the Delivery Point;
2. active power at the generator terminals (if the Generating Facility is composed by several units, each elementary power unit must be measured);
3. Set Point of the Governor including secondary reserve;
4. Position of the main actuator; and

5. Minimum sampling frequency of the recording: 50 Hz.

c) Test 1: Generating Unit, at maximum power according to external conditions on the day of test, minus the secondary reserve band : artificial injection of a ramp of MW, up, according to the declared ramp rate at the remote control panel and hold at for 30 min.

d) Test 2: Generating Unit, at maximum power according to external conditions on the day of test, minus the secondary reserve band : artificial injection of a ramp of MW, down, according to the declared ramp rate at the remote control panel and hold at for 30 min.

e) Test 3: Unit of production at Pmin unit: Artificial injection of a ramp up, according to the declared ramp rate at the remote-control panel and hold at for 30 min.

f) Test 4: Unit of production at Pmin unit to which the secondary reserve band is added: Artificial injection of a ramp down, according to the declared ramp rate at the remote-control panel and hold at for 30 min.

g) Compliance: The active power should follow the contractual ramp during the whole ramp, at minimum as a first order filter with a time constant 20 s during 95 % of the time.

D.2.8.7 TEST: FREQUENCY CONTROL

This test aims to evaluate the behavior of the frequency regulations, in real conditions; the analysis is performed by Kahramaa.

a) Input values:

1. Primary reserve (MW);
2. Secondary reserve (MW); and
3. Frequency primary reserve insensitivity (mHz).

b) Measurements: For these tests the Frequency Sensitive Mode is inactive or insensitive.

1. active power at the Delivery Point;
2. active power at the generator terminals (if the Generating Facility is composed by several units, each elementary power unit must be measured);
3. Set Point of the Governor including secondary reserve; and
4. position of the main actuator.

c) Test 1: Switching the unit from FSM off to FSM on (and vice versa).

d) Test 2: Switch from the secondary reserve off to on (and vice versa).

e) Test 3: Loss (or invalidity) of secondary reserve signal and return of signal.

f) Test 4: Reliability test for 8 hours; Generating Facility in normal condition (FSM, LFSM, secondary reserve active), connected to the grid. Observation by Kahramaa.

g) Compliance: No abnormal power variation during the tests.

D.2.8.8 TEST: ACTIVE POWER CONTROL

This test aims to evaluate the behavior of the frequency regulations, in real conditions. The analysis is performed by Kahramaa.

a) Input values:
   1. Primary reserve (MW);
   2. Secondary reserve (MW); and
   3. Frequency primary reserve insensitivity (mHz).

b) Measurements: For these tests the Frequency Sensitive Mode is inactive or insensitive.
   1. active power at the Delivery Point;
   2. active power at the generator terminals (if the Generating Facility is composed by several units, each elementary power unit must be measured);
   3. Set Point of the Governor including secondary reserve; and
   4. Position of the main actuator.

c) Test 1: Reliability test for 8 hours; Generating Facility in normal condition (FSM, LFSM, secondary reserve active), connected to the grid. Observation by Kahramaa.

d) Compliance: No abnormal power variation during the tests. The power generated should not deviate more than 1 % of the power set-point requested by Kahramaa.

D.2.8.9 TEST: PRIMARY VOLTAGE CONTROL AND REACTIVE POWER CAPACITY

This test aims to evaluate the dynamic and stability of the voltage control, and the reactive power capability of the Generating Facility. The U/Q and P/Q Capability Diagrams are input data, elaborated by the Generating Facility Owner, before the tests.

a) Input values/documents: U/Q or P/Q Capability Diagrams, considering the limiters implemented in the AVR, and conform to the Capability Diagrams of the Grid Code.

b) Measurements:
   1. RMS voltage at the Delivery Point;
   2. RMS Stator voltage;
   3. reactive power at the Delivery Point;
   4. active power at the Delivery Point;
   5. active power at the generator terminals;
   6. reactive power at the generator terminals;
   7. Set Point of the AVR;
   8. Limitation signalization coming from the AVR; and
   9. Minimum sampling frequency of the recording: 50 Hz.

c) Tests 1 - dynamic of the primary voltage regulation:

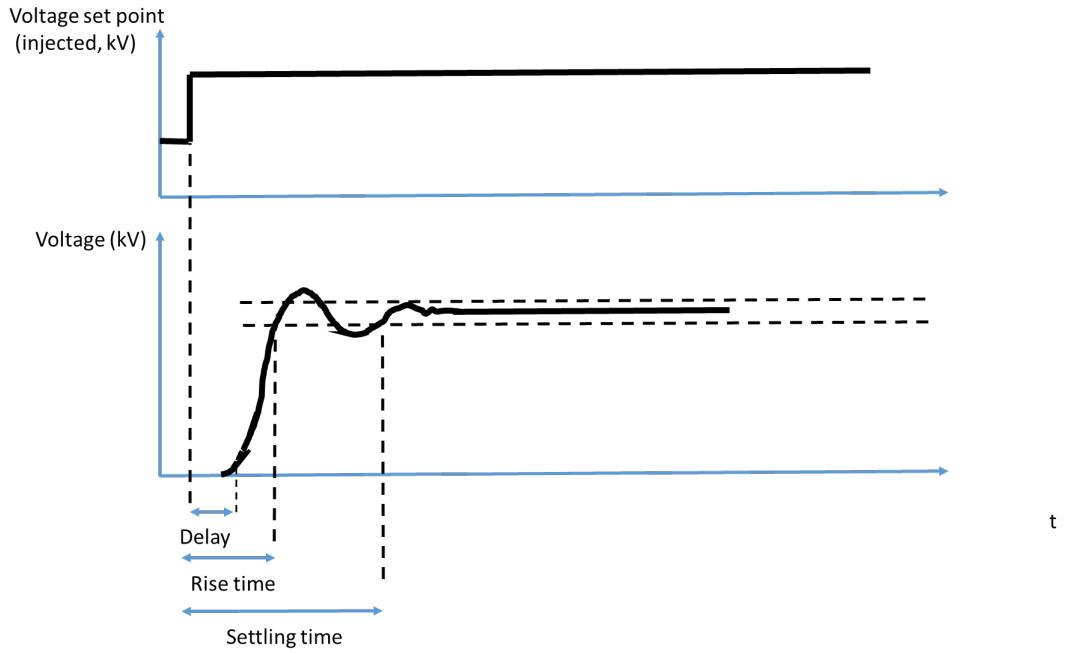

Figure D.2-14: Voltage control profile

d) Test 1.1 – Step up: at Pmax and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range) : +1 % step and 5 min later + 2 % step on the Set Point of the Automatic Voltage Regulator during 5 min.

e) Compliance:

1. The output shall fulfil the following requirements:
2. Stability: less than 2 oscillations;
3. Maximum settling time at +/- 5 % of the final value of the generator terminals voltage: 10 s;
4. Maximum settling time at +/- 2 % of the active power at the generator terminals voltage: 10 s; and
5. Static error: less than 0.2 %

f) Test 1.2 – Step down: at Pmax and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range): +1 % step and 5 min later -2 % step on the Set Point of the Automatic Voltage Regulator during 5 min.

g) Compliance :

1. Stability: less than 2 oscillations;
2. Maximum settling time at +/- 5 % of the final value of the generator terminals voltage: 10 s;
3. Maximum settling time at +/- 2 % of the active power at the generator terminals voltage: 10 s; and

4. Static error: less than 0.2 %.

h) Test 1.3 – Step up without PSS: at Pmax and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range) without PSS: +1% step on the Set Point of the Automatic Voltage Regulator during 5 min.

i) Compliance: Stability less than 4 oscillations

1. Test 1.4 – Step up with PSS gain multiplied by 2: at Pmax and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range) with PSS gain multiplied by 2: +1 % step on the Set Point of the Automatic Voltage Regulator during 5 min.
2. Compliance: Stability less than 4 oscillations.

j) Tests 2 - limitation at Maximum active power:

1. Test 2.1 - Generator at Pmax: hold at $Q = Q_{max}$ for 30 min. $Q = Q_{max}$ will reach the maximum lagging limitation within the normal range of voltage at the Delivery Point.
2. Compliance: The reactive power (considering the voltage and the active power) will be conform at least to the values according to the U/Q or P/Q Diagrams. Correct operation of the limiter for either step injection or generator transformer tap change.
3. Test 2.2 - Generator at Pmax: hold at $Q = Q_{min}$ for 30 min. $Q = Q_{min}$ will reach the maximum leading limitation within the normal range of voltage at the Delivery Point.
4. Compliance: The reactive power (considering the voltage and the active power) will be conform at least to the values according to the U/Q or P/Q diagrams. Correct operation of the limiter for either step injection or generator transformer tap change.

k) Tests 3 - limitations at minimum load P_{min} of the Generating Facility:

1. Test 3.1 – same test as test 2.1;
2. Test 3.2 – same test as test 2.2.

D.2.8.10 TEST: LFSM – O

This test aims to verify the Limited Frequency Sensitive Mode for Over-Frequency characteristics.

a) Input values/documents:

1. LFSM-O Droop value and frequency activation "Δf1" (%); and
2. LFSM-O rate (MW/min).

b) Measurements:

1. Set Point of the Governor (including injected signal);
2. active power at the generator terminals; and
3. Minimum sampling frequency of the recording: 10 Hz

c) Test: External injection for 5 min of a frequency step Δf at the input of the Governor so as to obtain a decrease of active power P of 30 % Pmax unit, then linear return at 50 Hz in 5 min.

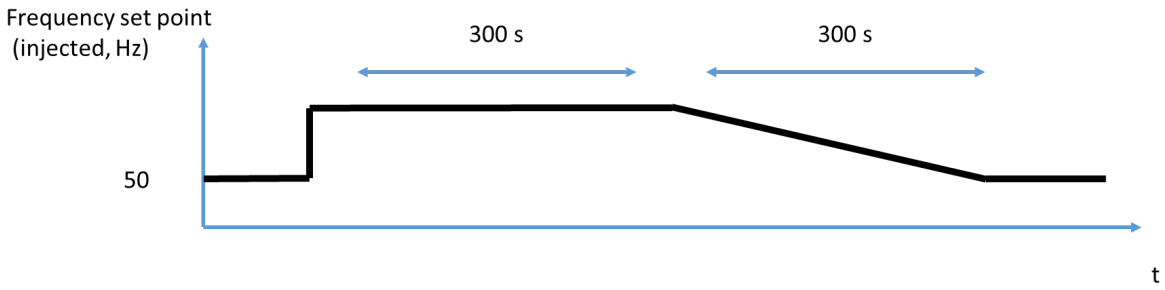

Figure D.2-15: Frequency injected profile LFSM-O

d) Compliance:

1. Droop corresponding to s2 (tolerance of +/-1 %);
2. Delay < 2 s; and
3. LFSM rate in MW/min respected (tolerance of 10 % applied to the rate).

D.2.8.11 TEST: LFSM-U

This test aims to verify the Limited Frequency Sensitive Mode for Under-Frequency characteristics.

a) Input Values/documents:

1. LFSM-U Droop value and frequency activation "Δf1" (%);
2. LFSM-U rate (MW/min); and
3. Minimum sampling frequency of the recording: 10 Hz.

b) Measurements:

1. Set Point of the Governor (including injected signal); and
2. Active Power at the generator terminals.

c) Test: Artificial injection for 5 min of a frequency step Δf at the input of the Governor so as to obtain an increase of 30 % P_{max} unit, then linear return at 50 Hz in 5 min.

NB: the natural frequency of the grid is disconnected for this test.

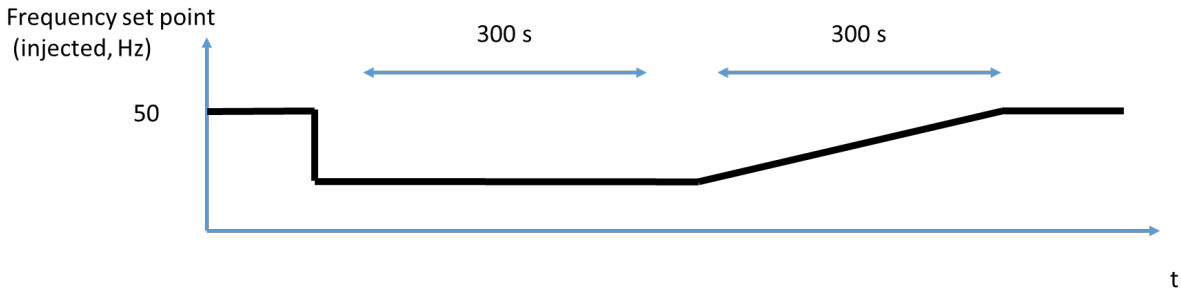

Figure D.2-16: Frequency injected profile LFSM-U

d) Compliance:

1. Delay < 2 s;
2. Droop corresponding to 2 s (tolerance of +/- 1 %); and
3. LFSM rate in MW/min respected (tolerance of 10 % applied to the rate).

D.2.8.12 TEST: TRIP TO HOUSE-LOAD AND ISLAND OPERATION

This test aims to verify the disconnection from the grid while keeping powering the auxiliaries, to check the stability of the Generating Unit in Island Operation and to verify the resynchronization and the possibility to recover normal active power.

Test: Island Operation of the unit from Pmax with reduced participation in Frequency Control (to be agreed with Kahramaa), then resynchronization after 30 min or more and rise to the Minimum Stable Operating Level.

D.2.8.13 TEST: BLACK-START

Tests are concerning generating units and generating facilities black-start capable.

a) Black-Start unit tests:

1. the relevant Generating Unit shall be synchronized and loaded;
2. all the auxiliary gas turbines and/or auxiliary diesel engines in the Black-Start facility in which that Generating Unit is situated, shall be shut-down;
3. the Generating Unit shall be de-loaded and De-Synchronized and all alternating current electrical supplies to its auxiliaries shall be disconnected;
4. the auxiliary gas turbine(s) or auxiliary diesel engine(s) to the relevant Generating Unit shall be started, and shall Re-Energize the unit board of the relevant Generating Unit;
5. the auxiliaries of the relevant Generating Unit shall be fed by the auxiliary power source, via the unit board, to enable the relevant Generating Unit to return to synchronous speed; and
6. the relevant Generating Unit shall be synchronized to the EPS but not loaded, unless the appropriate Instruction has been given by Kahramaa.

b) Black-Start Facility test:

1. All Generating Units at the Black-Start facility, other than the Generating Unit on which the Black-Start test is to be carried out, and all the auxiliary gas turbines and/or auxiliary diesel engines at the Black-Start facility, shall be shut-down;
2. The relevant Generating Unit shall be synchronized and loaded;
3. The relevant Generating Unit shall be de-loaded and De-Synchronized;
4. All external alternating current electrical supplies to the unit board of the relevant Generating Unit, and to the facility board of the relevant Black-Start facility, shall be disconnected; and

5. An auxiliary gas turbine or auxiliary diesel engine at the Black-Start facility shall be started, and shall Re-Energize either directly, or via the facility board, the unit board of the relevant Generating Unit.

Compliance: There is compliance if the relevant Generating Unit comply to be synchronized to the EPS within two hours of the auxiliary gas turbine(s) or auxiliary diesel engine(s) being required to start.

D.2.9 REQUIREMENTS FOR COMPLIANCE

Compliance is a process taking place during the whole connection project with the purpose of demonstrating the compliance to the required requirements.

The objective of the compliance process is to ensure that there is a clear and consistent demonstration of compliance by Generating Facility to the requirements of Grid Code and of the PWPA.

Compliance activity is supported by statements of compliance elaborated the Generating Facility Owner including checks, simulations and testing justifying the compliance of the Generating Facility to the requirements.

Considering the project milestones as defined in the Connection Code, the compliance activities are described in the following chart:

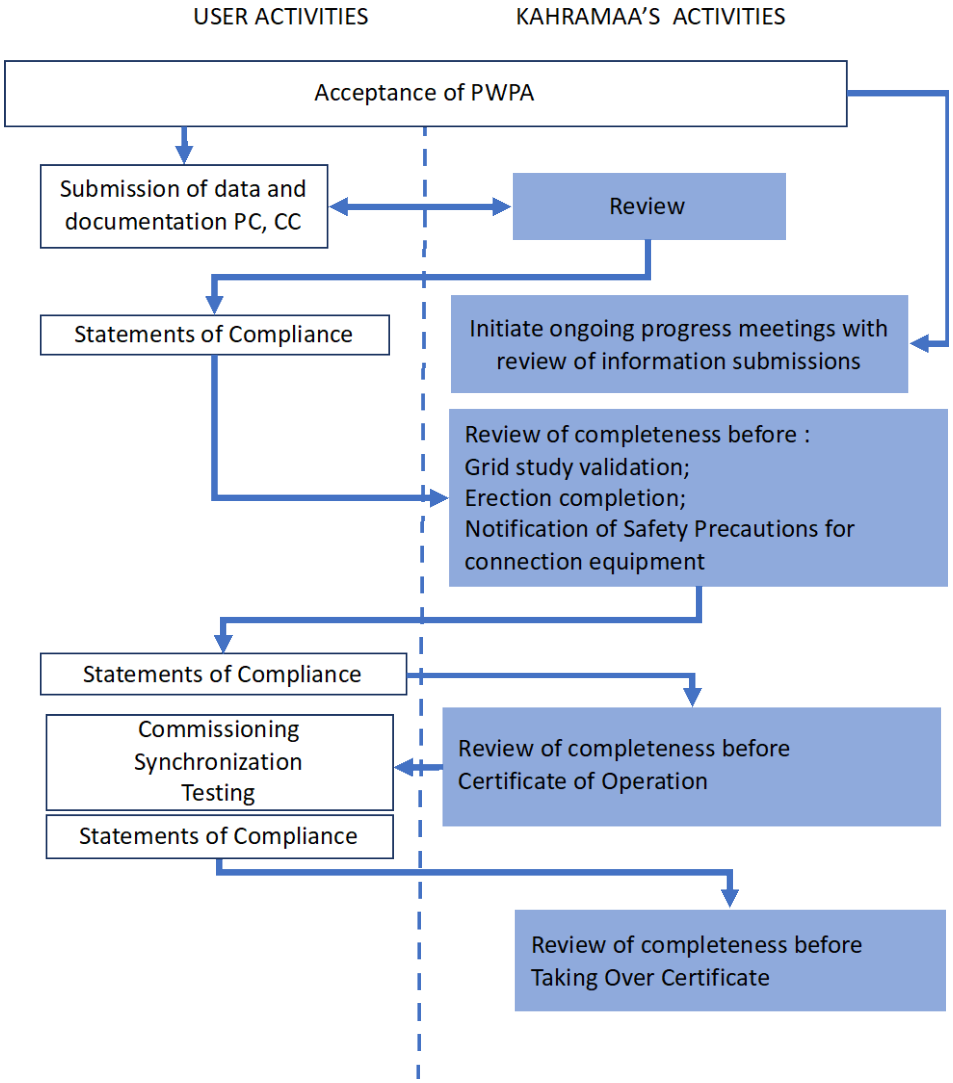

Figure D.2-17: Compliance process for Generation Facility

D.2.9.1 COMPLIANCE STATEMENTS

Compliance statements include all necessary documented checks and testing be carried out by the Generating Facility Owner according to four modes:

a) Declarative data (D): data corresponding to the technical characteristics of the installation (alphanumeric, drawings, charts, process flows, models, etc.). These data are provided by the Generating Facility Owner under his responsibility.

b) Simulations (S): results of studies such as reports, graphical outputs, corresponding to the responses of the installation for different disturbances caused on a fictitious network to which the installation is connected. The network / installation set is modelled with the help of a suitable tool. A modelling of the set group / regulator can be requested instead of simulations.

c) Certifications (C): manufacturer's or Generating Facility Owner document confirming the conformity of equipment to technical specifications. This document is provided by the facility owner under his responsibility.

d) Testing (T): verifications by the facility owner of certain functionalities of the Generating Facility and its different subsystems performed in a real environment or interfaced with a simulator.

D.2.9.2 CHECK MODES FOR REQUIREMENTS

a) The statements of compliance associated to the applicable requirements shall be built on the basis of the following check modes.

b) Kahramaa has the right to request to add a check mode for one or several requirements if the statement of compliance using the mentioned check modes in is not considered sufficient to evidence the compliance.

c) Kahramaa has the right to request to cancel a check mode for one or several requirements if the statement of compliance using the mentioned check modes in Table D.2-6: is considered redundant.

Chapter	Requirements	Check mode
D.2.1.1	Frequency ranges	D,C
D.2.1.2	Active power control	D,T
D.2.1.3	Synchronization	D,T
D.2.1.4.1	Frequency Sensitive Mode	D,T
D.2.1.4.2	LFSM-O	D,T
D.2.1.4.3	LFSM-U	D,T
D.2.1.4.4	Secondary control	C,T
D.2.2.1	Voltage ranges	D,C
D.2.2.2	Voltage control	D,T
D.2.2.3	Reactive power capability	D,C,T
D.2.2.4	Excitation System and PSS	D,C,T
D.2.3	Fault ride through capability	S
D.2.4.1	Grid connection	D,C
D.2.4.2	Electrical protections	D,C,S, T
D.2.4.3	Metering	D,C, T
D.2.4.3.1	Neutral Point	D
D.2.4.5	Recordings	D,T
D.2.4.6	Information exchange in operation	D,T
D.2.5	Simulation	D
D.2.6	Power quality	C,T,S
D.2.7.1	Power restoration	D,
D.2.7.2	Island Operation	D,S,T

Chapter	Requirements	Check mode
D.2.7.3	Quick-resynchronization	D,T
D.2.8	Testing	T
D.2.9	Compliance	D
D.3.3	Power as function of frequency	D,C,T,S
D.3.4	Voltage stability	D,C,T,S
D.3.5	Reactive power capability	D,T
D.3.6.1	Fault Ride Through capability	D,C,S
D.3.6.2	Fast Fault Current contribution	D, C,S
D.3.7	Testing category P	T

Table D.2-6: Check modes for Generating Facilities

D.3 REQUIREMENTS FOR GENERATING UNITS CATEGORY P

D.3.1 REQUIREMENTS IDENTICAL TO CATEGORY S AND APPLICABLE TO CATEGORY P

For Power Park Modules, the following applicable requirements are similar as for Synchronous Generating Units.

Chapter	Requirements
D.2.1.1	Frequency ranges
D.2.1.2	Active power control
D.2.1.3	Synchronization
D.2.2.1	Voltage ranges
D.2.4.1	Grid connection
D.2.4.2	Electrical protections
D.2.4.3	Metering
D.2.4.3.1	Neutral Point
D.2.4.5	Recordings
D.2.4.6	Communication
D.2.5	Simulation
D.2.6	Power quality
D.2.8.3	Synchronisation
D.2.9	Compliance

Table D.3-1: Requirements for categories P or D identical to category S

D.3.2 REQUIREMENTS SPECIFIC TO CATEGORY P

For Power Park Modules, the following technical requirements are specific due to the non-synchronous connection and, if applicable, due to the renewable nature of the primary energy source. They focus on robustness, voltage stability, reactive power compensation, Fault Ride Through, Fast Fault Current contribution and testing at the Connection Point.

Chapter	Requirements
D.3.3	Frequency Control as function of frequency
D.3.4	Voltage stability
D.3.5	Reactive power capability
D.3.6.1	Fault Ride Through capability
D.3.6.2	Fast Fault Current contribution
D.3.7	Testing

Table D.3-2:Specific requirements for categories P or D and different from category S

D.3.3 POWER CONTROL AS FUNCTION OF FREQUENCY

a) In case of deviation of the network frequency from its nominal value below 47.5 Hz, the Generating Unit shall be disconnected from the ETN.

b) When falling frequency, the Generating Unit shall operate according to the frequency/active power response curve illustrated in Figure D.3-1.

c) The active power Frequency Control as function of frequency is requested only for category P Generating Units. It is a linear function of the active power controller at the Generating Unit level.

d) The Slope of the decreasing ramp and the frequency where the power shall decrease may be modified by Kahramaa.

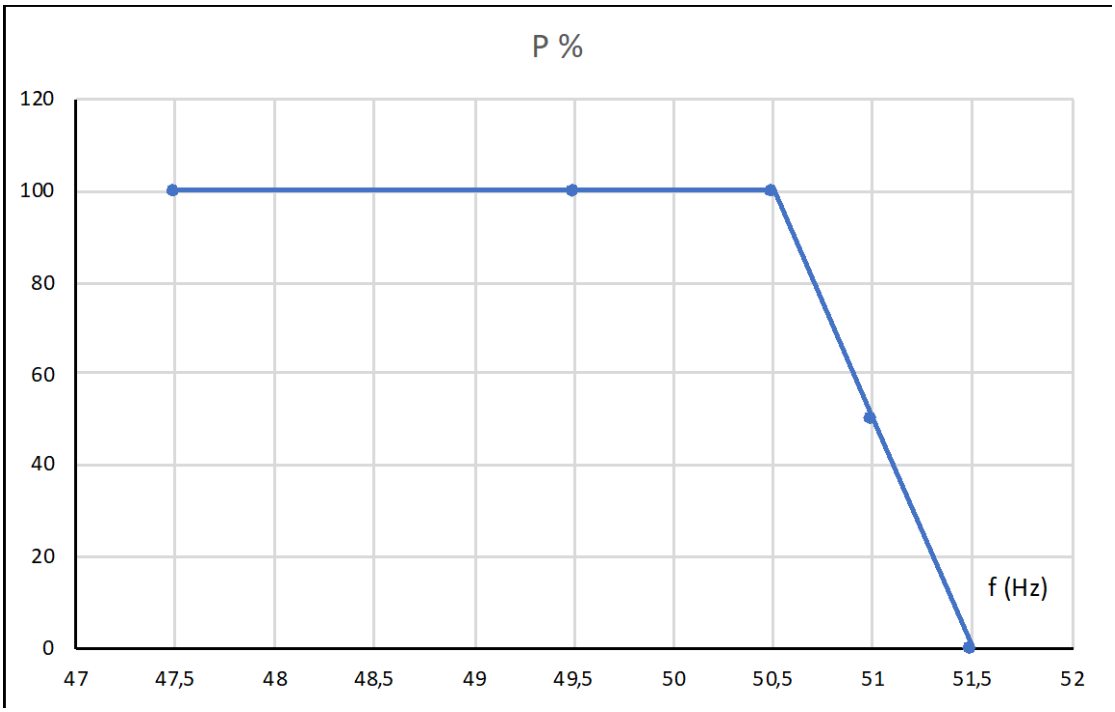

Figure D.3-1: Power output as function of frequency for category P Generating Units

D.3.4 REQUIREMENTS FOR VOLTAGE STABILITY

a) With regard to reactive/voltage control modes, the Generating Unit should be able to control automatically the voltage at the grid Delivery Point by either voltage control mode, reactive power control mode or Power Factor control mode:

1. For the purposes of voltage control mode, the Generating Unit shall be capable of contributing to voltage control at the Delivery Point by provision of reactive power exchange with a voltage set-point covering the unlimited voltage range of requirement in Table D.3-2. The set-point changes shall not be greater than 0.01 pu, with a Slope having a range of at least 2 to 7 % in steps no greater than 0.5 %. When the grid voltage value at the Delivery Point equals the voltage set-point, then the reactive power output shall stay stable.
2. The set-point may be operated with or without a dead-band selectable in a range from zero to ± 5 % of reference 1 pu of network voltage in steps no greater than 0,5 %. The value of the dead band shall be selected according to the test results.
3. Following a step change in voltage, the Generating Unit shall be capable of achieving 90 % of the change in reactive power output within a time t_1 to be specified by Kahramaa in the range of 1 to 5 seconds, and must settle at the value specified by the Slope within a time t_2 to be specified by Kahramaa in the range of 5 to 60 seconds, with a Steady State reactive tolerance no greater than 5 % of the maximum reactive power.
4. For the purpose of reactive power control mode, the Generating Unit shall be capable of setting the reactive power set-point anywhere in the reactive power range, with setting steps no greater than 5 MVAr or 5 % (whichever is smaller) of full reactive power, controlling the reactive power at the Delivery Point to an accuracy within plus or minus 5 MVAr or plus or minus 5 % (whichever is smaller) of the full reactive power.
5. for the purpose of Power Factor control mode, the Generating Unit shall be capable of controlling the Power Factor at the Delivery Point within the required reactive power range, with a target Power Factor in steps no greater than 0,01 pu. Kahramaa shall specify the target Power Factor value, its tolerance and the period of time to achieve the target Power Factor following a change of active power output. The tolerance of the target Power Factor shall be expressed through the tolerance of its corresponding reactive power. This reactive power tolerance shall be expressed by either an absolute value or by a percentage of the maximum reactive power of the Power Park Module.

Note: depending on voltage level, some control mode may be forbidden.

b) The voltage loop control shall include the tap changers of the step-up transformers. A proportional integral (PI) voltage control loop (with a limited integral term) is required in order to have a limited control action. The auxiliary devices for reactive power compensation must be included in the control loop.

c) Reactive power compensation in the Delivery Point is required in case the primary energy source (wind/sun) is interrupted. It is mandatory to compensate reactive power as close as possible to zero.

d) With regard to prioritizing active or reactive power contributions, Kahramaa shall specify whether active power contribution or reactive power contribution has priority during faults for which Fault-Ride-Through capability is required. If priority is given to active power contribution, this contribution has to be established no later than 250 ms from the fault inception.

e) With regard to voltage recovery and to the functioning of system protections, the Generating Facility shall be capable of providing the transient current component of the fault current at the point of connection as appropriate in the case of symmetrical (three-phase) faults, under the condition that the generators shall be able to activate the supply of the fault current transient component by:

   1. assuring the supply of the transient current component of the fault current at the connection, as appropriate, corresponding to the voltage variation with a proportional factor (k) of 2 to 10 according to the formula $\Delta I = k * \Delta U$; and
   2. measuring the voltage variations at the Delivery Point and providing the transient current component of the fault current at their terminals (the reactive current component).

f) Kahramaa shall determine the characteristics, timing and accuracy of Fast Fault Current contribution including voltage deviation, reaction to asymmetrical faults shall provide.

D.3.5 REQUIREMENTS FOR REACTIVE POWER CAPABILITY

a) The Generating Unit must be able to provide reactive power at the grid Delivery Point at any operating point inside the area of the P/Pmax-Q/Pmax profile delimited by dotted lines in the context of varying voltage.

b) In the event of voltage or power oscillations, the Generating Unit shall retain Steady State Stability when operating at any operating point of the P/Pmax-Q/Pmax Capability Diagram and be capable of remaining connected to the ETN and operating without power reduction, as long as voltage and frequency remain within the specified limits pursuant to requirements D.2.1.1 and D.2.2.1.

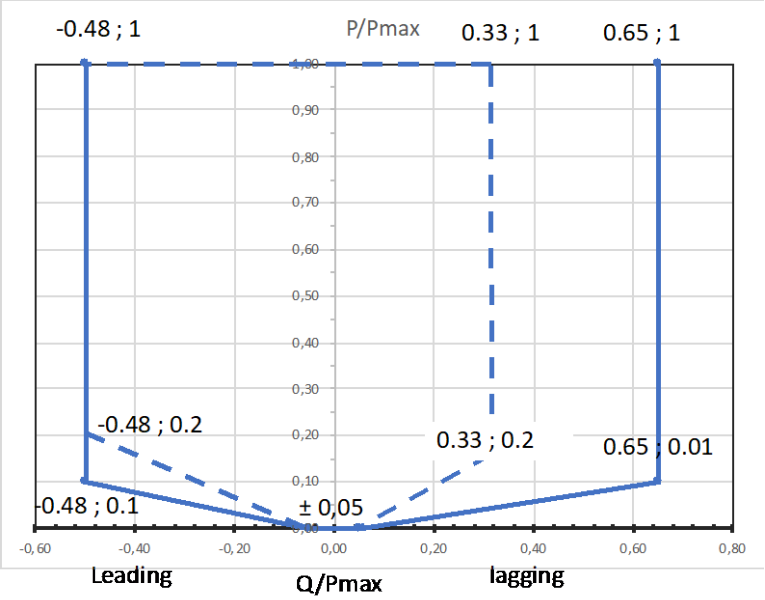

Figure D.3-2: Reactive power capability for category P Generating Units

This figure is typical of the P/Pmax-Q/Pmax Diagram as a dependence between the power delivered at the Delivery Point, as the case may be, expressed as the ratio between the real value and the reference value in relative units and the ratio between the reactive power (Q) and the Maximum Capacity (Pmax). The region within the dotted blue lines may be shifted within the area bounded by the solid blue lines according to the need of reactive power at the Delivery Point.

c) The position, the size and the shape of the doted frame are indicative, depending on the system conditions at the connection, other shapes of the P/Pmax-Q / Pmax Diagram can be requested in the maximum ranges of U and Q/Pmax according to Table D.3-3.

Maximum range of Q/Pmax	Maximum range of permanent voltage level, expressed in relative units
0.81	0.2

Table D.3-3: Maximum range of permanent voltage level, expressed in relative units

D.3.6 REQUIREMENT FOR FAULT RIDE THROUGH AND FAST FAULT CURRENT CONTRIBUTION

The two following requirements are defined to support the stability in case of voltage dips and are complementary depending on the characteristics of the grid and the severity of the voltage deviation.

The design parameters of the associated controls are determined after specific dynamic power studies.

D.3.6.1 REQUIREMENT FOR FAULT RIDE THOUGH

a) The Generating Unit shall be capable of remaining connected to the ETN and continuing to operate stably when the actual course of the phase-to-phase voltages on the network at the Delivery Point is low during a symmetrical fault, given the pre-fault and post-fault conditions, unless the protection scheme for internal electrical faults requires the disconnection of the Generating Unit from the ETN. The protection schemes and settings for internal electrical faults must not jeopardize Fault-Ride-Through performance.

b) The details of that capability shall be subject to coordination and agreements on protection schemes and settings.

c) With regard to Fault-Ride-Through capability of the Generating Unit:

1. Figure D.3-3 specifies a voltage-against-time-profile at the Delivery Point for fault conditions, for which the Generating Unit is capable of remaining connected to the ETN and continuing to operate stably after the EPS has been disturbed by faults on the ETN;

2. the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltage on the network voltage level at the Delivery Point during a symmetrical fault, as a function of time before, during and after the fault; and

3. the lower limit referred U_{clear} is specified by Kahramaa using the parameters within the ranges set out in Table D.3-4.

d) Kahramaa will specify the pre-fault and post-fault conditions for the Fault-Ride-Through capability in terms of:

1. calculation of the pre-fault minimum short-circuit capacity at the Delivery Point;

2. pre-fault active and reactive power operating point of the Generating Unit at the Delivery Point and voltage at the Delivery Point; and

3. calculation of the post-fault minimum short-circuit capacity at the Delivery Point.

e) At the request of the Generating Unit, Kahramaa shall provide the pre-fault and post-fault conditions to be considered for Fault-Ride-Through capability as an input of the calculations at the Delivery Point regarding:

1. pre-fault minimum short-circuit capacity at Delivery Point expressed in MVA;

2. pre-fault operating point of the Generating Unit expressed in active power output and reactive power output and voltage at the Delivery Point, and

3. post-fault minimum short-circuit capacity at the Delivery Point expressed in MVA. Alternatively, Kahramaa may provide generic values derived from typical cases.

f) Under-voltage protection (either Fault-Ride-Through capability or minimum voltage specified at the Delivery Point voltage) shall be set according to the widest possible technical capability of the Generating Unit, unless Kahramaa requires narrower settings in accordance with electrical protection schemes and settings. The settings shall be justified by the Generating Unit according to this principle; and

g) Fault-Ride-Through capabilities in case of asymmetrical faults can be specified by Kahramaa.

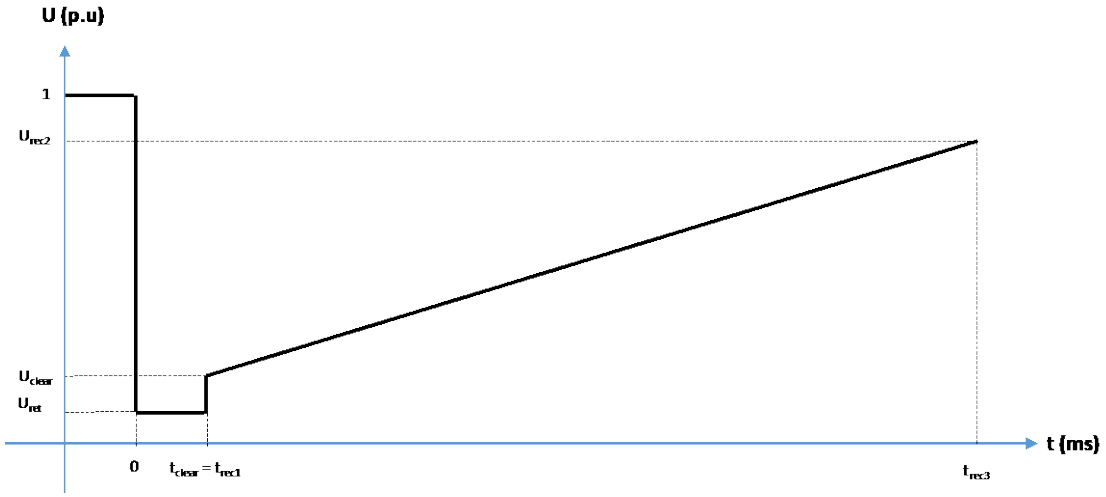

Figure D.3-3:Diagram for Fault-Ride-Through capability for Generating Unit type P

This figure represents the lower limit of a voltage-against-time profile of the voltage at the Delivery Point, expressed as the ratio of its actual value and its reference 1 pu value before, during and after a fault. U_{ret} is the retained voltage at the Delivery Point during a fault. t_{clear} is the instant when the fault has been cleared and U_{clear} the corresponding voltage. U_{rec2}, t_{rec1}, and t_{rec3} specify certain points of lower limits of voltage recovery after fault clearance.

Parameters referring to passing over the defect are provided in next tables.

Voltage parameters (pu.)		Time parameters (ms)	
U_{ret}	$0.05 \leq U \leq 0.15$	T_{clear}	$140 \leq t \leq 250$
U_{clear}	$U_{ret} \leq U \leq U_{ret} + 0.15$	T_{rec1}	T_{clear}
U_{rec2}	$0.85 \leq U \leq 0.9$	T_{rec3}	$1500 \leq t \leq 3000$

Table D.3-4: Parameters for Fault-Ride-Through capability of Generating Units type P

D.3.6.2 REQUIREMENTS FOR FAST FAULT CURRENT CONTRIBUTION

a) Kahramaa has the right to specify that a power park module be capable of providing Fast Fault Current at the Delivery Point in case of symmetrical (3-phase) faults, under the conditions that the power park module shall be capable of activating the supply of Fast Fault Current either by:

   1. ensuring the supply of the fast fault current at the Delivery Point; or
   2. measuring voltage deviations at the terminals of the individual units of the power park module and providing a fast fault current at the terminals of these units.

b) Kahramaa shall specify:

   1. how and when a voltage deviation is to be determined as well as the end of the voltage deviation;

2. the characteristics of the Fast Fault Current, including the time domain for measuring the voltage deviation and fast fault current; and
3. the timing and accuracy of the Fast Fault Current, which may include several stages during a fault and after its clearance.

D.3.7 REQUIREMENTS FOR TESTING FOR CATEGORY P

D.3.7.1 FRAMEWORKS FOR TESTING PROCEDURES

a) All the tests will be coordinated with Kahramaa to ensure the EPS stability.

b) The recording will be achieved without other filtering than anti-aliasing frequency filtering (sampling frequency divided by 2). Kahramaa can authorize a more convenient filter in case of difficulties. The recordings will be sent to Kahramaa in csv format to be analysed.

c) A document will be sent to Kahramaa, including operating points, curves representing all the recorded signals with accurate zoom, analyses, calculations, comparisons to the acceptance criteria, and comments.

d) The detailed trial tests procedures must be sent to Kahramaa at least 1 month before the tests.

NB: In all the frequency tests, the injected frequency (analog or digital) signal replaces rather than sums with the real system frequency of the grid. It is injected at the front input of the frequency part of power-frequency control system.

D.3.7.2 TEST: INFORMATION EXCHANGE

The information exchanges will be tested and conform to the data required by Kahramaa.

D.3.7.3 TEST: SYNCHRONIZATION AND ACTIVE POWER RAMPS

This test aims to verify the conditions of synchronization, and the rates of active power that will be possible in operation:

a) Input values: Ramp rates (up, down) (MW/min)

b) Measurements:

1. Active power at the Delivery Point;
2. Active power at inverter terminals;
3. Active power Set Point;
4. Voltage (at the Delivery Point); and
5. Minimum sampling frequency of the recording: 50 Hz.

c) Tests:

1. Test 1: connection of the main transformer;
2. Test 2: synchronization of the Power Park Module;
3. Test 3: ramp up from P_{min} to Pmax;

4. Test 4: Power Park Module at P_{max} during 15 min;
5. Test 5: ramp down unit from P_{max} to P_{min}; and
6. Test 6: Power Park Module at P_{min} during 15 min;

d) Acceptance:

1. No trip;
2. Test 1, 2: maximum voltage deviation: 5% of the voltage, measured at the Delivery Point; and
3. Test 3, 5: the ramp is compliant with the declared ramps of power up and down.

D.3.7.4 TEST: QUALITY OF ELECTRICITY

This test aims to verify the disturbances due to the Power Park Module, according to the tolerances of the Grid Code:

a) Flicker/unbalance/harmonics; flicker Pst is calculated as specified in IEC 61000-4-15;

b) Measurements are performed for 1 week at least; and

c) Compliance: Conformity to the requirements for power quality of the Grid Code.

D.3.7.5 TEST: ACTIVE POWER CONTROL

This test aims to evaluate the behavior of the frequency regulations, in real conditions; the analysis is performed by Kahramaa:

a) Inputs: Power set-points (0-100 % by steps 10 %, each 15 min)

b) Measurements:

1. Active power at the Delivery Point; and
2. Active power at the inverter terminals.

c) Test 1: Reliability test for 8 hours with the Power Park Module in normal condition, connected to the grid. Observation by Kahramaa.

d) Compliance: No abnormal power variation during the tests. The power generated should not deviate more than 1 % of the power set-points requested by Kahramaa.

D.3.7.6 TEST: PRIMARY VOLTAGE CONTROL AND REACTIVE POWER CAPACITY

This test aims to evaluate the dynamic and stability of the voltage control, and the reactive power capability of the Power Park Module. The voltage against reactive power diagrams are input data, elaborated by the Power Park Module Owner, before the tests:

a) Input Values/documents: The voltage against reactive power diagrams, considering the limiters implemented in the AVR, and conform to the capability diagrams of the Grid Code.

b) Measurements:

1. RMS voltage at the Delivery Point;

2. RMS Stator voltage;
3. reactive power at the Delivery Point;
4. Active power at the Delivery Point;
5. Active power at inverter terminals;
6. Reactive power at inverter terminals;
7. Set Point of the AVR;
8. Limitation signalization coming from the AVR; and
9. Minimum sampling frequency of the recording: 50 Hz.

c) Tests 1 - dynamic of the primary voltage regulation:

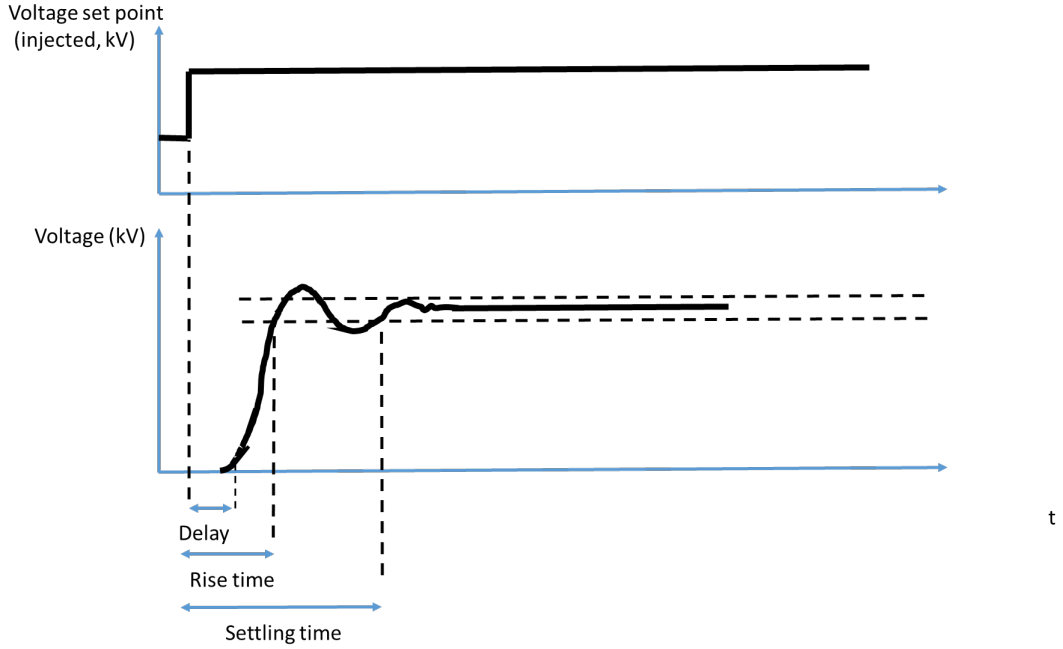

Figure D.3-4: Voltage control profile

d) Test 1.1 – Step up: at Pmax and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range) : +1 % step and 5 min later + 2 % step on the Set Point of the AVR during 5 min.

e) Compliance:

The output shall fulfil the following requirements:

1. Stability: less than 2 oscillations;
2. Maximum settling time at +/- 5 % of the final value of the generator terminals voltage: 10 s;
3. Maximum settling time at +/- 2 % of the active power at the generator terminals voltage: 10 s; and
4. Static error: less than 0.2 %;

f) Test 1.2 – Step down: at P_{max} and Power Factor = 1 as far as possible given the configuration of the network (the voltage must remain in the normal range): +1 % step and 5 min later -2 % step on the Set Point of the AVR during 5 min.

g) Compliance :

1. Stability: less than 2 oscillations;
2. Maximum settling time at +/- 5 % of the final value of the inverter terminals voltage: 10 s;
3. Maximum settling time at +/- 2 % of the active power at the inverter terminals voltage: 10 s; and
4. Static error: less than 0.2 %.

h) Test 1.3 – Step up: at Pmax and Power Factor =1 as far as possible given the configuration of the network (the voltage must remain in the normal range) +1 % step on the Set Point of the AVR during 5 min.

i) Tests 2 - limitation at maximum active power:

1. Test 2.1 - Invertor at Pmax: hold at $Q = Q_{max}$ for 30 min. $Q = Q_{max}$ will reach the maximum lagging limitation within the normal range of voltage at the Delivery Point.
2. Compliance: The reactive power (considering the voltage and the active power) will be conform at least to the values according to the U/Q. Correct operation of the limiter for either step injection or unit transformer tap change.
3. Test 2.2 - Invertor at P_{max}: hold at $Q = Q_{min}$ for 30 min. $Q = Q_{min}$ will reach the maximum leading limitation within the normal range of voltage at the Delivery Point.
4. Compliance: The reactive power (considering the voltage and the active power) will be conform at least to the values according to the U/Q. Correct operation of the limiter for either step injection or unit transformer tap change.

j) Tests 3 - limitations at minimum load P_{min} of the Generating Facility:

1. Test 3.1 – same test as test 2.1
2. Test 3.2 – same test as test 2.2

D.3.7.7 TEST: POWER CONTROL AS FUNCTION OF FREQUENCY

This test aims to verify the limitation of the power when frequency rises.

a) Input values/documents: Frequency set-points (47.5 to 51.5 step 0.5 Hz).

b) Measurements:

1. Set Point at inverter;
2. Active power at the inverter terminals;
3. Minimum sampling frequency of the recording: 10 Hz.

c) Test: External injection for 5 minutes of a frequency step Δf

d) Compliance:

1. Power at inverter terminal according to D.3.3;
2. Delay < 2 s.

D.4 REQUIREMENTS FOR DEMAND FACILITIES

D.4.1 REQUIREMENTS FOR FREQUENCY AND VOLTAGE RANGES

a) Demand Facilities are connected to 3-phases 50 Hz network.

b) The voltage level at the grid Delivery Point is determined by Kahramaa considering the data provided by the Demand Facility Owner in the application for grid connection.

c) Demand Facilities shall be capable of remaining connected to the ETN and operating at the ranges and time periods specified in Table D.2-2 and in Table D.2-1.

d) If required by Kahramaa, a Demand Facility shall be capable of automatic disconnection at specified voltages. The terms and settings for automatic disconnection shall be agreed between Kahramaa and the Demand Facility Owner.

D.4.2 REQUIREMENTS FOR POWER CONSUMPTION

a) The available power at the Delivery Point is determined by Kahramaa considering the data provided by the facility owner in the application for grid connection. In abnormal grid situation, the level of power may be not delivered.

b) The Delivery Point is the physical point where power quality is observed. It defines also the property limit.

D.4.3 REQUIREMENTS FOR REACTIVE POWER CAPABILITY

a) Demand Facilities shall be capable of maintaining their Steady State operation at their Delivery Point within a reactive power range specified by Kahramaa, according to the following condition: the actual reactive power range specified by Kahramaa for importing and exporting reactive power shall not be wider than 48 percent of the larger of the maximum import capacity or maximum export capacity (0,9 Power Factor import or export of active power), except in situations where either technical or financial system benefits are demonstrated by the Demand Facility Owner and accepted by Kahramaa.

b) The Demand Facility Owner designs his installation so that Kahramaa needs for reactive power are satisfied at the time of initial connection.

c) When these needs evolve upwards, within the constructive limits described in the regulations in force, the Demand Facility Owner has a maximum period of 6 months to provide Kahramaa with the reactive energy capacities necessary for the operation of the ETN.

D.4.4 REQUIREMENTS FOR SHORT-CIRCUIT

a) Based on the rated short-circuit withstand capability of the ETN elements, Kahramaa shall specify the maximum short-circuit current at the Delivery Point that the Demand Facility shall be capable of withstanding.

b) Kahramaa shall deliver to the Demand Facility Owner an estimate of the minimum and maximum short-circuit currents to be expected at the Delivery Point as an equivalent of the network.

c) After an unplanned event, Kahramaa shall inform the affected Demand Facility as soon as possible, and no later than one week after the unplanned event, of the changes for the maximum short-circuit current.

d) Kahramaa shall request information from a Demand Facility concerning the contribution in terms of short-circuit current from that facility or network.

e) After an unplanned event, the Demand Facility Owner shall inform Kahramaa, as soon as possible and no later than one week after the unplanned event, of the changes in short-circuit contribution above the threshold set by Kahramaa.

D.4.5 REQUIREMENTS FOR NEUTRAL POINT

The choice of the grounding scheme used for the connection of the installation is specified in the Consultancy Service Agreement.

D.4.6 REQUIREMENTS FOR PROTECTIONS AND RECORDINGS

D.4.6.1 REQUIREMENTS FOR PROTECTIONS

a) The definition and application of function numbers and acronyms for devices and functions used for electrical protections in connection equipment and in demand facilities shall be compliant with the latest IEEE C 37.2 standards.

b) Demand Facilities Owners shall follow the requirements and specifications of the latest issue of Kahramaa Protection Guidelines/Standard ET-P26-G1 (Guidelines For Protection/Energy meter requirements for Power supply to Bulk Consumers).

c) The design document shall be submitted to Kahramaa for review and approval. Deviation if any from the standard shall be brought to the notice of Kahramaa for review and approval at the initial stage of the project itself.

d) Demand Facilities Owners shall provide required new protection or modify existing protection of the Kahramaa interfacing bays.

e) Kahramaa and the Demand Facilities Owners shall agree with Kahramaa on protection schemes and settings relevant for the Demand Facility.

f) Kahramaa will review the Connection Equipment protection scheme and settings. The protection and settings of all other equipment and circuits in the Demand Facility are under the responsibility of Demand Facility Owners.

g) Protection schemes and devices shall cover the following events and equipment:

1. External and internal short-circuits;
2. Over- and under-voltage at the Delivery Point to the ETN;
3. Over- and under-frequency;
4. Demand circuit (cable/line);

5. Unit transformer;
6. Switchgear malfunction;
7. Breaker failure; and
8. Busbar.

h) Protections shall be provided by Demand Facilities as mandatory for interfacing bay at both the ends, and the required modifications to match with the local end at the remote end of Kahramaa Substations.

i) The protection document required by Kahramaa at each stage of project shall be submitted to Kahramaa for review/approval/record.

j) Electrical protection of the Demand Facility shall take precedence over operational controls while respecting system Security, health and safety of staff and the public.

k) Kahramaa and the Demand Facility Owner shall agree on any changes to the protection schemes relevant for the Demand Facility, and on the arrangements for the protection schemes of the Demand Facility.

l) The maintenance of all protection equipment at the premises of the Demand Facility including those of Connection Equipment is at the responsibility of Demand Facilities in coordination with Kahramaa, as applicable.

m) The Demand Facilities Owner shall comply with Kahramaa Interlocking requirements and shall test such interlocking in Kahramaa's engineer presence.

D.4.6.2 REQUIREMENTS FOR RECORDINGS

a) Demand Facilities shall be equipped with fault recording and monitoring of dynamic system behaviour. Records at least include the following parameters at Delivery Point:

1. Voltage;
2. Current;
3. Active power;
4. Reactive power; and
5. Status of connection equipment (trip relays, triggering relays/functions, etc.).

b) On Kahramaa request, specific signals elaborated by the facility may be collected by the fault recording system.

c) The settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the Demand Facility Owner and Kahramaa.

d) The facilities for recording and monitoring shall include arrangements between the Demand Facility Owner and Kahramaa to access the information. The communication protocols for recorded data shall be agreed between the Demand Facility Owner and Kahramaa. The recordings shall be preserved by Demand Facility and produced when asked by Kahramaa.

e) The fault recording and monitoring system shall be synchronized using a time protocol agreed by Kahramaa.

D.4.7 REQUIREMENTS FOR METERING

a) Meters, measuring reducers (current and voltage transformers) accompanied by the metering panel, and accessories associated with this panel are provided by the Demand Facility Owner.

b) The Bulk Consumer may only use the instrument transformers with the written consent of Kahramaa and in compliance with the conditions indicated by Kahramaa.

c) The Bulk Consumer shall send to Kahramaa the verification and/or Test Certificates guaranteeing compliance with the rules and standards in force for the equipment it supplies, before being put into service.

d) Prior to any order / purchase, a material submittal is requested for Kahramaa approval. After installation, an inspection request shall be submitted. Communication aspect shall be confirmed with Kahramaa.

e) The equipment provided by the Bulk Consumer is put in place at his own expense. The meter is connected by the Bulk Consumer to the connection circuits from the measurement transformers, to any auxiliary power supply and is connected to the telecommunication network used. The equipment is sealed by Kahramaa in the presence of the Bulk Consumer.

D.4.8 REQUIREMENTS FOR CONTROL

a) Kahramaa and the Demand Facility Owner shall agree on the schemes and settings of the different control devices of the Demand Facility relevant for system Security.

b) This agreement shall cover at least the following elements:

   1. Isolated (network) operation; and
   2. Damping of oscillations.

c) Kahramaa and the Demand Facility Owner shall agree on any changes to the schemes and settings of the different control devices of the Demand Facility relevant for system Security.

d) With regard to priority ranking of protection and control, the Demand Facility Owner shall set the protection and control devices of its Demand Facility, in compliance with the following priority ranking, organised in decreasing order of importance:

   1. ETN protection;
   2. Demand Facility system protection;
   3. Demand response (active power adjustment); and
   4. Active or reactive Power restriction.

D.4.9 REQUIREMENTS FOR INFORMATION EXCHANGE IN OPERATION

Demand Facilities shall be equipped according to Kahramaa standard (ES–EST-P1-G1 Guideline for System Control Requirements for Power Supply to Bulk Consumers) in order to exchange the protection information between Kahramaa and the Demand Facility with the specified time stamping.

D.4.10 REQUIREMENTS FOR DEMAND DISCONNECTION AND DEMAND RECONNECTION

a) All Demand Facilities shall fulfil the following requirements related to low frequency demand disconnection functional capabilities:

1. the low frequency demand disconnection functional capabilities shall allow for disconnecting demand in stages for a range of operational frequencies;
2. the low frequency demand disconnection functional capabilities shall allow for operation from a nominal AC input to be specified by Kahramaa, and shall meet the following requirements:
   i. Frequency range: at least between 47-50 Hz, adjustable in steps of 0.05 Hz; and
   ii. operating time: no more than 150 ms after triggering the frequency Set Point.
3. The AC voltage supply used in providing low frequency demand disconnection functional capabilities shall be provided from the network at the frequency signal measuring point, as used in providing functional capabilities, so that the frequency of the low frequency demand disconnection functional capabilities supply voltage is the same as the one of the network.

b) With regard to low voltage demand disconnection functional capabilities, the following requirements shall apply:

1. if Kahramaa decides to implement a low voltage demand disconnection functional capability, the equipment low voltage demand disconnection shall be installed in coordination with Kahramaa;
2. the method for low voltage demand disconnection shall be implemented by relay or control room initiation;
3. the low voltage demand disconnection functional capabilities shall have the following features:
   i. the low voltage demand disconnection functional capability shall monitor the voltage by measuring all three phases; and
   ii. blocking of the relays' operation shall be based on direction of either active power or reactive power flow.

c) All Demand Facilities shall fulfil the following requirements related to disconnection or reconnection of a Demand Facility:

1. with regard to the capability of reconnection after a disconnection, Kahramaa shall specify the conditions under which a Demand Facility is entitled to reconnect to the ETN. Installation of automatic reconnection systems shall be subject to prior authorization by Kahramaa;
2. with regard to reconnection of a Demand Facility, the Demand Facility shall be capable of:
   i. re-connection for frequencies within the ranges set out in D.2.1.1. Kahramaa and the Demand Facility Owner shall agree on the settings of synchronization devices prior to connection of the Demand Facility, including voltage, frequency, phase angle range and deviation of voltage and frequency; and

ii. being remotely disconnected from the transmission system when required by Kahramaa. If required, the automated disconnection equipment for reconfiguration of the system in preparation for block loading shall be specified by Kahramaa. Kahramaa shall specify the time required for remote disconnection.

D.4.11 REQUIREMENTS FOR POWER QUALITY

D.4.11.1 MEASUREMENTS FOR VOLTAGE SURGES

The frequency and amplitude of the voltage surges caused by the installation of the Bulk Consumer at the Delivery Point must be less than or equal to the values delimited by the amplitude-frequency (Meister) curve in IEC 61000-2-2. The amplitude suddenly created at the Delivery Point must not exceed 5 % of the voltage supply. The amplitude of the voltage surge is measured independently on each of the 3 voltages between phases, in accordance with the method defined by standard IEC 61000-4-30.

D.4.11.2 MEASUREMENTS FOR FLICKER

a) The level of short-term severity of the flicker (or probability short term called "Pst") generated by the Demand Facility alone at the Delivery Point must remain in the range 0-1 for Voltages Level below 220 kV and in the range 0-0.6 above.

b) The disturbing load generates a voltage imbalance rate less than or equal to 1 % in 11 kV to 220 kV and 0.6 % in 400 kV.

c) Failing this, and if the short-circuit power made available by Kahramaa to the Bulk Consumer is greater than the reference value, the Bulk Consumer is obliged to take, at the request of Kahramaa, any provisions so that its installations do not cause an imbalance rate higher than 1 % in 11 kV to 220 kV networks and 0.6 % in 400 kV.

d) The product imbalance rate is measured in accordance with IEC 61000-4-30 with a 10 min measurement time interval.

e) The short-term severity level of the flicker is measured in accordance with standard IEC 61000-4-30 with a measurement time interval of 10 min.

D.4.11.3 MEASUREMENTS FOR HARMONICS

a) The Demand Facility Owner shall limit indicated in Table D.4-1 to the values τ_g indicated in the formula below:

$$\tau_g = \sqrt{\sum_{n=2}^{40} {I_{hn}}^2} . \frac{\sqrt{3}U_c}{S} \qquad \text{where} \qquad I_{hn} = k_n . \frac{S}{\sqrt{3}U_c}$$

- τ_g is the total harmonic distortion;

- Uc is the value of the declared voltage supply;

- S is equal to the apparent power corresponding to the actual power as long as S remains less than 5 % of Scc, otherwise S is taken equal to 5 % of Scc;

- Scc is the minimum value of the short-circuit power supplied by the ETN at the Delivery Point; and

- kn is a limiting coefficient defined according to the rank n of the harmonic.

The table below gives the value of k_n:

Odd	k_n (%)	Even	k_n (%)
3	6.5	2	3
5;7	8	4	1.5
9	3	> 4	1
11;13	5		
> 13	3		
Total harmonic distortion for U< 161 kV: 2.5 %			
Total harmonic distortion for U> 161 kV: 2 %			

Table D.4-1: Limiting coefficient for harmonic ranks

b) Values are compliant with IEEE 519-2014 and shall be multiplied by 0.6 for installations connected at 400 kV.

c) The measurement is carried out in accordance with IEC 61000-4-30 with a measurement time interval of 10 min.

D.4.11.4 OTHER SPECIFIC PERTURBATIONS

In case of disturbances caused by the Demand Facility require the implementation of special provisions on the ETN, these are the subject of a technical proposal from Kahramaa.

D.4.12 REQUIREMENTS FOR SIMULATION

a) Kahramaa may require studies using simulation models or equivalent information showing the behaviour of the Demand Facility, in steady and dynamic states. The studies may be:

1. Calculation of the intensities and verification of the thermal resistance of the elements of the network;
2. Calculations of the voltage differences and verification of the deviations of the voltage networks;
3. Protection settings coordination study;
4. Calculation of the fault currents and verification of the operation of the phase-to-phase fault and phase to earth protection scheme of the ETN and the primary substation; and
5. Verification of the single-line diagram of the primary substation, the metering device and the measurement reducers.

b) Depending on the use, nature and characteristics of the electrical equipment used, studies additional checks are sometimes necessary:

1. calculation and verification of individual levels of contribution to voltage flicker;
2. calculation and verification of individual levels of harmonic currents injected;
3. calculation and verification of individual levels of voltage imbalance; and
4. calculation and verification of the impact on the transmission of the tariff signal.

c) For the purpose of dynamic simulations, the simulation model or equivalent information shall contain the following sub-models or equivalent information:

1. Power control;
2. Voltage control;
3. Demand Facility protection models;
4. Structure and block diagrams;
5. Electro-technical characteristics of the Demand; and
6. models of power electronics devices.

d) Kahramaa shall specify the requirements of the performance of the recordings of Demand Facilities, in order to compare the response of the model with these recordings.

D.4.13 REQUIREMENTS FOR TESTING FOR DEMAND FACILITY

D.4.13.1 INFORMATION EXCHANGE AND CONTROL

Test: To check transmission, accuracy and update of all information required to be transmit to NCC and information and control to be received from Kahramaa facilities.

D.4.13.2 ENERGIZATION

a) Test 1: Connection of the unit transformer.

b) Test 2: Voltage measurement.

c) Test 3: Reactive power measurement.

d) Test 4: Power quality measurement.

e) Any other test as advised by Kahramaa.

D.4.14 REQUIREMENTS FOR COMPLIANCE

Compliance is a process taking place during the whole connection project with the purpose of demonstrating the compliance to the required requirements.

The objective of the compliance process is to ensure that there is a clear and consistent demonstration of compliance by Demand Facility to the requirements of Grid Code and of the BSA.

Compliance activity is supported by statements of compliance elaborated by the Demand Facility Owner including checks, simulations and testing justifying the compliance of the Demand Facility to the applicable requirements.

Compliance statements shall be submitted for approval to Kahramaa at least 10 Business Days before following milestones a), b) and c) of a connection project as described in Connection Code:

a) Commissioning of the primary substation;

b) Test and connection to the facility;

c) First supply date; and

d) Before the delivery by Kahramaa of the Connection Permit.

D.4.14.1 COMPLIANCE STATEMENTS

Compliance statements include all necessary documented checks and testing be carried out by the Demand Facility Owner according to four modes:

a) Declarative data (D): data corresponding to the technical characteristics of the installation (alphanumeric, drawings, charts, process flows, models…). These data are provided by the Demand Facility Owner under his responsibility.

b) Simulations (S): results of studies such as reports, graphical outputs, corresponding to the responses of the installation for different disturbances caused on a fictitious network to which the installation is connected. The network / installation set is modelled with the help of a suitable tool. A modelling of the load can be requested instead of simulations.

c) Certifications (C): manufacturer's or Demand Facility Owner document confirming the conformity of equipment to technical specifications. This document is provided by the facility owner under his responsibility.

d) Testing (T): verifications by the facility owner of certain functionalities of the Demand Facility and its different subsystems performed in a real environment or interfaced with a simulator.

D.4.14.2 CHECK MODES FOR REQUIREMENTS

a) The statements of compliance associated to the applicable requirements shall be built on the basis of the following check modes.

b) Kahramaa has the right to request to add a check mode for one or several requirements if the statement of compliance using the mentioned check modes in is not considered sufficient to evidence the compliance.

c) Kahramaa has the right to request to cancel a check mode for one or several requirements if the statement of compliance using the mentioned check modes in Table D.4-2 is considered redundant.

d) The following requirements shall be evidenced in the statement of compliance according to the associated check modes.

Chapter	Requirements	Check modes for Demand Facility
D.4.1	Frequency and voltage	D
D.4.2	Power consumption	D
D.4.3	Reactive power capability	D
D.4.4	Short-circuit	D
D.4.5	Neutral point	D
D.4.6	Electrical protections	D,C S,T
D.4.7	Metering	D,C,T
D.4.8	Control	D,T
D.4.9	Information exchange	D,T
D.4.10	Disconnection	D,T
D.4.11	Power quality	D,C,T
D.4.12	Simulation	D,S
D.4.13	Testing	D,C,T
D.4.14	Compliance	D,C

Table D.4-2: Check modes for Demand Facilities

E. OPERATION CODE (OC)

E.1 INTRODUCTION

The Operation Code describes the guideline, requirements and operating actions necessary to operate the ETN to transmit adequate and safe energy and to meet at all times Reliability and Security Standards.

The scope of the Operation Code includes:

a) The missions entrusted to Kahramaa for operation;

b) The roles and the requirements applicable in operation to Generating and to Demand Facilities;

c) The system performances;

d) The operational security requirements;

e) The operating procedures;

f) The operating reserve and margin policy; and

g) Other general requirements for monitoring, safety and public information.

E.2 MISSIONS

E.2.1 FOR SYSTEM OPERATION

The ETN is operated by Kahramaa in compliance with operational Security requirements set out in subsection E.5 Operational Security.

Kahramaa has the responsibility:

a) To operate the ETN in real time and in all circumstances;

b) To ensure the balance between consumption and production in the best economic conditions, supplying electricity in reliable, secure and efficient way to Grid Users and distribution facilities;

c) To arrange regular operation, maintenance and protection checking of the systems and components of the ETN;

d) To ensure the operation of the EPS, at the lowest cost and with a quality of supply of electricity compliant with the standards set out in article E.4 System performance ;

e) To control the operating Security of the EPS by:

   1. assessing potential infringement of the technical envelope or power system operating procedures which could affect the security of the power system;
   2. ensuring that the power system is operated within the limits of the technical envelope;
   3. Limiting the Risks of Incidents in the EPS; and
   4. Mitigating the consequences of possible major Incidents (Blackout, large load shedding...).

f) To restore the electrical power in case of interruption within shortest possible time adhering to all safety measures;

g) To facilitate grid expansion for accommodating future Demand through regular operations of grid equipment;

h) To manage interconnections to ensure scheduled energy exchanges and, among other things, to provide mutual assistance between interconnected countries; and

i) To maintain and improve EPS Security.

E.2.2 FOR TRANSMISSION NETWORK OPERATION

Kahramaa has the responsibility:

a) To operate and to maintain the ETN; and

b) To develop the ETN.

The relationship between Kahramaa and GCCIA, and particularly the reconnection conditions after a disconnection of the ETN from GCCIA, are ruled by the GCCIA Interconnector Transmission Code.

E.3 ROLES OF GRID USERS

a) Generating and Demand Facilities are contributing to EPS performances, Reliability and Security by:

   1. Participating to operational planning, providing operational data and operational scheduling for power delivery and consumption;
   2. Providing Ancillary Services (Frequency Control, power reserves, voltage control, etc.); and
   3. Being operated in compliance with the Grid Code requirements with the best standards of operation and maintenance.

b) Each Grid User shall make Declarations in accordance with the schedules in chapter E.11 in respect of each of its Demand and Generating Facilities. Declarations shall reflect the true operating characteristics of the Facility, determined in accordance with prudent practice.

c) For supporting EPS Security, it is a responsibility of Demand Facility operators:

   1. To maintain their share in energy takeout as per contract demand and to limit excess consumption beyond agreed contract;
   2. To maintain the Availability and the Reliability of the protection systems;
   3. To limit consumption of reactive power consumption; and
   4. To not inject electrical perturbations.

E.3.1 ROLES OF GENERATING UNITS

Generating Facility Owners and operators shall:

a) Declare all available Generating Units for operation;

b) Operate Generating Units according to NCC instructions;

c) Coordinate with NCC for the outage planning of the Generating Units; and

d) Coordinate with Kahramaa for the implementation and the operation of their contribution to the Defense and Restoration Plans.

E.3.2 ROLES OF DEMAND FACILITIES

Demand Facility Owners shall:

a) coordinate with Kahramaa for the operation and maintenance of the facility;

b) coordinate with Kahramaa for the implementation and the operation of their contribution to the Defense Plan; and

c) operate Demand Facilities Units according to NCC Instructions in case of emergency.

E.4 SYSTEM PERFORMANCE

E.4.1 FREQUENCY TARGETS AND CHARACTERISTICS

a) Considering calculated load forecast, operational generation planning and scheduling shall be performed to operate the system within a standard frequency range target of 50 Hz ± 50 mHz with a probability of 99 %.

b) In case of impaired operation, the maximum Steady State frequency deviation is set at:

1. 150 mHz if the ETN is interconnected with GCCIA network; or
2. 500 mHz if the ETN is disconnected from GCCIA network.

c) The frequency ranges and the time periods for system operation are:

Frequency ranges	Time periods for operation
47.5 Hz – 49.5 Hz	Maximum 30 min
49.5 Hz – 50.5 Hz	Unlimited
50.5 Hz – 51.5 Hz	Maximum 30 min

Table E.4-1: Frequency ranges and time periods for system operation

d) In case of listed contingency, operating reserves shall be available in power and in energy to:

1. Not activate the first step of load shedding in case of loss of the largest infeed; and
2. Recover the unlimited frequency range within less than 30 min.

E.4.2 VOLTAGE TARGETS AND CHARACTERISTICS

The ETN shall be operated to meet the following voltage ranges and time period targets:

Voltage Level (1 pu)	Voltage range	Time period for operation
11 kV – 66 kV	0.85 pu - 0.90 pu	Maximum 30 min
	0.9 pu – 1.1 pu	Unlimited
	1.1 pu - 1.15 pu	Maximum 30 min
132 kV	0.85 pu-0.925 pu	Maximum 60 min
	0.925 pu – 1.075 pu	Unlimited
	1.075 pu - 1.15 pu	Maximum 20 min
220 kV	0.85 pu - 0.90 pu	Maximum 60 min
	0.90 pu – 1.1 pu	Unlimited
	1.1 pu - 1.15pu	Maximum 20 min
400 kV	0.85 pu - 0.95 pu	Maximum 60 min
	0.95 pu – 1.05 pu	Unlimited
	1.05 pu - 1.1 pu	Maximum 20 min

Table E.4-2: Voltage ranges and time periods for network operation

E.4.3 PERFORMANCE INDICATORS

a) The quality objectives of the ETN are monitored by the following indicators:
   1. Number of Incidents;
   2. Number of occurrences and duration in Alert and Emergency State;
   3. Number and duration of frequency deviations outside the limited time period for operation;
   4. Number and duration of voltage deviations per voltage level outside the limited time period for operation;
   5. Percentage of ETN scheduled outages rejection; and
   6. Energy lost during interruption of supply due to MV and HV switching.

b) Kahramaa is responsible for elaborating a yearly report analysing the indicators.

c) These indicators are subject to review by the GCRP as well as progress actions engaged by Kahramaa. The report is published on the Kahramaa's website.

E.5 OPERATIONAL SECURITY

This chapter provides the framework for achieving and maintaining a secure ETN. It also provides the conditions under which Kahramaa can intervene in the processes of the electricity market and issue directions to Grid Users so as to maintain or re-establish a secure and reliable ETN.

This chapter has the following aims:

a) to detail the principles and guideline for achieving and maintaining EPS Security; and

b) to establish a framework enabling Kahramaa to plan and to conduct operations within the ETN to achieve and maintain EPS Security.

E.5.1 GENERAL PRINCIPLES FOR MAINTAINING EPS SECURITY

The EPS Security principles are:

a) to the extent practicable, the EPS shall be operated to remain in the Normal Operating State (see E.5.2.1);

b) following a Contingency Event (whether credible or not credible) or a significant change in the EPS conditions, Kahramaa should take all reasonable actions to adjust, wherever possible, the operating conditions with the objective to return the EPS to the normal Operating State as soon as it is practical, within thirty (30) minutes;

c) Emergency control schemes should be available and in service to:

   1. restore the EPS to a Normal Operating State following Protected Events; and

   2. significantly reduce the Risk of cascading outages and major supply disruptions following significant multiple Contingency Events.

d) sufficient three phase fault level should be maintained at each fault level node to meet the applicable System Strength requirements.

E.5.2 OPERATING STATES

E.5.2.1 NORMAL OPERATING STATE

The EPS is defined as being in a satisfactory or Normal Operating State when all the following conditions are fulfilled:

a) the frequency at all energized busbars of the ETN is within the unlimited operating frequency range in accordance with clause E.4.1;

b) the voltage magnitudes at all energized busbars at any switchyard or Substation of the ETN are within the limits set in accordance with clause E.4.2;

c) the power flows are within their current limits in terms of thermal rating including the transitory admissible overloads; and

d) the configuration of the ETN is such that the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment.

E.5.2.2 ALERT STATE

The EPS shall be declared in the Alert State when:

a) voltage and power flows are within the Operational Security Limits defined in accordance with E.5.3; and the reserve capacity is reduced by more than 20 % for longer than 30 min and there are no means to compensate for that reduction in real-time system operation; or

b) frequency meets the following criteria:

1. the absolute value of the Steady State system frequency deviation is not larger than the maximum Steady State frequency deviation; and

2. the absolute value of the Steady-State system frequency deviation has continuously exceeded 50 % of the maximum Steady-State frequency deviation for a time period longer than an Alert State trigger time defined by Kahramaa or the standard frequency range for a time period longer than time to restore frequency; or

c) at least one contingency from the contingency list defined in accordance with E.5.10.1 leads to a violation of the Operational Security Limits, even after the activation of remedial actions.

E.5.2.3 REMEDIAL ACTIONS

a) Kahramaa shall ensure that the ETN remains in the Normal State and shall be responsible for managing operational security violations. To achieve that objective, Kahramaa shall design, prepare and activate remedial actions taking into account their Availability, the time and resources needed for their activation and any conditions external to the ETN which are relevant for each remedial action.

b) When selecting the appropriate remedial actions, Kahramaa shall apply the following criteria:

1. activate the most effective and economically efficient remedial actions;

2. activate remedial actions as close as possible to real-time taking into account the expected time of activation and the urgency of the system operation situation they intend to resolve; and

3. consider the Risks of failures in applying the available remedial actions and their impact on Operational Security such as the Risks of failure or short-circuit caused by topology changes or the Risks of outages caused by active or reactive power changes on Generating Units or Demand Facilities; and the Risks of malfunction caused by equipment behaviour.

E.5.3 TECHNICAL ENVELOPE

a) Kahramaa shall determine and periodically revise the operational characteristics forming the Technical Envelope by taking into account the prevailing ETN and Generating Facility conditions as described in E.11.1. In determining and revising the Technical Envelope, Kahramaa shall consider matters such as:

1. Forecast of total EPS load;

2. Operating capabilities of Generating Facility contributing to EPS Security;

3. Contingency capacity reserves available to handle any Credible Contingency Event;
4. Advised generation minimum load constraints;
5. Constraints on transmission networks, including short term limitations;
6. The existence of proposals for any major equipment or Generating Facility testing, including the checking of, or possible changes in, transmission assets Availability; and
7. Applicable Performance Standards for Grid Users as declared in PC (section B).

b) Kahramaa must, when determining the secure operating limits of the ETN, assume that the applicable Performance Standards are being met, subject to:

1. a Grid User notifying Kahramaa that a performance standard is not being met; or
2. Kahramaa otherwise becoming aware that a performance standard is not being met.

E.5.4 OPERATIONAL SECURITY LIMITS

a) Kahramaa shall specify the Operational Security Limits for each element of ETN, taking into account at least the following physical characteristics:

1. Voltage limits in accordance with E.5.6;
2. Short-circuit Current limits according to E.5.8; and
3. Current limits in terms of thermal rating including the transitory admissible overloads.

b) When defining the Operational Security Limits, Kahramaa shall take into account the capabilities of Significant Grid Users to prevent that voltage ranges and frequency limits in Normal and Alert States lead to their disconnection.

c) In case of changes of ETN elements, Kahramaa shall validate and where necessary update the Operational Security Limits.

E.5.5 FREQUENCY CONTROL AND ACTIVE POWER MANAGEMENT

a) Frequency Control is necessary to stabilize the frequency deviations and to recover frequency at 50 Hz using power reserves. It is built by the aggregation of three staged control modes: primary control (within seconds), secondary control (from seconds to minutes) and tertiary controls (mobilization of stand-by Generating Units from minutes to hours).

b) Primary and secondary Frequency Control is performed by load Frequency Control systems implemented in Generating Units. The combination of primary and secondary controls in terms of power volume and response time allows the NCC to keep the system frequency within the ranges defined in E.4.1 in Normal and in Alert States.

c) Generating Units participating in frequency control shall declare, periodically and on a time period defined by Kahramaa, the level of participation in load frequency control (ability, amount of participating MW per type of reserve).

d) Failure to bring declared primary, secondary and tertiary reserve or to participate, as declared by Generating Units are considered violations of Grid Code and detailed report including causes and remedial actions shall be shared with Kahramaa by respective Generating Units.

E.5.5.1 PRIMARY FREQUENCY CONTROL

The goal of the Primary Frequency Control is, using enough primary power reserve, to stabilize the frequency deviation after a sudden change in frequency due to a generation-demand imbalance.

a) Primary Frequency Control provides primary reserves delivered by operated Generating Units having enough available rotating power reserve to increase power (in case of frequency fall) or decrease power (in case of frequency raise). It is activated automatically by the Frequency Control System of the Generating Units participating to primary reserve. Full activation (e.g. delivery of the full power available for primary Frequency Control) takes place in the period of up to 30 s.

b) Kahramaa shall define, according to RGCC (section D), the parameters used by Generating Units and operated in FSM or in L-FSM.

c) Kahramaa shall monitor in real time the performances of the primary Frequency Control (considering the stabilization of the frequency) as well as individual contributions of Generating Units.

E.5.5.2 SECONDARY FREQUENCY CONTROL

a) The goal of the secondary Frequency Control is, using enough secondary power reserve, to restore the frequency at its original value observed before the frequency changes.

b) Secondary Frequency Control provides secondary reserves delivered by operated Generating Units able to increase or decrease power according to an automatic or manual action changing the power Set Point of the Generating Unit. Secondary Frequency Control takes place in the time scale from 30 s up to 30 min after the change in frequency.

c) Kahramaa shall define, according to RGCC (section D), the parameters used by Generating Units selected to be operated in secondary control.

d) Kahramaa shall monitor in real time the performances of the secondary Frequency Control as well as individual contributions of the Generating Units.

E.5.5.3 TERTIARY CONTROL

a) Tertiary control provides tertiary reserve and frees up secondary reserve. It is activated by the NCC rescheduling Generating Units including units that are held as tertiary reserve.

b) Tertiary reserve comprises Generating Units having been declared available but not previously scheduled to be synchronized and with the capability to be synchronized within 30 min. Generating Units that are available to synchronize however outside this time scale are considered to be re-scheduled by the NCC.

E.5.6 VOLTAGE CONTROL AND REACTIVE POWER MANAGEMENT

a) Kahramaa shall endeavour to ensure that during Normal State the voltage remains in Steady State conditions at the Connection Points of the ETN within the ranges specified in the table mentioned in RGCC.

b) Kahramaa shall endeavour to ensure that, during Normal State and after the occurrence of a contingency, the voltage remains, within wider voltage ranges for limited times of operation in RGCC.

c) If voltage at a Connection Point of the ETN is outside the ranges defined in RGCC, Kahramaa shall apply remedial actions based on voltage control and reactive power management in order to restore voltage at the Connection Point within the range specified and within time range specified.

d) Kahramaa shall ensure reactive power reserve, with adequate volume and time response, in order to keep the voltages on the ETN and on interconnectors within the ranges set out in RGCC.

e) Kahramaa shall be entitled to use all available transmission-connected reactive power capabilities for effective reactive power management and maintaining the voltage ranges.

f) Kahramaa shall define the reactive power Set-Points, Power Factor ranges and voltage Set Points for voltage control at the interface between the ETN and the Bulk Customers and the Distribution Systems, the usage of use reactive power resources and rights to give voltage control instructions to distribution-connected Grid Users.

g) Kahramaa shall, directly or indirectly, operate reactive power resources, including the blocking of automatic voltage/reactive power control of transformers, voltage reduction and low voltage demand disconnection, in order to maintain Operational Security Limits and to prevent a voltage collapse of the EPS.

E.5.7 POWER FLOW MANAGEMENT

a) Kahramaa shall maintain power flows within the Operational Security Limits defined in E.5.3 when the EPS is in Normal State, and after the occurrence of a contingency from the contingency list referred to in E.5.10.

b) In listed contingency situation, in the Normal State, Kahramaa shall maintain power flows within the transitory admissible overloads having prepared remedial actions to be applied and executed within the time frame allowed for transitory admissible overloads.

E.5.8 SHORT-CIRCUIT CURRENT MANAGEMENT

a) Kahramaa shall determine the maximum short-circuit current at which the rated capability of circuit breakers and other equipment is exceeded, and the minimum short-circuit current for the correct operation of protection equipment.

b) Kahramaa shall perform short-circuit current calculations in order to evaluate the impact of SGUs on the short-circuit current levels on the ETN. Where a connected

Distribution System has an impact on short-circuit current levels, it shall be included in the ETN short-circuit current calculations.

c) While performing short-circuit current calculations, Kahramaa shall use the most accurate and high-quality available data, take into account International Standards (IEC 60909) and consider operational conditions delivering the maximum level of short-circuit current.

d) Kahramaa shall apply operational and other measures to prevent deviations from the maximum and the minimum short-circuit current limits at all time frames and for all protection equipment. A deviation from those limits is allowed only during switching sequences.

e) The ETN topology shall be defined in order to not violate short circuit rating due to any equipment outage or any other circumstances.

E.5.9 AVAILABILITY OF MEANS, TOOLS AND FACILITIES

Kahramaa shall ensure the availability, reliability and redundancy of the following items:

a) Facilities for monitoring the system state of the EPS, including state estimation applications and facilities for Load-Frequency Control;

b) Means to control the switching of circuit breakers, coupler circuit breakers, transformer tap changers and other equipment which serve to control ETN elements;

c) Means to communicate with the control rooms, Generating Facilities and regional control centres; and

d) Tools for operational security analysis.

E.5.10 CONTINGENCY EVENT ANALYSIS

E.5.10.1 CONTINGENCY EVENT LIST

a) The Technical Envelope shall be used as the basis of determining events considered to be credible contingency events at a defined time.

b) Kahramaa shall establish a contingency event list, including the internal and external events, by assessing whether any of those contingency events endanger the Operational Security. The list shall include identified contingencies.

c) Establishing a contingency event list, Kahramaa shall classify each contingency event on the basis of whether it is credible, non-credible or beyond-design basis, taking into account the frequency of occurrence of the event.

E.5.10.2 CONTINGENCY ASSESSMENT

a) Kahramaa shall perform Contingency Analysis based on the forecast of operational data and on real-time operational data. The starting point for the Contingency Analysis in the N-situation situation shall be the relevant topology of the ETN which shall include planned outages in the operational planning phases.

b) Kahramaa shall ensure that the real-time data is sufficiently accurate to allow the convergence of load-flow calculations which are performed in the Contingency Analysis;

c) Kahramaa shall identify the contingencies which endanger or may endanger Operational Security;

d) Kahramaa shall assess:

1. the Risks associated with the contingencies after simulating each contingency from its contingency list and after assessing whether it can maintain the EPS within the Operational Security Limits in the N-situation; and
2. the remedial actions that may be necessary to address the consequences of the contingencies, including mitigation of the impact of contingencies with unacceptable Risks.

e) When Kahramaa assesses that the Risks associated with a listed contingency are so significant that it might not be able to prepare and activate remedial actions in a timely manner to prevent non-compliance with the N-situation criterion or that there is a Risk of propagation of a disturbance to the interconnected GCCIA power systems, Kahramaa shall prepare and activate mitigation actions to achieve compliance with the N-situation criterion as soon as possible.

f) In case of an N-situation caused by a disturbance, Kahramaa shall activate a remedial action in order to ensure that the EPS is restored to a Normal State as soon as possible and that this N-situation situation becomes the new N-situation situation.

g) Kahramaa shall not be required to comply with the N-situation criterion in the following:

1. During switching sequences; and
2. During the time period required to prepare and activate remedial actions.

h) Unless the Authority determines otherwise, Kahramaa shall not be required to comply with the N-situation criterion as long as there are only local consequences.

Listed contingencies		N-situation	Operational planning criteria
Faults on individual grid components	400kV towers	N-1	- Frequency deviations less than maximum quasi Steady State frequency deviation and non-automatic load shedding - Voltage deviations in the range of the table 0 - Loads (A) lower than rating of circuits and transformers. - Maximum short-circuit current corresponding to the short-circuit in the immediate vicinity of the downstream terminals of the protection device lower than the rated short-circuit breaking Current.
	Transformers		
	Busbar (as necessary)		
	Overhead lines		
	Cables or feeders		
Loss of generation	Generating Unit	Largest	
Load shedding	demand disconnected simultaneously		

Table E.5-1: Listed contingencies and planning criteria for operation

E.5.11 PROTECTIONS

E.5.11.1 GENERAL REQUIREMENTS

a) Kahramaa shall operate the EPS with the primary protection and backup protection equipment in order to automatically prevent the propagation of disturbances that could endanger the Operational Security of the EPS and of the interconnected GCCIA power systems.

b) Kahramaa shall review its protection strategy and concepts when required and update when and where necessary to ensure the correct functioning and the maintenance of the protection.

c) Kahramaa shall specify Set Points for the protection equipment of the ETN that ensure reliable, fast and selective fault clearing, including backup protection for fault clearing in case of malfunction of the primary protection system.

d) Before entry into service of protection and backup protection equipment or following any modifications, Kahramaa shall agree with the neighbouring TSOs on the definition of protection Set Points for the interconnectors and shall coordinate with those TSOs before changing the settings.

e) The Grid Users shall coordinate and agree with Kahramaa when they intend to revise the settings of their protections.

f) Simultaneously failure of primary and backup protection for any equipment shall restrict the use of the same equipment even if it results in N-situation unless authorized by relevant Authority.

E.5.11.2 SPECIAL PROTECTION SCHEMES

Where using a special protection scheme, Kahramaa shall:

a) Ensure that each special protection scheme acts selectively, reliably and effectively;

b) Evaluate, when designing a special protection scheme, the consequences for the EPS in the event of its incorrect functioning;

c) Verify that the special protection scheme has a comparable reliability to the protection systems used for the primary protection of EPS elements;

d) Operate the EPS with the special protection scheme within the Operational Security Limits determined in accordance with E.5.3;

e) Coordinate special protection scheme functions, activation principles and Set Points with neighboring TSOs and affected SdFs; and

f) When Generating Facility, Demand Facility or neighboring TSO use special protection scheme, it shall be communicated and agree with Kahramaa.

E.5.12 SECURITY PLAN FOR CRITICAL INFRASTRUCTURE PROTECTION

a) Kahramaa shall elaborate a confidential Security Plan containing a Risk assessment of its owned or operated assets, covering major physical or cyber threat scenarios.

b) The Security Plan shall consider potential impacts to the GCCIA and include organizational and physical measures aiming at mitigating the identified Risks.

c) Kahramaa shall review every 3 years the Security Plan to address changes of threat scenarios and reflect the evolution of the EPS.

E.6 OPERATING PROCEDURES

E.6.1 OPERATION OF THE ELECTRIC TRANSMISSION NETWORK

a) The ETN is controlled, operated and maintained by Kahramaa under operating procedures elaborated by Kahramaa including System Operation Memorandums (SOM).

b) Operating procedures are prepared for the proper understanding and performance of network operations and for the safety of Kahramaa employees and others against injury in the course of action of their duties.

c) Operational procedures:

1. are elaborated for different time scales (year, month, week and day), and are considering:

   i. The operational forecast of the system Demand;

   ii. The planning and scheduling of the outages of ETN elements (Generating and demand Units, transmission components…);

   iii. The operating programs of the ETN;

   iv. The planning and the dispatching of the Generating Units;

   v. The control of the frequency and of the voltage at the power stations; and

   vi. The operational liaison between Kahramaa and concerned Grid Users.

2. are covering:

   i. Relations and coordinated operation between NCC and Generating and Demand Facilities;

   ii. Operational responsibility between NCC and other control centres;

   iii. Operation and maintenance rules and special precautions for systems and components of the ETN; and

   iv. Safety documents and their issuance and cancelation procedures as per type of work.

d) With regard to coordination with water production, operating procedures and SOM shall take into account water production constraints and limits for facilities producing simultaneously water and power.

E.6.2 OPERATIONAL DEMAND FORECAST

E.6.2.1 INTRODUCTION

Operating procedures are covering the preparation of Demand Forecasts for the following purposes:

a) Preparation of the yearly operating program;

b) Preparation of the monthly operating program;

c) Preparation of the weekly operating program; and

d) Preparation of the Daily Generation Program.

E.6.2.2 OBJECTIVE

This paragraph identifies:

- The main sources of information to be used by Kahramaa in the preparation of the Demand Forecasts;
- The factors to be taken into account by Kahramaa in the preparation of the Demand Forecasts; and
- The procedures which will ensure that the Demand Forecasts for different time scales are produced on a consistent basis.

In producing yearly, monthly, daily and weekly forecasts, Kahramaa shall take account of:

a) The Demand Forecasts used in the production of the three-year operating program;

b) The Demand Forecasts and load factors extracted from the load forecast for the EPS;

c) Historic records of electricity sales;

d) Historic records of peak days;

e) The reserve policy determined under E.7.1; and

f) Any other information that Kahramaa, in its reasonable opinion, believes is relevant.

E.6.2.3 YEARLY DEMAND FORECAST

a) For each month of the yearly operating program, the following values shall be forecast by Kahramaa:

   1. The volume of electricity sales;
   2. The volume of electricity used in Substations and ETN losses;
   3. The day peak and evening peak; and
   4. The reserves required.

b) The Demand Forecasts shall be completed by the end of November of the year preceding the year for which the yearly operating program is to be produced.

E.6.2.4 MONTHLY DEMAND FORECAST

a) For each day of the monthly operating program, the following values shall be forecast by Kahramaa:

   1. The volume of electricity sales;
   2. The volume of electricity used in substations and ETN losses;
   3. The day peak and evening peak; and
   4. The reserve required.

b) The Demand Forecasts shall be completed by the end of third week of the month preceding the month for which the monthly operating program is to be produced.

E.6.2.5 WEEKLY DEMAND FORECAST

a) For each day of the weekly operating program, the following values shall be forecast by Kahramaa:

1. The volume of electricity sales;
2. The volume of electricity used in station services and ETN losses;
3. The day peak and evening peak; and
4. The reserve required.

b) In producing these forecasts, Kahramaa shall take account of the weather forecast for the week for which the Weekly Generation Program is to be prepared.

c) The Demand Forecasts shall be completed prior to the end of the week preceding the week for which the weekly operating program is to be produced.

E.6.2.6 DEMAND FORECAST FOR DAILY GENERATION PROGRAM

a) For each hour of the Daily Generation Program, the following values shall be forecast by Kahramaa:

1. The total Demand to be met in Substations and ETN losses; and
2. The power reserve required.

b) In addition, Kahramaa shall forecast the value of the day peak and the Equipment Certificate, and the hours in which they will fall.

c) In producing these forecasts, Kahramaa shall take account of the weather forecast for the day for which the Daily Generation Program is to be prepared.

d) The Demand Forecasts defined for weeks and days shall be completed by 10:00 hours on the day preceding the day for which the Daily Generation Program is to be produced.

E.6.3 MAINTENANCE SCHEDULING

Schedule OC-MS lists the data and information Generating Facility operators shall declare when planning outages.

E.6.3.1 INTRODUCTION

This chapter regulates the coordination of the maintenance of the Generating Units with the operation of the ETN (at Delivery Point) and the release of Generating Units for construction, repair and maintenance purposes.

The resulting maintenance schedule produced by Kahramaa has been prepared with full regard to the contents of the relevant operating programs and the Daily Generation Program to ensure the matching of generation output with Demand Forecast (including an allowance for operating reserve) produced in accordance with Demand Forecasting.

In this procedure, year 0 means the current Calendar Year, year 1 means the next Calendar Year, year 2 means the Calendar Year after year 1, and so on.

a) Where information must be submitted on a Non-Business Day, the information shall be submitted on the last Business Day before the due day.

b) Whilst Kahramaa will make every reasonable endeavour to accommodate the Generating Facility operator' requests for scheduled outages at particular dates, considerations of system stability and economics may impose that such requests cannot be granted. Kahramaa's decision on outage dates is final and binding, and shall be confirmed, if necessary, to achieve compliance, by the issuing of a Directive.

E.6.3.2 OBJECTIVE

The objective is to enable Kahramaa to harmonize the outages of all Generating Units and the ETN, whilst:

a) Maintaining sufficient available Generating Unit and ETN capacity to meet the Demand Forecast, including operating reserve; and

b) Minimizing the system cost when releasing Generating Units for outage.

E.6.3.3 MAINTENANCE SCHEDULING: YEARS 1

a) On the first day of each Calendar Year each Generating Facility operator will provide Kahramaa, in writing, with a provisional outage program for Calendar Year 1, giving for each of its Generating Units:

   1. The identification of the Generating Unit;
   2. The MW of capacity involved;
   3. Where the outage is for statutory or insurance inspection reasons, the reason for the outage and the date by which the work must be completed;
   4. The expected duration of the outage, in days and weeks;
   5. The preferred start date for the outage;
   6. Where there is a possibility of flexibility in the dates, the earliest start date; and
   7. The latest finish date.

b) Between the first day of each Calendar Year and the end of week 12 of the year Kahramaa will:

   1. Prepare a maintenance schedule for Calendar Year 1, taking account of the following:
      i. The Demand Forecast as laid down in the load forecast for the EPS;
      ii. The maintenance schedule prepared in the previous Calendar Year for year 1;
      iii. The submissions from the Generating Facility operators;
      iv. The requirements for ETN outages;
      v. The need to minimize, as far as is practicable, the total system costs of the required outages; and

vi. Any other factors which, in Kahramaa's is reasonable opinion, are relevant.

2. Provide each Generating Facility operator, in writing and in respect of each of its Generating Units for which an outage was requested, with the dates on which it is proposed the outages will start and finish.

c) Where a Grid User is not satisfied with the outage program allocated to any of its Generating Units, it shall contact Kahramaa in writing, and no later than the end of week 16 of the Calendar Year, to explain its concerns. Kahramaa and the Grid User shall discuss the concerns and seek to resolve the problem. Where, in Kahramaa's reasonable opinion, the change requested by the Grid User does not threaten System Security or cause unreasonable additional costs to the EPS, Kahramaa shall agree to the change. If the possible resolution of the problem requires the involvement of other Grid Users, Kahramaa may arrange a meeting with the Grid Users involved.

d) By the end of week 26 of the Calendar Year each Generating Facility operator will submit to Kahramaa an updated provisional outage generation. In the same form and covering the same information, which shall take account of any revisions to that Generating Facility operator's outage requirements and any revisions to the outage program agreed under E.6.3.3; and

e) By the end of week 32 of the Calendar Year, Kahramaa will:

1. Revise and issue a preliminary maintenance schedule for Calendar Year 1, taking account of:

   i. the maintenance schedule produced;

   ii. any changes to the maintenance schedule agreed;

   iii. any revisions to a Generating Facility operator's provisional outage program submitted;

   iv. the requirements for ETN outages;

   v. assess the total costs to the EPS of the requested outages; and

   vi. any other factors which in Kahramaa's reasonable opinion are relevant.

2. Provide each Generating Facility operator, in writing and in respect of each of its Generating Units for which an outage was requested, with a preliminary outage program on which it is proposed the outages will start and finish dates.

f) Where a Grid User disagrees with the outage program allocated to any of its Generating Units it shall contact Kahramaa, in writing and no later than the end of week 34 of the Calendar Year, to explain its concerns. Kahramaa and the Grid User shall discuss its concerns and seek to resolve the problem. Where, in Kahramaa's reasonable opinion, the change requested by the Grid User does not threaten System Security or cause unreasonable additional costs to the EPS, Kahramaa shall agree to the change. If the possible resolution of the problem requires the involvement of other Grid Users, Kahramaa may arrange a meeting with the Grid Users involved.

g) By the end of week 44 of the Calendar Year, Kahramaa shall have:

1. produced a final version of the maintenance schedule (the final maintenance schedule) for Calendar Year 1, substantially based upon the maintenance schedule

produced and incorporating, without material deviation, any changes agreed under; and

2. provided each Generating Facility operator, in writing and in respect of each of its Generating Units for which an outage was requested, with the dates on which it is proposed the outages will start and finish.

E.6.3.4 MAINTENANCE SCHEDULING: YEAR 0

E.6.3.4.1 BASIS

The basis for the maintenance schedule for Calendar Year 0 will be Calendar Year 1 of the final maintenance schedule produced and issued at the end of week 48 of the previous Calendar Year.

E.6.3.4.2 INFORMATION

In respect of outages in Calendar Year 0 which are either not included in the final maintenance schedule or for which some parameter has changed, each Generating Facility operator will promptly inform Kahramaa, in writing, with the following details for each of its Generating Units concerned:

a) the identification of the Generating Unit;

b) the MW of capacity involved;

c) where the outage is for statutory or insurance inspection reasons, the reason for the outage and the date by which the work must be completed;

d) the expected duration of the outage, (and the original agreed duration, as shown in the final maintenance schedule, if appropriate) in days and weeks;

e) the preferred start date for the outage; (and the original agreed start date, as shown in the final maintenance schedule, if appropriate);

f) the provisional outage program submitted; and

g) where there is a possibility of flexibility in the dates, the earliest start date and the latest finish date.

E.6.3.4.3 MONTHLY MAINTENANCE SCHEDULE

a) In respect of outages in Calendar Year 0 which are either included in the final maintenance schedule or for which a request for outage has been made under E.6.3.4, each Generating Facility operator will, by the end of week 2 of each month provide Kahramaa, in writing, with the following details for the next two complete months and for each of its Generating Units for which an outage is required:

   1. the identification of the Generating Unit;
   2. the MW of capacity involved;
   3. where the outage is for statutory or insurance inspection reasons, the reason for the outage and the date by which the work must be completed;

4. the expected duration of the outage, (and the duration agreed with Kahramaa, if appropriate) in weeks, days and hours;
5. the preferred start time and date for the outage; (and the start time and date agreed with Kahramaa, appropriate); and
6. where there is a possibility of flexibility in the times or dates, the earliest start time or date and the latest finish time or date.

b) During the 4th week of each month of Calendar Year 0, Kahramaa will examine the maintenance schedule for the next following month and revise it as necessary, taking account of:

1. the final maintenance schedule for the relevant month of Calendar Year 0;
2. any revisions to the Demand Forecast for the relevant month as produced;
3. any requests for either new outages or revisions to planned outages made by the Generating Facility operators; and
4. any other factors which, in Kahramaa's reasonable opinion, are relevant.

c) By not later than 10 days prior to the commencement of each month Kahramaa shall have:

1. produced a final version of the maintenance schedule (the monthly maintenance schedule) for the next following month, based upon the maintenance schedule produced; and
2. provide each Generating Facility operator, in writing and in respect of each of its Generating Units for which an outage was requested, with the dates on which it is pro-posed the outages will start and finish;

d) In event of breakdown at Generating Facility or in transmission network resulting reduction in forecasted generation, Kahramaa shall modify maintenance schedule, if it deems necessary, in best economic way to accommodate unforeseen breakdown at the earliest possible duration.

E.6.3.4.4 WEEKLY MAINTENANCE SCHEDULE

a) In respect of outages in Calendar Year 0 which are either included in the monthly maintenance schedule and for which dates have been agreed or for which a request for outage has been made, each Generating Facility operator will, by 12:00 hours each Monday provide Kahramaa, in writing, with the following details for the next two complete Calendar Weeks and for each of its Generating Units for which an outage is required:

1. the identification of the Generating Unit;
2. the MW of capacity involved;
3. where the outage is for statutory or insurance inspection reasons, the reason for the outage and the date by which the work must be completed;
4. the expected duration of the outage, (and the duration agreed with Kahramaa, if appropriate) in weeks, days and hours;

5. the preferred start time and date for the outage; (and the start time and date agreed with Kahramaa, if appropriate); and
6. where there is a possibility of flexibility in the times or dates, the earliest start time or date and the latest finish time or date.

b) During the period from 12:00 hours on Monday to 12:00 hours on Wednesday of the week concerned, Kahramaa will examine the maintenance schedule for the next following week and revise it as necessary, taking account of:

1. the monthly maintenance schedule for the relevant week of Calendar Year 0;
2. any revisions to the Demand Forecast for the relevant week as produced;
3. an estimate of the current capacity available from Generating Units and the ETN and an assessment of this capacity which may become unavailable for unplanned reasons;
4. any requests for outages made by the Generating Facility operators under maintenance schedules previously announced; and
5. any other factors which, in Kahramaa's reasonable opinion, are relevant.

c) By 12:00 hours on each or the last working day of a week Kahramaa shall have:

1. produced a final version of the maintenance schedule (the weekly maintenance schedule) for the next following week, based upon the monthly maintenance schedule produced; and
2. provide each Generating Facility operator, in writing and in respect of each of its Generating Units for which an outage was requested, with the dates on which it is pro-posed the outages will start and finish.

d) In event of breakdown at Generating Facility or in ETN reducing the forecasted generation, Kahramaa may modify maintenance schedule in best economic way to accommodate unforeseen breakdown at the earliest possible duration.

E.6.3.4.5 DAILY MAINTENANCE SCHEDULE

a) In respect of outages in Calendar Year 0 which are either included in the weekly maintenance schedule and for which dates have been agreed or for which a request for outage has been made, each Generating Facility operator will, between 08:00 and 10:00 hours each day provide Kahramaa, in writing, with the following details for the next following day and for each of its Generating Units for which an outage is required:

1. the identification of the Generating Unit;
2. the MW of capacity involved;
3. the expected duration of the outage, (and the duration agreed with Kahramaa, if appropriate) in weeks, days and hours;
4. the preferred start time and date for the outage (and the start time and date agreed with Kahramaa, if appropriate); and
5. where there is a possibility of flexibility in the times or dates, the earliest start time or date and the latest finish time or date.

b) During the period from 10:00 hours to 13:30 hours on each day, Kahramaa will examine the maintenance schedule for the next following day and revise it as necessary, taking account of:

1. the weekly maintenance schedule for the relevant day;
2. any revisions to the Demand Forecast for the relevant week as produced in accordance;
3. an estimate of the current capacity available from Generating Units and the ETN and an assessment of this capacity which may become unavailable for unplanned reasons;
4. any requests for outages made by the Generating Facility operators; and
5. any other factors which, in Kahramaa's reasonable opinion, are relevant.

c) By 13:30 hours on each day Kahramaa shall have:

1. produced a final version of the maintenance schedule (the Daily Maintenance Schedule) the next following day, based upon the weekly maintenance schedule produced; and
2. inform any Generating Facility operator for which an outage has been agreed for any of its Generating Units in respect of the next following day as to whether or not the Generating Unit can be released for its outage.

d) In event of breakdown at Generating Facility or in ETN reducing the forecasted generation, Kahramaa may modify maintenance schedule in best economic way to accommodate unforeseen breakdown at the earliest possible duration.

E.6.4 OPERATIONAL PLANNING

This chapter regulates the production of the operating programs over the time scales of 1 year and 1 month. The preparation of the operating programs requires the matching of forecast generation output with the Demand Forecast, including operating reserve. The operating programs and the maintenance schedules produced under E.6.3, are developed in parallel.

E.6.4.1 OBJECTIVE

The operating programs:

a) defines the conditions for system adequacy integrating Demand Forecast, generation capacity and operating margins;

b) integrates the planned generation and transmission outages taking account of the overall economics of system operation and the need to maintain system stability without hindering System Security;

c) optimizes the thermal regimes, taking account of forecast fuel restrictions, environmental constraints and other relevant issues; and

d) assists in the identification and solution of operational problems.

E.6.4.2 YEARLY OPERATING PROGRAM

a) The yearly operating program is prepared on a Calendar Year basis. It will show the following:

1. a statement of monthly generation output and Demand;
2. a generation and ETN outage program, prepared in accordance with E.6.3; and
3. provisions to develop gas savings.

b) Between the beginning of the Calendar Year and the beginning of January, Kahramaa will:

1. obtain the relevant Demand Forecasts;
2. produce a draft of the expected generation and transmission maintenance schedule for the year; and
3. establish a merit order of all Generating Facilities taking into account their priority dispatch and their forecast fuel availability and costs.

c) Before the beginning of January, Kahramaa will:

1. take account of any proposed or agreed changes to the Demand Forecast and the maintenance schedule;
2. optimise, as far as is practicable, the parallel operation of thermal Generating Facilities, taking account of any environmental restrictions and fuel restrictions;
3. determine the total EPS costs, including the costs of generation, the costs of restrictions resulting from generation and ETN outages; and
4. prepare a first draft of the yearly operating program for internal review.

d) Between the beginning of June and the end of August, Kahramaa will:

1. finalise the yearly operating program, taking account of any factors that Kahramaa, in its reasonable opinion, believes are relevant; and
2. issue the yearly operating program.

e) Kahramaa shall continually monitor the yearly operating program against any expected changes to the program. In the case of ‘significant problems’ that will have, or may have, an effect on the expected operation, Kahramaa will consider if, in its reasonable opinion, the yearly operating program will need to be revised and re-issued. In such a case, Kahramaa will carry out such investigations and actions, as it deems necessary. Examples of the "significant problems" would be (but not limited to) the long run breakdown of a Generating Unit or a major breakdown in ETN or significant postponement of generation or ETN investments.

E.6.4.3 MONTHLY OPERATING PROGRAM

The monthly operating program is prepared on a calendar month basis and is based upon the relevant month of the yearly operating program. It will show a statement of daily generation output and Demand, and a generation and ETN outage program, prepared in accordance with E.6.3.

a) By no later than ten (10) days prior to the commencement of the relevant month, Kahramaa will:

1. obtain the relevant Demand Forecasts;
2. produce a draft of the expected generation and transmission maintenance schedule for the month;
3. optimise, as far as is practicable, the parallel operation of thermal Generating Units, taking account of environmental restrictions and fuel restrictions;
4. establish a Merit Order of all Generating Units taking into account their forecast fuel availability and costs;
5. determine the total EPS costs, including the costs of generation, the costs of restrictions resulting from generation and ETN outages and the costs of redispatching operation of thermal Generating Units; and
6. issue the monthly operating program.

b) In event of major breakdown at the ETN resulting reduction in capacity of transmission, Kahramaa shall modify maintenance schedule, if it deems necessary, in best economic way to accommodate unforeseen breakdown at the earliest possible duration and Kahramaa shall modify ETN topology to accommodate uncontrollable outage, if it is required to maintain short-circuit limits and it may affect other planned outage.

E.6.5 GENERATION PLANNING

E.6.5.1 INTRODUCTION

This chapter regulates the production of the weekly operating program and the Daily Generation Program. It covers:

a) the submission to Kahramaa by the Generating Facility operators of an Availability Declaration and information on their current operating characteristics; and

b) the production and issue of the weekly operating program and the Daily Generation Program by Kahramaa.

E.6.5.2 OBJECTIVE

The objective is to enable Kahramaa to ensure that it receives sufficient information, in a timely manner, to allow for the production of optimal operating generations for 1 week ahead and 1 day ahead, taking account of:

a) Generating Unit Availabilities and operating characteristics;

b) Demand Forecasts;

c) System economics;

d) Environmental restriction and fuel supply restrictions; and

e) Constraints on the ETN.

E.6.5.3 WEEKLY OPERATING PROGRAM

The weekly operating program shall be prepared by Kahramaa in accordance with the rules laid down below:

a) The weekly operating program is prepared on a Calendar Week basis and is based upon the relevant week of the monthly operating program. It will show the following:

   1. a statement of expected daily Generating Facility production and Demand; and
   2. a generation and ETN outage program, at Connection Point, prepared in accordance with E.6.3.

b) Between 10:00-12:00 hours on each Sunday each Generating Facility operator shall submit to Kahramaa by means that have been agreed by Kahramaa the following information, in respect of each of their Generating Units and for the next following Calendar Week, the following information:

   1. availability Declaration stating the capacity at which the Generating Unit may be operated in any time period (given in a whole number of MW) and the start and finish times for each such time period;
   2. for any Generating Unit which has been declared as available and for which any operating characteristic (as listed in PC schedules) has a value which is different from the value of the equivalent registered operating characteristic or has a value which is different from that declared by the Generating Facility operator in its previous Declaration the Generating Facility operator shall give the following:
      i. New values of the operating characteristics;
      ii. The time from when this new value will apply; and
      iii. The time for which the new value is expected to apply.
   3. in the event of no Declaration being made in respect of an operating characteristic, Kahramaa shall assume that the last valid Declaration for this operating characteristic shall apply, or, if no previous valid Declaration has been made, that the value of the registered operating characteristic shall apply; and
   4. any restrictions on operation which may arise from environmental considerations.

c) By 12:00 hours on the Thursday or the last working day of the week before the start of the week to which the weekly operating program will refer, Kahramaa will:

   1. obtain the relevant Demand;
   2. produce a draft of the expected generation and ETN maintenance schedule for the week in accordance with E.6.3;
   3. establish a merit order of all Generating Units;
   4. determine the total EPS costs, including the costs of generation, the costs of restrictions resulting from generation and ETN outages and the costs of redispatch operation of Generating Units; and
   5. prepare the weekly operating program and issue it internally within Kahramaa and to each Generating Facility operator.

d) If the information shall be submitted or issued on Non-Business Day, Kahramaa shall have informed the Grid User, in writing, not less than 7 days prior to this revised day.

e) In the event that, in Kahramaa's reasonable opinion, the flexibility of operation of the Generating Units (as demonstrated by their current declared operating characteristics) is such that the scheduling of sufficient operating reserve is not possible, then Kahramaa may take the actions and the results of such actions will be reflected in the weekly operating program.

E.6.5.4 DAILY GENERATION PROGRAM

The Daily Generation Program shall be prepared by Kahramaa in accordance with the rules laid down below:

a) The Daily Generation Program is prepared on a daily basis and is based upon the relevant day of the weekly operating program. It will show the following:

   1. A statement of hourly power production, unit commitment and Demand; and
   2. A generation and ETN outage program.

b) Between 08:00 and 10:00 hours on each day, each Generating Facility operator shall submit to Kahramaa by facsimile (or by such other means as have been agreed by Kahramaa) the following information, in respect of each of their Generating Units and for the next following day, the following information:

   1. an availability Declaration stating the capacity at which the Generating Unit may be operated in any time period (given in a whole number of MW) and the start and finish times for each such time period;
   2. for any Generating Unit which has been declared available and for which any operating characteristic (as listed in PC schedules) has a different value from these registered or declared by the Generating Facility operator in a previous Declaration, the Generating Facility operator shall give the following:
      i. identification of the operating characteristic;
      ii. the new value of the operating characteristic;
      iii. the reason for changing the value of the operating characteristic;
      iv. the time from when this new value will apply; and
      v. the time for which the new value is expected to apply;
   3. In the event of no Declaration being made in respect of an operating characteristic, Kahramaa shall assume that the last valid Declaration for this operating characteristic shall apply, or, if no previous valid Declaration has been made, that the value of the Registered operating characteristic shall apply; and
   4. any restrictions on operation which may arise from environmental considerations.

c) By 14:00 hours on the day before the start of the day to which the Daily Generation Program will refer, Kahramaa will:

   1. obtain the relevant Demand Forecasts;
   2. produce a draft of the expected generation and ETN maintenance schedule for the day;
   3. establish a Merit Order of all Generating Units;

4. determine the total EPS costs, including the costs of generation, the costs of restrictions resulting from generation and ETN outages and the costs of redispatching operation of Generating Units; and
5. prepare the daily operating program and issue it internally within Kahramaa and to each Generating Unit operator.

d) In the event that, in Kahramaa's reasonable opinion, the flexibility of operation of the Generating Units (as demonstrated by their current declared operating characteristics) is such that the scheduling of sufficient operating reserve is not possible, then Kahramaa may take the actions and the results of such actions will be reflected in the daily operating program.

E.6.5.5 REVISIONS TO AVAILABILITY AND OPERATING CHARACTERISTICS

a) If at any time a Generating Facility operator finds that, in respect of any of its Generating Units any part of the last Declaration made under E.6.5 is no longer valid, it shall inform Kahramaa of this fact and the revised value or values (and the times for which they shall apply) without delay, by Control Telephony or such other means as Kahramaa might, from time to time agree, and shall confirm the same in writing within (1) hour (save that no revisions to any economic operating characteristic will be accepted).

b) In the event that a Generating Facility operator experiences a partial Forced Outage or a Forced Outage, then such event shall be advised without delay to Kahramaa. Any necessary revision to the last Declaration shall be made as soon as reasonably practical, and the Generating Facility operator shall keep Kahramaa reasonably informed of the likely time of the affected Generating Unit(s) being returned to the operating status originally declared.

E.6.6 GENERATION DISPATCH

E.6.6.1 INTRODUCTION

Generation scheduling and dispatch procedures are complementary to E.6.5. Generation dispatch subsection sets out the Procedures for Kahramaa to:

a) Issue dispatch Instructions to Generating Facility operators;

b) Give permission for a Generating Facility operator to take its Generating Unit out on planned outage; and

c) Re-optimise the Daily Generation Program.

All Instructions shall be given in the English language.

E.6.6.2 OBJECTIVE

The objective is to enable, as far as possible, Kahramaa to match continuously generation and Demand (together with an appropriate level of reserve) in an economic way, taking account of:

a) The intentions expressed in the Daily Generation Program, including the requirements to release Generating Units on Planned Outage;

b) The merit orders as derived under E.6.5; and

c) The preservation of the security and the reliability standards of the EPS.

E.6.6.3 INFORMATION TO BE USED

In making decisions on which Generating Units to dispatch and on the prudence of releasing Generating Units for planned outages, Kahramaa will take account of the following information to the extent that, in its reasonable opinion, is appropriate:

a) the Daily Generation Program, produced and issued in accordance with E.6.5.4, for the day in question;

b) the latest Availability Declaration or Declaration Of Operating characteristics made in respect of any Generating Unit;

c) the system frequency and network voltage as known to Kahramaa via the SCADA system; and

d) any other such information as Kahramaa, in its reasonable opinion, considers to be relevant.

E.6.6.4 DISPATCH INSTRUCTIONS

E.6.6.4.1 AUTOMATIC DISPATCH INSTRUCTIONS

The control of the active power Set Points of Generating Units is normally be carried out directly by the AGC program at the NCC, via the SCADA system. Kahramaa will advise a Generating Facility operator if Generating Units are being transferred to verbal or written dispatch control of active power.

All other dispatch instructions will normally be given in verbal form or, occasionally, in written form (in English).

E.6.6.4.2 ISSUE OF VERBAL OR WRITTEN DISPATCH INSTRUCTIONS

a) Dispatch Instructions relating to a particular day may be issued at any time during that day or, when operational reasons so dictate, at a time before the start of the day.

b) Dispatch Instructions are issued by Kahramaa directly to the Generating Facility operator at the relevant Generating Facility and include exchange of operator names. They shall be issued by Control Telephony or by such other means as has been agreed between Kahramaa and the Generating Facility operator. The format of Dispatch Instructions is defined in E.6.6.5.

c) All communications between the NCC and the Generating Facility operators shall be recorded.

d) The receipt of a dispatch Instruction must be formally acknowledged immediately by the Generating Facility operator indicating the Generating Facility operator's acceptance or non-acceptance of the Instruction. A Generating Facility operator may only refuse to accept an Instruction properly given by Kahramaa:

1. on the grounds of safety of personnel or Generating Facility; or
2. because the Instruction requires the Generating Unit to perform outside of its declared capabilities or, as the case may be, Kahramaa has not stated that the Instruction is issued under conditions of an Emergency State.

e) In the event that a Generating Facility operator experiences unforeseen difficulty in carrying out the Instruction, it shall inform Kahramaa of this fact without delay.

f) In addition to dispatch Instructions relating to the provision of active power, dispatch Instructions may include:

1. instructions to act in support of system frequency through the provision of reserve;
2. instructions to act in support of network voltage through the generation or consumption of reactive power (within the safe operating limits of the unit);
3. notice and changes of notice to synchronise by a given time;
4. instructions to synchronise or de-synchronise;
5. instructions relating to the energizing or tap positions of a generation transformer;
6. instructions relating to the operation of any protection equipment relating to the interface between the Generating Facility and the ETN;
7. instructions relating to the operation of any control equipment relating to the interface between the Generating Facility and the ETN (where this duty has been given to the Generating Facility operator through an Agreement between the Generating Facility operator and Kahramaa); and
8. instructions to change fuel (where this right is conferred on Kahramaa through an Agreement between Kahramaa and the Generating Facility operator).

E.6.6.4.3 ACTION REQUIRED FROM GENERATING FACILITY OPERATORS

With regards to E.6.6.4.2 e) and f) a Generating Facility operator:

a) shall comply with any Instruction properly given by Kahramaa without delay;

b) is required to achieve the following dispatch accuracy in the operation of its Generating Units:

1. synchronised or de-synchronised within approximately 5 minutes of the target time notified by Kahramaa;
2. where no specific target time is given then, other than for a synchronisation or de-synchronisation Instruction, the output level to which it is instructed will be achieved within approximately 2 minutes of the time it should have achieved if it changed output at its loading, or, as the case may be, de-loading rate; and
3. where a specific target time is given then, other than for a synchronisation or de-synchronisation Instruction, the output level to which it is instructed will be achieved within approximately 2 minutes of the target time.

c) Kahramaa may re-optimize the Daily Generation Program during the day.

E.6.6.5 DISPATCH INSTRUCTION PROTOCOL

E.6.6.5.1 VERBAL OR WRITTEN DISPATCH INSTRUCTIONS

a) Verbal or written dispatch Instructions are normally be given in the following form:

1. exchange of operator names;
2. identification of the specific Generating Unit (if it is not a Facility dispatch) to which the Instruction applies;
3. the duty which the Generating Unit / Facility is to perform or the output level to which it is instructed;
4. the start time at which the Generating Unit / Facility is to start complying with the Instruction (if this is different from the Instruction issue time);
5. where necessary, a target time by which the output level must be reached, or the Instruction must be completed; and
6. the issue time of the Instruction.

b) Dispatch Instructions for the control of the active power Set-Points of Generating Units are normally be given automatically from the AGC via the SCADA system.

Examples of the main types of Instructions to be given are shown below. In each example it is assumed that the required exchange of names has taken place. An Instruction can have both a start time and a target time, although not all possible combinations of these dates have been shown.

In each example the Instruction is for unit 3 /Facility to change output to 100 MW, with the Instruction given at 13:00 hours:

- In this first version, the implementation of the Instruction starts immediately: "unit 3/Facility to 100 MW, Instruction timed at 13:00 hours";
- In this next version, the implementation of the Instruction starts in one hour: "unit 3/Facility to 100 MW, start time 14:00 hours, Instruction timed at 13:00 hours"; and
- Finally, the Instruction is to achieve the instructed level by 13:30 hours: "unit 3/Facility to 100 MW at 13:30 hours, Instruction timed at 13:00 hours".

E.6.6.5.2 INSTRUCTION TO SYNCHRONIZE

a) In the case of an Instruction to synchronize, a loading Instruction is issued at the same time.

b) If such a loading Instruction is not included, then the Generating Unit should be synchronised and immediately loaded to its Minimum generation level. The Generating Facility operator shall report to Kahramaa that it has achieved this level.

c) In giving a Synchronisation Instruction, Kahramaa shall always comply with the notice to synchronise time given by the Generating Facility operator.

In the example below, unit 2 has been instructed to synchronise, with the Instruction issued at 08:00 hours. The notice to synchronise time for the Generating Facility operator is 4 hours:

- In this first example, the required synchronisation time is in line with the notice to synchronise time: "unit 2 synchronise at 12:00 hours, Instruction timed at 08:00 hours";
- If the required synchronisation time is later than required by the notice to synchronise time, the Instruction would be of the form: "unit 2 synchronise at 14:00 hours, Instruction timed at 08:00 hours".

E.6.6.5.3 INSTRUCTION TO DE-SYNCHRONISE

a) In case of an Instruction to De-Synchronise, (or "Shutdown") the required de-loading Instruction is assumed to be included.

b) In case where the Generating Unit is not required to immediately de-load and come off, a target time will be given.

In the examples below, unit 1 is running at 60 MW and has a De-Loading Rate of 6 MW/min. It is given a de-synchronisation Instruction at 11:00 hours. Based upon its De-Loading Rate it can de-synchronise by 11:10 hours.

- If unit 1 is required to de-synchronise as soon as possible, the Instruction is: "unit 1 shutdown, Instruction timed at 11:00 hours";
- If, however, unit 1 is required to De-Synchronise by 12:00 hours, the Instruction will be: "unit 1 shutdown at 12:00 hours, Instruction timed at 11:00 hours".

E.6.6.5.4 INSTRUCTION TO CONTROL FREQUENCY

a) Frequency Control is normally performed by the AGC of the Generating Units Active Power Set-Points.

b) Should NCC automatic frequency control not be available, one Generating Facility or more will be designated as the system Frequency Controller for a given length of time.

Example Instructions are:

- "Generating Facility operator 'X' to be system Frequency Controller for 1 hour 30 minutes, Instruction timed at 12:00 hours";
- "Generating Facility operator target frequency 50.1 Hz, Instruction timed at 12:00 hours".

E.6.6.5.5 INSTRUCTION TO PROVIDE OPERATING RESERVE

The Instruction to provide operating reserve will normally be given as part of a loading Instruction by NCC.

An example would be: "Generating Facility Total Output to 600 MW and 60 MW operating reserve, Instruction timed at 13:30 hours"

E.6.6.5.6 INSTRUCTION TO PROVIDE VOLTAGE SUPPORT

Unless the voltage support Instruction has with it an active power loading Instruction, the Generating Facility operator must maintain the active power output of its Generating Unit at the current instructed level.

Examples of voltage support Instructions would be of the form:

- "Maintain the substation 'Y' 220 kV busbar voltage at 225 kV, Instruction timed at 12:00 hours.
- "unit 1 increase/decrease reactive power output by 10 MVAr, Instruction timed at 12:00 hours";
- "unit 2 maximum/minimum reactive power output, Instruction timed at 12:00 hours".

E.6.6.5.7 HIGH LOAD NOTICE

For security purposes of the ETN, the Generating Facility operator shall notify the NCC before loading individual Generating Unit for more than ninety percent (90%) of each unit's capacity.

E.6.7 FREQUENCY AND VOLTAGE CONTROL

This chapter regulates the role of Kahramaa and of the Generating Units to maintain, as far as is reasonably possible, system frequency and voltage within the required operational limits.

E.6.7.1 SYSTEM FREQUENCY CONTROL

E.6.7.1.1 AUTOMATIC FREQUENCY CONTROL

a) Kahramaa shall:

1. be responsible for coordinating the scheduling of the operation of Generating Units in accordance with E.6.5, and issuing dispatch Instructions, in accordance with E.6.6, to control the frequency of the EPS; and
2. ensure that, as far as is practicable, sufficient operating reserve as laid down in E.6.7, has been scheduled and dispatched.

b) The system frequency of 50 Hz shall be maintained using the AGC system at the NCC.

c) When required by Kahramaa, Generating Facility operators shall operate their Generating Units under RGCC requirement “FSM” at all times and shall participate to secondary control.

E.6.7.1.2 FREQUENCY SYSTEM EMERGENCY

a) If system frequency falls, not transiently, to or below 49.5 Hz and no specific dispatch Instruction to the contrary is issued, then category S Generating Units participating to frequency control shall increase the output according to RGCC requirement “LFSM-U”, unless there are reasons of safety, of their personnel or Generating Facility not to do so.

b) If system frequency rises, not transiently, to or above 50.5 Hz and no specific dispatch Instruction to the contrary is issued, then:

1. Generating Units category S shall reduce their output of their synchronized Generating Units, according to RGCC requirement “LFSM-O”; and

2. Generating Units category P shall reduce their output according to RGCC requirement “Power Control as Function of Frequency”.

c) Such changes in output required in item a) and b) shall be made without reference to Kahramaa and shall be maintained until system frequency has returned to target system frequency or the Generating Facility operator has received a revised dispatch Instruction. In order to assist Kahramaa in its control of system frequency, Kahramaa shall be informed of the action taken as soon as practicable, and in any event within 5 min, after the change in system frequency to the defined level;

d) During a high frequency system emergency, Generating Units may be instructed to De-Synchronize even if this breaches the requirements of their current Declaration of minimum up-time and refusal of such Instruction is only allowed on the grounds of safety to personnel or Generating Unit;

e) If the flexibility characteristics are such that the scheduling of sufficient operating reserve is not possible, then Kahramaa will contact any Generating Facility operator for which the current declared operating characteristics provide enough flexibility for operation. Kahramaa may request that the Generating Facility operator provides revised values where appropriate.

E.6.7.2 ELECTRIC TIME CORRECTION

When receiving instruction from GCCIA-ICC for electric time correction, Kahramaa may adjust the relevant control settings of the AGC and report to GCCIA-ICC.

E.6.7.3 SYSTEM VOLTAGE CONTROL

E.6.7.3.1 RESPONSIBILITIES

a) Kahramaa shall decide on the reactive generation and reactive reserve capacity required and shall take account of such requirements in the scheduling and dispatch of Generating Units.

b) Generating Facility operators shall ensure that their each synchronized Generating Units are operated under the control of continuously acting AVR, which shall be set so as to maintain a constant terminal voltage to maintain the transmission voltage level at the target level declared by Kahramaa's dispatcher at Delivery Points and provide the reactive power and reactive reserve required to maintain voltage level.

c) At all times unless technical reasons preclude this mode of operation (which fact must be reported to Kahramaa without delay) or unless relieved of this obligation by Kahramaa.

E.6.7.3.2 EMERGENCY ACTION

a) In the event of a sudden drop in network voltage, Generating Facility operators must ensure that the additional MVAr output of their Generating Units is maintained until so instructed by Kahramaa, other than for reasons of safety, of either personnel or equipment. Generating Facility operators must increase the MVAr output to the maximum reactive power capability of the units when so instructed by Kahramaa.

b) In the event of a sudden rise in network voltage, Generating Facility operators must not take action to recover MVAr output lost on their Generating Units until so instructed by Kahramaa other than for reasons of safety, of either personnel or plant.

E.6.8 OPERATIONAL LIAISON

This chapter sets out:

a) the requirements for the exchange of information concerning operations (scheduled or planned action) and related to the operation of any part of the system);

b) the rules for the investigation in case of Incident;

c) the modes for communication & technical discussions for orientation between Kahramaa and Generating Facility operators to familiarize each other with the interfaces between electrical Connection Equipment and grid for safe & secure switching operation; and

d) the System Operation Memorandums (SOM) with mutual agreement between Kahramaa & Generating Facility operators/users to meet specific technical requirement of each other to perform switching operation & isolation. Such SOM should be circulated by Kahramaa to the all concerned in soft & hard format.

E.6.8.1 PROCEDURES RELATING TO OPERATIONS

a) In the case of an operation on any part of the ETN which has had or may have an Operational Effect or an Incident, Kahramaa shall notify the concerned Grid Users, as soon as reasonably possible.

b) In the case of an operation on any Generating Facility which has had or may have an Operational Effect, the Generating Facility operator shall report and notify Kahramaa, as soon as reasonably practical (and, in any event, before the operation is initiated, unless such delay would itself increase the Risk of an Operational Effect or an Incident) of the operation.

c) In the case of an operation notified to Kahramaa under the provisions of item b), Kahramaa shall itself notify any Grid Users whose operation may, in Kahramaa's reasonable opinion, be affected by the operation, as soon as is reasonably practical, of the operation.

d) On receipt of any notification of an operation, and subject to the provisions of item f), Kahramaa may contact the Grid User issuing the notification to seek clarification. The Grid User shall:

   1. provide the answers required; and
   2. circulate copies of the questions and answers to all recipients of the notification.

e) A notification and any response to any questions asked under item d) shall, subject to the provisions of item f):

   1. contains the name, position, organisation and full phone/fax addresses of the individual issuing the notification and the date and time of issue;
   2. describes the consequences of the Operational Effect or the Incident;

3. eventually, describes or proposes the immediate mitigation measures to be taken to prevent/fix/correct the Operational Effect or the Incident; and
4. be of sufficient detail to enable the recipient of the notification reasonably to consider and assess the Risks to its own operation and to put in place any reasonable plans which may be applicable to reduce this Risk.

f) Where Kahramaa is notified by a Grid User, under item b), of an operation and, under item c), notifies other Grid Users of this operation, Kahramaa shall include the name and organisation of the individual reporting the operation on behalf of the Grid User. Recipients of such a notification may seek clarification as if this individual had issued the notification to other Grid Users.

Examples of operations which are required to be reported include, but are not limited to, the following:

- the withdrawal of any item of Generating Facility equipment from service for outage or testing (other than as approved by Kahramaa), which may reduce the Reliability of the EPS; or
- the withdrawal of any item of ETN equipment from service for outage or testing (other than as approved by Kahramaa), which may reduce the Reliability of the EPS; or
- the carrying out of tests on any Generating Facility equipment even when this does not require the removal from service of this equipment; or
- the operation of any circuit breaker or isolating device or Earthing Device, other than under Instruction from Kahramaa; or
- any other instance of non-standard operation which the Grid User has to instigate, other than when it is so instructed by Kahramaa.

E.6.8.2 PROCEDURES RELATING TO INCIDENTS

E.6.8.2.1 INCIDENT REPORTING

a) Any Incident shall be reported as per Operational Effect according to E.6.8.1.

b) When a report of an Incident is given orally:

1. it will be dictated by the sender to the recipient;
2. and:
    i. unless the nature of the Incident requires immediate action to be taken, the recipient will record and repeat each phrase as it is received and on completion of the report the recipient shall read back the complete report to the sender who shall confirm that it is accurate; or
    ii. if the requirement to take immediate action has meant that the confirmation of the report required by item a) has not been obtained at the time the report was given, such confirmation must be sought from the sender by the recipient as soon as is reasonably possible.

E.6.8.2.2 SIGNIFICANT INCIDENT REPORTING

a) Kahramaa defines the criteria for classify reported Incidents as Significant.

b) In case of Significant Incident, Kahramaa may seek additional written reports from the Grid User reporting the Incident or, where the primary cause of the Incident was within the ETN, Kahramaa will prepare such a report itself. Such a report will contain details of the initial report given of the Incident and such other information as Kahramaa reasonably considers it necessary and has so informed the producer of the report.

c) Report produced pursuant to item a) shall be classed as a Significant Incident Report and shall be produced and issued to Kahramaa as soon as is reasonably practical. Kahramaa shall issue copies of any such report to any User who, in Kahramaa's reasonable opinion, has been, or could have been, affected by the Incident.

E.6.8.2.3 SIGNIFICANT INCIDENT MEETING

a) Where a Significant Incident Report has been produced and issued, the issuer or any recipient of that report may, if it believes that it is necessary, request Kahramaa, in writing, to convene a meeting of all interested parties to discuss the Incident (which request Kahramaa shall not unreasonably refuse).

b) Where there have been a series of Significant Incidents and the party requesting the meeting under item a) believes that they may be connected, that party may request that the meeting considers all such Significant Incidents.

c) Where it has been agreed that a meeting will be convened to discuss one or more Significant Incidents, Kahramaa will convene such a meeting as soon as reasonably practicable. All affected Grid Users will be invited to send a representative to the meeting, which Kahramaa will chair. The attendees will decide the procedures and rules of conduct of the meeting.

E.6.8.3 CONFIDENTIALITY

Grid Users shall treat all information received under OC-6.8 as confidential and shall only release this information to third parties (after consultation with Kahramaa):

a) where required to do so under any provision of the Grid Code;

b) where:

1. a contract between the Grid User and the third party requires such disclosure; and
2. the third party is connected to the ETN only via some facility owned by the Grid User and which is itself connected to, or is part of, the system; and
3. had the third party been connected directly to the ETN, it would have received the information in its own right.

c) where required to do so under any law or statute;

d) where the information has entered the public domain other than by this Grid User breaching the conditions of this subsection.

E.7 OPERATING RESERVES AND MARGINS

The operating margins comprise reserves mobilized in case of listed contingencies and reserves necessary to cover operating uncertainties on generation and Demand. Operating margins are defined in terms of power and energy, depending on usage.

E.7.1 RESERVE POLICY

a) In preparing Demand Forecasts, maintenance schedules, operating programs, and Daily Generation Program (and in dispatching generation or Demand), Kahramaa shall set the levels of contingency and operating reserves.

b) In scheduling and dispatching Generating Units, Kahramaa shall take account of the total cost of the fossil-fired Generating Units, the operating characteristics of the Generating Units and any other constraints on EPS operation.

c) The amounts of primary, secondary and tertiary and cold stand by reserves required is determined by Kahramaa having regard to historic trends in unplanned reductions of Generating Unit Availability, the intermittency of variable renewable power sources, the largest secured loss of generation and unplanned increases in Demand Forecast.

E.7.2 RESERVE FOR ELECTRIC TIME CORRECTION

Kahramaa shall define, in calculating operating reserves, the quantity of energy to add or to withdraw in operation to correct the electrical time deviation, which shall include:

1. the frequency Set-Point adjustments to return electrical time deviation to zero form UTC; and
2. the actions to increase or decrease the average system frequency by means of active power reserves.

E.8 MONITORING AND VERIFYING PERFORMANCES

E.8.1 OBJECTIVE

In order to allocate responsibilities for safe, secure, and economic operation of the ETN, Kahramaa needs to carry out certain testing to monitor, to investigate, and to verify the performances of Grid Users.

a) Kahramaa establish a procedure for verifying that the Grid Users are operating within their design, operating and other contractual requirements, as specified in the relevant Agreement between the Grid User and Kahramaa.

b) Kahramaa shall treat all information and data collected from Grid User pursuant to the provisions of this section as confidential.

E.8.2 MONITORING

a) Monitoring shall be either continuous or continuous for periods of time, and shall be done by monitoring, data recording, and analysis, or by such other methods as Kahramaa reasonably determines to be appropriate in the circumstances. Advance notification from Kahramaa to Grid Users may not be necessary in every case.

b) Data recordings may be performed by standard monitoring system as per RGCC or by specific data logging system.

c) Where a specific data logging system is used for monitoring, Kahramaa shall inform the Grid User and, on request from the Grid User, shall make available to the Grid User reasonable information in respect of the data recording and analysis system.

d) Monitoring may be carried out at any time by Kahramaa and may result, without the application of further testing, in the evaluation by Kahramaa of Grid Users' non-compliance.

e) Where the Grid User disputes a finding of non-compliance, Kahramaa shall provide the Grid User any data collected during the monitoring over the period of alleged non-compliance and such other documentation as may be reasonably necessary to prove evidence of non-compliance.

f) Performance parameters that Kahramaa shall monitor may include, but not limited to, the compliance with dispatch Instructions; and the compliance with RGCC including, without limitation:

   1. primary, secondary, tertiary and cold stand by operating reserve response provided by participating Generating Units;
   2. electrical parameters at the delivery point of the Generating Unit; and
   3. electrical parameters at the generator / PPM terminals of the Generating Units;

E.8.3 INVESTIGATION

a) Kahramaa may, if it suspects non-compliance by the Grid User, carry out complementary investigation to acquire or verify information relevant to Grid User's

Generating Facility and/or apparatus design, operation, or other contractual requirements under the Grid Code, or the existing agreement.

b) Investigation by Kahramaa usually applies to information not collected on a regular basis by means of monitoring. Kahramaa may, having given reasonable notice, send a coordinator or subcontractor to a Grid User's Site to investigate any equipment or operational procedure applicable to the Grid User Site is compliant with the Grid Code, Connection Agreement, and/or any other Agreement(s) between the Grid User and Kahramaa.

E.8.4 TESTING TO VERIFY PERFORMANCE

a) The verification of the performances may be derived from periodical check or from monitoring of performance during operation or during a specific test.

b) Kahramaa shall issue an Instruction for periodical check including the concerned Generating and Demand Facility, the period of time and the list of performances to be checked. Checks should be based as much as possible on data collected and observed in operation. Testing, if needed, is specified in compliance to RGCC "Requirements for testing for Generating Units category P", "Requirements for testing for Generating Units category S" and "Requirements for testing for Demand Facility".

c) Kahramaa may:

1. issue a dispatch Instruction and induce controlled EPS frequency or voltage conditions;
2. generate variations for the purpose of determining that the Generating Unit's response is in accordance with its declared Availability, system service capabilities, and/or operating characteristics; and
3. request from Generating Facilities to perform testing as specified in and in compliance to RGCC testing requirements.

d) If Kahramaa subcontracts testing work on a Grid User's site, then the Grid User and Kahramaa must be in agreement on the selection of a suitable subcontractor.

E.9 SAFETY REQUIREMENTS

E.9.1 INTRODUCTION

At times, Kahramaa and Grid Users may need to work on, or in close proximity to, each other's systems which are electrically interconnected. It will be, consequently, imperative that Kahramaa and Grid Users' personnel operate strictly in accordance with:

a) The latest release of approved Safety Rules (SR) which is Kahramaa's public prescription for works during control, operation and maintenance of the Kahramaa ETN. Safety Rules are designed for the protection of Kahramaa's employees and others against injury in the course of their duties and to ensure the safe and efficient operation of the Kahramaa's assets. Safety rules ensure safety of life, network, and equipment for such situations.

b) The latest release of the System Operation Memorandum (SOM) which is part of the Safety Rules and which provides detailed requirements and guidance on specific operational activities related to control, Operation & Maintenance of the Kahramaa ETN.

E.9.2 OBJECTIVE

In compliance with SR and SOM, the objective of this section is to set the specific requirements for Kahramaa personnel and Grid Users to operate the electrical interface and the Connection Point between the Generating or the Demand Facility and the ETN.

E.9.3 SAFETY REPRESENTATIVES

a) The roles and the responsibilities of the safety representatives are defined in the SR.

b) On Kahramaa side, the safety representative is the designated System Control Engineer or Field Engineer. On Grid User' side, this the responsibility for the facility operator to nominate a Grid User Authorized Person.

c) All the safety representatives must possess a valid Authority Certificate issued by Kahramaa Safety Authorization Committee, mentioning jurisdiction of respective safety representative.

E.9.4 SAFETY AT THE DELIVERY POINT

a) Depending on the activities needed at the Delivery Point (access, work, test, isolation, Earthing, handing over of site, release of equipment), a safety document as per SR is filled and validated by the safety representatives to set the demarcation of responsibility.

b) Each Grid User will cooperate with Kahramaa in developing safety documents on any matters that may be relevant for ensuring overall site safety and, in particular, the safety of the Delivery Point Equipment.

c) For situations requiring either modification or a change in operational practices with potential operational impact on a Grid User site, Kahramaa and the Grid User shall review the adequacy of overall site safety.

d) Where necessary, grounding and short-circuit facilities, as further detailed in Kahramaa's Safety Rules, shall be applied to Generating Facility and/or equipment at either side of the Delivery Point to allow work to be carried out safely at the Delivery Point or either side of the Delivery Point.

e) Grid Users shall be aware of clearance limits and shall perform work only within the approved clearance limits on the Grid User side of the Connection Point.

E.9.5 LOGS OF CROSS-BOUNDARY SAFETY PRECAUTIONS

a) Kahramaa and the Grid Users shall maintain proper logs (in chronological sequence) to record all messages relating to safety.

b) These logs shall be retained for at least two years.

E.9.6 AGREEMENT ON SAFETY DOCUMENTS

a) When Kahramaa or a Grid User wishes to carry out work on the system:

1. It is the responsibility of Kahramaa Field Engineer (in Kahramaa substation) and Grid User Authorized Person (in the Grid User utility) to decide the location at which the safety precautions will be implemented or applied and shall specify the proposed location(s) at which isolation and/or grounding are to be established; and
2. Proper safety document shall be issued according to type of work with prior approval of NCC and it shall be preserved during the course work and it shall be cancelled after completion of the work.

b) When the working party is considering that safety precautions are required on the Authorized Person's system, the working party shall inform the Authorized Person.

E.9.7 COORDINATION ON POINTS-OF-ISOLATION

a) As per Safety Rules (SR), the choice of the points of isolation shall be defined in a coordinated manner by Kahramaa and the Grid User.

b) Kahramaa's System Control Engineer should be advised if the requesting party and the implementing party are unable to agree on the location of the isolation and (if requested) grounding.

Kahramaa's System Control Engineer should be advised if Kahramaa Field Engineer and Grid User Authorized Person are unable to agree on the location of the isolation and (if requested) grounding.

E.9.8 AUTHORIZATION OF TESTING

a) Testing on electrical equipment shall be performed according to the following procedures:

1. The Sanction-for-Test document is only issued to Kahramaa Authorized Person;
2. All safety documents other than the current safety document have been cancelled in accordance with the procedures set out in SR; and
3. Only one Sanction-for-Test document is issued on an EPS apparatus at a time.

b) The Authorized Person will inform System Control Engineer by notice as soon as the test has been completed or cancelled.

E.10 INFORMATION

Kahramaa shall ensure that the information listed in this code is published at a time and in a format that does not create an actual or potential competitive advantage or disadvantage to any individual party or category of party and taking due account of sensitive commercial information.

E.11 SCHEDULES

E.11.1 SCHEDULE OC-DF: OPERATIONAL DEMAND FORECAST

a) List of Delivery Points for Consumers and for Distribution Systems, voltage, power, time periods, energy;

b) Volume of Demand;

c) Day peak; and

d) Reserve required and reserve policy.

E.11.2 SCHEDULE OC-MS: MAINTENANCE SCHEDULING

a) The identification of Generating Units;

b) Name and function of contact persons;

c) The MW of capacity involved;

d) Where the outage is for statutory or insurance inspection reasons, the reason for the outage and the date by which the work must be completed;

e) The expected duration of the outage, (and the original agreed duration, as shown in the final maintenance schedule, if appropriate) in days and weeks;

f) The preferred start date for the outage; (and the original agreed start date, as shown in the final maintenance schedule, if appropriate); and provisional outage generation submitted; and

g) Where there is a possibility of flexibility in the dates, the earliest start date and the latest finish date.

E.11.3 SCHEDULE OC-OP: OPERATIONAL PLANNING

a) List of Delivery Points for Consumers and for Distribution Systems, voltage, power, time periods, energy;

b) Name and function of contact persons;

c) Forecast fuel availability and costs;

d) Proposed changes to the Demand Forecast;

e) Proposed changes to the maintenance forecast;

f) Environmental and fuel restrictions; and

g) Cost of generation (fixed and variable costs).

E.11.4 SCHEDULE OC-GP: GENERATION PLANNING

a) The identification of the Generating Unit;

b) Name and function of contact persons;

c) Availability Declaration stating the capacity at which the Generating Unit may be operated in any time period (given in a whole number of MW) and the start and finish times for each such time period;

d) For any Generating Unit which has been declared as available and for which any operating characteristic (as listed in PC) has a value which is different from the value of the equivalent registered operating characteristic or has a value which is different from that declared by the Generating Facility operator in its previous Declaration the Generating Facility operator shall give the following:

1. Identification of the operation characteristics;
2. new values of the operating characteristic;
3. the time from when this new value will apply; and
4. the time for which the new value is expected to apply.

e) Any restrictions on operation which may arise from environmental considerations.

F. EMERGENCY AND RESTORATION CODE (ERC)

F.1 OBJECTIVES

The Emergency and Restoration Code (ERC) provides general guidance on the enforcement of operational activities for:

a) Safeguarding the Operational Security of the EPS;

b) Preventing the propagation or deterioration of an Incident;

c) Avoiding a widespread disturbance or a Blackout State; and

d) For allowing an efficient and rapid restoration of the EPS from the Emergency or Blackout States.

F.1.1 SCOPE

With regard to the General Provisions of the Grid Code, the guidance of the ERC is applicable:

a) to Kahramaa as operator of the EPS in particular:

1. to ensure that rules are established to allow independent action by appropriate Authorized Operators to avoid a complete breakdown of the EPS;
2. to establish the procedures to be followed to restore the EPS after an under-frequency Emergency State, partial or total Blackout State; and
3. to set the protection system to avoid cascade tripping.

b) to the following Generating Units and Demand Facilities:

1. existing and new significant Generating Facilities classified as category S and P (SgFs);
2. existing and new significant Demand Facilities (SdFs); and
3. energy storage units of SgF.

c) to Defense Service Providers or Restoration Service Providers according to they have been identified as participants in the Defense Plan, in the Restoration Plan or in a relevant service contract.

F.1.2 RESPONSIBILITIES

a) Kahramaa has the responsibility to implement ERC in operation procedures considering and updating as necessary:

1. "ES-M2 Qatar Power System Restoration Plan" which provides particular guidance to the respective Kahramaa staffs for the restoration of the EPS from Blackout State; and
2. "ES-M3 System Emergency, Categorization, Communication & Restoration Responsibility" which provides particular guidance to Kahramaa staff for categorization of transmission & distribution emergencies, communication protocol used during this period and role of individual responsible for the same for the restoration of the EPS from the Emergency.

b) In Emergency, Blackout and Restoration States, Kahramaa is responsible for:

1. the management of all actions performed on the EPS;
2. the management of communication with Grid Users and with related business parties or administrative entities; and
3. the coordination of the actions with other interconnected TSOs through GCCIA Agreement.

F.1.3 ENTRY CONDITIONS

F.1.3.1 EMERGENCY STATE

The ETN is considered in Emergency State if:

a) there is at least one violation of an Operational Security Limits defined in accordance with subsection A.8 Definitions and Glossary;

b) frequency does not meet the criteria for the Normal State and for the Alert State defined in accordance with subsection A.8 Definitions and Glossary;

c) at least one measure of the Defense Plan is activated; and/or

d) there is a failure in the functioning of tools, means and facilities defined in accordance with F.5.3 resulting in the unavailability of those tools, means and facilities for longer than 30 min.

F.1.3.2 BLACKOUT STATE

The ETN is considered in Blackout State if:

a) a total Blackout occurs, and all Demand Facilities are not anymore powered by the ETN; and/or

b) following a frequency emergency event as per OC (section E) or a partial Blackout and during restoration phase, the EPS is operated outside of frequency and voltage standards.

F.1.3.3 RESTORATION STATE

The ETN is considered in Restoration State, being in the Emergency or Blackout State, Kahramaa has started to activate measures of its Restoration Plan.

F.2 DEFENSE PLAN

F.2.1 DESIGN OF THE DEFENSE PLAN

a) Kahramaa elaborates a Defense Plan in case of frequency fall or cascade tripping and provides guidance to the Kahramaa staffs and to the related Grid Users for its implementation, activation and management.

b) When designing the Defense Plan, Kahramaa takes into account at least the following elements:

1. the Operational Security Limits set out in accordance with OC (section E);
2. the behaviour and capabilities of load and generation within the synchronous area;
3. the specific needs for high priority of certain SGUs and the terms and conditions for their disconnection; and
4. the load shedding priorities defined without any prejudice to particular Demand Facility, Generating Unit, individual or group of Bulk Consumers in best possible way with intention to bring back system to normalcy.

c) The Defense Plan shall contain at least the following provisions:

1. the conditions under which the Defense Plan is activated, in accordance with F.2.2;
2. the Defense Plan Instructions to be issued by the Kahramaa;
3. the measures subject to real-time consultation or coordination with the identified parties;
4. a list of the measures to be implemented by Kahramaa on its installations;
5. a list of the significant Generating Units responsible for implementing on their installations the measures that result from the Grid Code;
6. a list of High Priority SGU and the terms and conditions for their disconnection, and
7. the implementation deadlines for each measure listed in the Defense Plan.

d) SGUs shall follow emergency operations procedures adopted by Kahramaa in the Defense Plan.

F.2.2 ACTIVATION OF THE DEFENSE PLAN

a) The Defense Plan shall include at least the following technical and organizational measures:

1. Protection Schemes for automatic load shedding including at least Under-Frequency Control Scheme, Automatic Over-Frequency Control Scheme, protection schemes against cascade tripping, scheme against voltage collapse; and
2. procedures, including at least frequency deviation management procedure, voltage deviation management procedure, power flow management, assistance for active power procedure, manual demand disconnection procedure.

b) Procedures for activation of the Defense Plan shall specify provisions for communication with SGUs and monitoring.

c) Arrangements for protection schemes shall be made whereby, in an Emergency State, load can be shed in shedding blocks. The load shedding blocks for each individual location shall be allocated, where appropriate considering the impact on the limitation of the frequency fall and on the consequences of priority Demand Facilities.

F.2.2.1 AUTOMATIC-UNDER-FREQUENCY CONTROL SCHEME

a) The scheme for the automatic control of under-frequency of the Defense Plan shall include a scheme for the automatic low frequency demand disconnection and the settings of the Limited Frequency Sensitive Mode Under Frequency (LFSM-U).

b) Kahramaa shall design the scheme for the automatic low frequency demand disconnection in accordance with the parameters for shedding load in real-time laid down in the SOM.

c) The LFSM-U shall be activated prior to the activation of the scheme for the automatic low frequency demand disconnection, where the rate of change of frequency allows it.

d) Prior to the activation of the automatic low frequency demand disconnection scheme, each energy storage units acting as load shall:

1. automatically switch to generation mode within the time limit and at an active power Set-Point established in the Defense Plan; or
2. when the energy storage unit is not capable of switching within the time limit established by Kahramaa in the Defense Plan, automatically disconnect the energy storage unit acting as load.

e) Under-frequency automatic load shedding shall be executed by the operation of under-frequency relays, installed at appropriate points throughout the EPS. The settings of the under-frequency relays and their locations shall be detailed on the appropriate emergency action sheets.

f) The settings on the under-frequency relays shall allow for load shedding in steps at frequencies values defined by Kahramaa.

g) The implementation of the scheme for the automatic low frequency demand disconnection shall:

1. avoid setting an intentional time delay in addition to the operating time of the relays and circuit breakers;
2. minimize the disconnection of Generating Units, especially those providing Inertia; and
3. limit the risk that the scheme leads to power flow deviations and voltage deviations outside Operational Security Limits.

h) The Instructions to be followed to execute manual load shedding shall be determined by Kahramaa; and

i) Kahramaa reserves the right to install automatic protection systems, such as automatic generation shedding, should this be necessary for the safety and stability of the EPS.

F.2.2.2 AUTOMATIC OVER-FREQUENCY CONTROL SCHEME

a) The scheme for automatic over-frequency control of the Defense Plan shall lead to an automatic decrease of the total active power injected in the EPS.

b) Kahramaa shall set out the following parameters of its scheme for automatic over-frequency control:

   1. the frequency thresholds for its activation; and
   2. the reduction ratio of injection of active power.

c) The Automatic Over-Frequency Control Scheme shall take into account the capabilities of the Generating Units concerning the Limited Frequency Sensitive Mode Over Frequency (LFSM-O) and of the energy storage units. If the LFSM-O does not exist or is not sufficient to fulfil the requirements set out in points a) and b), Kahramaa shall set up in addition a stepwise linear disconnection of generation.

F.2.2.3 LOAD SHEDDING FOR VIOLATING GCCIA SECURITY LIMITS

a) Kahramaa shall have automatic or manual load shedding scheme in case of violation of Security Limits on GCCIA interconnectors.

b) Kahramaa shall set out load shed priorities, buffer margins and other relevant settings for load shedding scheme in case of violation of Security Limits on GCCIA interconnectors.

c) Kahramaa shall intimate affected Grid Users in case of violation of Security Limits on GCCIA interconnectors and direct them future course of action.

F.3 RESTORATION PLAN

F.3.1 DESIGN OF THE RESTORATION PLAN

a) Kahramaa elaborates a Restoration Plan to define the policy and to provide guidance to the respective Kahramaa staffs and to the Significant Grid Users (SGU) for restoration from a Blackout State.

b) SGUs shall follow emergency operations procedures adopted by Kahramaa in the Restoration Plan.

c) When designing the Restoration Plan, Kahramaa shall take into account at least the following elements:

1. the behaviour and capabilities of load and generation;
2. the specific needs of the high priority power recovery for SGUs; and
3. the characteristics of the ETN and of the underlying distribution networks.

F.3.2 TECHNICAL AND ORGANIZATIONAL PROVISIONS FOR RESTORATION

a) The Restoration Plan shall contain at least the following technical measures:

1. the conditions under which the Restoration Plan is activated;
2. the Restoration Plan Instructions to be issued by the Kahramaa;
3. the measures subject to real-time consultation or coordination with identified parties;
4. a list of the measures to be implemented by Kahramaa on its installations;
5. a list of the SgFs responsible for implementing on their installations the measures that result from mandatory requirements set out in CC (section C) and OC (section E);
6. the list of high priority SdFs and the terms and conditions for their Re-Energization;
7. a list of Substations which are essential for its Restoration Plan procedures;
8. the number of power sources necessary to Re-Energize the EPS with Bottom-Up Re-Energization Strategy having Black-Start Capability, quick Re-Synchronization capability (through House-Load Operation) and Island Operation capability; and
9. the implementation deadlines for each listed measure.

b) The organizational measures contained in the Restoration Plan shall integrate the following principles:

1. impact on Grid Users shall be minimal;
2. economical effectiveness;
3. only measures that are necessary shall be activated; and
4. the measures shall not lead the EPS into Emergency State or Blackout State.

c) The Restoration Plan shall include at least the following organizational measures:

1. for Re-Energization activities;
2. for Frequency control;
3. for voltage control at substations considered necessary; and
4. for Re-Synchronization activities.

d) Re-Energization procedure:

1. Black-Start:
   i. Certain SgFs are registered under Connection Conditions in the Connection Code as capable of starting without any external electricity supply ("Black-Start Capability").
   ii. In the event of a total or partial Blackout, Black-Start Capable SgFs may be instructed by Kahramaa to perform a Black-Start. In giving this Instruction, Kahramaa may give to the generator such other Instructions as, in its reasonable opinion, are necessary to accomplish a Re-Energization. In such a case, a SgF shall not refuse such Instructions.
   iii. Upon receiving an Instruction to perform a Black-Start, the SgF shall initiate the start-up as soon as possible and shall inform Kahramaa when this has been accomplished. Following such confirmation Kahramaa will endeavour to stabilize the operation of the Generating Unit by the establishment of appropriate loads and the start-up and synchronization of other Generating Units. If during this restoration period any generator experiences difficulties in maintaining the operation of any of its Generating Units within safe operating limits, it shall inform Kahramaa of this fact without delay and Kahramaa will, where possible, take such actions as are necessary to alleviate the problem.
2. The Re-Energization procedure shall contain at least measures for managing voltage and frequency deviations due to Re-Energization.
3. These measures shall include monitoring and managing Island Operation, and re-synchronizing Island Operation areas including priorities for re-establishing the local grid by re-synchronizing available SgFs and energizing restoration path to connect local grid with GCCIA.

e) Frequency policy:

1. The frequency policy of the Restoration Plan shall contain a set of measures aiming at restoring frequency back to the nominal frequency;
2. Kahramaa shall activate these measures:
   i. in preparation of the Re-Synchronization procedure, when the Synchronous Area is split in several asynchronized regions;
   ii. in case of frequency deviation; or
   iii. in case of Re-Energization.
3. The frequency measures shall include at least:
   i. a list of actions regarding the settings of the load-frequency controller;

ii. the establishment of target frequency in case of Bottom-Up Re-Energisation Strategy;

iii. Frequency management after frequency deviation;

iv. Frequency management after area split; and

v. the determination of the amount of load and generation to be reconnected, taking into account the available active power reserves within the synchronized region in order to avoid major frequency deviations.

f) The Re-Synchronization procedure of the Restoration Plan shall include, at least:

1. the appointment of a Re-Synchronization leader;
2. the measures allowing Kahramaa to apply a Re-Synchronization strategy; and
3. the maximum limits for phase angle, frequency and voltage differences for connecting lines.

F.4 MARKET INTERACTIONS

a) Kahramaa may temporarily suspend one or more market activities where:

1. the EPS is in Blackout State; or
2. Kahramaa has exhausted all options provided by the SGUs and the continuation of market activities under the Emergency State would deteriorate one or more of the conditions referred in subsection F.1.3.1; or
3. the continuation of market activities would decrease significantly the effectiveness of the restoration process to the Normal or Alert State; or
4. tools and communication means necessary for Kahramaa to operate market activities are not available.

b) Kahramaa defines the market restoration conditions to determine market suspension time periods.

c) When defining the conditions for suspension and restoration of market, Kahramaa shall:

1. assess the percentage/amount of load that would need to be disconnected to perform an efficient Re-Energization; and
2. develop rules for energy settlement.

F.5 INFORMATION EXCHANGES, COMMUNICATION, TOOLS AND FACILITIES

F.5.1 INFORMATION EXCHANGES

a) In addition to the provisions of subsection E.6.5 Generation planning, when the EPS is in the Emergency, Blackout or Restoration States, Kahramaa is entitled to gather from SGUs and Restoration Service Providers, information about at least the following conditions:

1. the current status of the installation;
2. the Operational Limits;
3. the full activation time and the time to increase generation; and
4. any information which is considered critical for the processes of the SGUs and Restoration Service Providers.

b) In emergency, Blackout or Restoration States, Kahramaa provides, in due time, information about the state of EPS and, where available, additional information explaining the situation:

1. to PWPA holders and to SdFs; and
2. to any other relevant party, as appropriate.

F.5.2 COMMUNICATION

a) Each SgF identified in accordance with F.3.2 and each Restoration Service Provider shall have a voice communication system in place with sufficient equipment redundancy and backup power supply sources to allow the exchange of the information needed for the Restoration Plan for at least 24 hours, in case of total absence of external electrical energy supply or in case of failure of any individual voice communication system equipment.

b) Kahramaa shall establish, in consultation with SdFs and SgFs and with Restoration Service Providers, the technical requirements to be fulfilled by voice communication systems in order to allow their interoperability and to guarantee that the Kahramaa's incoming call can be identified and answered immediately.

c) With regards to paragraph a), SgFs and Restoration Service Providers identified in accordance with F.1.1 that are category D, shall have the possibility to have only a data communication system, instead of a voice communication system, if agreed upon with the Kahramaa. This data communication system shall fulfil the requirements laid down in paragraphs a) and b).

F.5.3 TOOLS, MEANS AND FACILITIES

a) The NCC shall have at least one geographically separate backup control room.

b) The backup control room shall include at least the critical functions of tools and facilities referred to in chapter OC-5.9 "Availability of means, tools and facilities".

c) Kahramaa shall arrange a backup power supply for its backup control room for at least 24 hours in case of loss of primary power supply.

d) Kahramaa shall prepare a transfer procedure for moving functions from the main control room to the backup control room as quickly as possible, and in any case in a maximum time of three hours. The procedure shall include the operation of the system during the transfer.

e) Substations identified as essential for the Restoration Plan procedures pursuant to F.1.1 shall be operational in case of loss of primary power supply for at least 24 hours.

F.6 COMPLIANCE AND REVIEW

F.6.1 COMPLIANCE TESTING OF CAPABILITIES

F.6.1.1 TESTING CONDITIONS

a) Kahramaa shall periodically assess the proper functioning of all equipment and capabilities considered in the Defense Plan and the Restoration Plan. To this end, Kahramaa shall prepare a test plan to periodically verify the Grid Code compliance of such equipment and capabilities.

b) The test plan shall include the periodicity and conditions of the tests, following the minimum requirements outlined in RGCC chapters "Black-Start", "trip to House-Load, Islanding" and "Communication".

c) Each SgF, SdF and Restoration Service Provider shall not endanger the Operational Security of the EPS and of the interconnected GCCIA power systems during the test. The test shall be conducted in a way that minimizes the impact on Grid Users.

d) The test is deemed to be successful when it fulfils the conditions established by Kahramaa. As long as a test fails to fulfil these criteria, SgF, SdF and Restoration Service Provider shall repeat the test.

F.6.1.2 COMPLIANCE TESTING FOR BLACK-START AND TRIP TO HOUSE-LOAD

a) Each Restoration Service Provider which is a Generating Unit delivering Black-Start service shall execute a Black-Start Capability test, at least every three years, following the methodology laid down in RGCC (section D).

b) Each Restoration Service Provider which is a Generating Unit delivering a quick Re-Synchronization service shall execute tripping to House-Load test after any changes of equipment having an impact on its House-Load Operation capability, or after two unsuccessful consecutive tripping in real operation, following the testing methodology laid down in RGCC (section D).

F.6.2 COMPLIANCE TESTING AND REVIEW OF DEFENSE PLAN AND RESTORATION PLAN

F.6.2.1 COMPLIANCE TESTING AND PERIODIC REVIEW OF THE DEFENSE PLAN

a) Each SdF concerned by the implementation of the low frequency demand disconnection on its installations shall update once a year the communication to the notifying system operator provided for in F.2.2. This communication shall include the frequency settings at which Netted Demand disconnection is initiated and the percentage of Netted Demand disconnected at every such setting.

b) Kahramaa shall monitor the proper implementation of the low frequency demand disconnection on the basis of the yearly written communication referred to in paragraph a).

c) Kahramaa shall review, at least every five years, its complete Defense Plan to assess its effectiveness. Kahramaa shall in this review take into account at least:

1. the development and evolution of the ETN since the last review or first design;
2. the capabilities of new equipment installed on the EPS and Distribution Systems since the last review or first design;
3. the SgFs commissioned since the last review or first design, their capabilities and relevant services offered;
4. the tests carried out and the analysis of EPS Incidents; and
5. the operational data collected during normal operation and after disturbance.

F.6.2.2 COMPLIANCE TESTING AND PERIODIC REVIEW OF THE RESTORATION PLAN

Kahramaa shall review the measures of its Restoration Plan using computer simulation tests, using data from the SdFs identified in F.1.1 and the Restoration Service Providers, at least every five years. Kahramaa shall define these simulation tests in a dedicated testing procedure covering at least:

a) the energizing restoration path from Restoration Service Providers with Black-Start or Island Operation Capabilities;

b) the supply of Generating Unit main auxiliaries;

c) the demand reconnection process; and

d) the process for Re-Synchronization of networks in Island Operation.

F.7 IMPLEMENTATION

All relevant clauses in contracts and general terms and conditions of SgFs and SdFs relating to participation to Defense and Restoration Plans shall comply with the guidance of this code. To that effect, concerned contracts and general terms and conditions shall be modified accordingly.